中国海水富营养化业务化监测
Marine Eutrophication operational monitoring in China

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www.nmecmc.org.cn
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3. Assessment method
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Introduction

Who we are

National Marine Environmental Monitoring Centre (NMEMC) as well as the Institute of Marine Environmental Protection of State Oceanic Administration (SOA) of China was established in 1959.

As the national operation center directly under the SOA, Undertakes the tasks of organizing for marine environmental monitoring and sea use monitoring and surveillance in China.
Introduction

What we do

1. Developing annual program of national marine environmental monitoring
2. Developing monitoring technology and making it operational
3. Establishing the assessment criteria for marine environmental quality, making quality control and assurance
4. Managing national marine environment monitoring data and processing information products
5. Implementing technical training, technique instructing and supporting on monitoring skills for national monitoring system, etc.
Introduction

What we do

Provide annual Bulletin of Marine Environmental Status of China.

Since 2000-2016, ........

Eutrophication Assessment (2011-2016)
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Operational monitoring system in China

- Since 2011, Eutrophication assessment as an official operational work has been implemented.

- 2010, “Coastal Eutrophication Status assessment guide” has passed the expert review by SOA.

- 2015, “Technical regulation for evaluation of seawater quality condition” (Trial version) has been defined and implemented. And the evaluation software was developed and applied.
Operational monitoring system in China

- Monitoring Spatial scope
  - nearshore
  - offshore

- Trend sample stations (1941)
Operational monitoring system in China

Eutrophication Assessment process

Data processing

1. Data report and collation
2. Multi-layer average of each voyage data
3. Data verification

Seawater quality assessment

1. Single factor spatial interpolation (N, P, COD...)
2. Multiple-factor spatial interpolation (Spatial overlay)
3. Eutrophication index model

Statistics & cartography

1. The spatial distribution of eutrophication index
2. Assessment conclusion (Evaluation grade)
Eutrophication Automatic Assessment Process

Data online transmission system

Data receiving system

Assessment and production system

National Marine environment monitoring operational management system
Operational monitoring system in China

- Some coastal provinces also follow the Technical regulation. Such as...
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Assessment method

Single index method

- **Physical parameter method**: Water color, transparency, illumination, radiation quantity, etc.
- **Chemical parameter method**: DO, CO₂, N, P, COD, etc.
- **Biological parameter method**: Chla, $H'$ (Diversity index), AGP (Algae growth potential), etc.
Assessment method

Comprehensive index method

- Nutrient quality index:  
  \[ NQI = \frac{COD}{CODs+TN/TNs+TP/TPs+Chla/Chlas} \]
- Ratio method:  
  \[ \frac{COD \times DIN \times DIP}{4500 \times 10^6} \]  
  (Okaichi Woori, 邹景忠等)
- Dissolved oxygen saturation method:  
  \[ D = \left( (Xs)^2 + (Xb)^2 \right)^{1/2} \]  
  (Justic etc.)
- Normal distribution method:  
  The data of N and P are normalized so that the data becomes normal distribution, and \( \mu \) and \( \sigma \) are determined  
  （Ignatiades L.et al.1992）
- Fuzzy evaluation method based on fuzzy theory  
  （彭云辉 等，1991）
Assessment method

Based on Pressure-state-response

Assessment of Estuarine Trophic Status, ASSETS

National Estuarine Eutrophication Assessment, NEEA
Assessment method

Definition

- The concentration of nitrogen and phosphate in seawater exceeds the normal level.—“Technical specification for evaluation of seawater quality condition” (Trial version)

- The increase of organic matter supply rate in ecosystem (Nixon, 1995)
- The process of changing the nutritional status of specific water by increasing the supply of inorganic nutrients (Jorgensen & Richardson, 1996)
- “Due to the enrichment of nutrient in water, algae or other higher plants accelerate appreciation, the balance of organisms in water and water quality cause unnecessary interference, especially refers to the human activities lead to the adverse impact of the nutrient enrichment” (OSPAR Convention & Nitrate Directive, 1991 & Urban Water-Water Treatment Directive, EU)

Assessment method

Interpolation

Overlay maps to the space grid

Evaluation grid layer

Evaluation Results

Eutrophicat ion index method

N
P
COD
Assessment method

Delaunay Triangulation
Assessment method

Seawater spatial Interpolation model

Why use IDW interpolation algorithm?

- Fast speed, calculation time is short
- The interpolation is smooth and will not exceed the maximum and minimum values
- Overall practicability

Spatial interpolation based on IDW model:
The interpolation method is used to assign values to the grid of the evaluation region

$$Z(E) = \sum_{i=1}^{n} Z(X_i) \lambda_i \quad \cdots \quad (1)$$

$$\lambda_i = \frac{1}{d_i^4} \left/ \sum_{i=1}^{n} \frac{1}{d_i^4} \right. \quad \cdots \quad (2)$$
Seawater Eutrophication Assessment

Eutrophication Index

The comprehensive index method was used in the operational assessment of seawater eutrophication:

\[ E = \left( \frac{C_{\text{COD}} \times C_{\text{DIN}} \times C_{\text{DIP}} \times 10^6}{4500} \right) \]

- \( E \) —— Eutrophication index;
- \( C_{\text{COD}} \) —— Chemical oxygen demand concentration, Unit: mg/L;
- \( C_{\text{DIN}} \) —— Inorganic nitrogen concentration, include the concentration of Nitrite nitrogen \((NO_2-N)\), Nitrate nitrogen \((NO_3-N)\) and Ammonia nitrogen \((NH_4-N)\), Unit: mg/L;
- \( C_{\text{DIP}} \) —— Active phosphate concentration, Unit: mg/L

- The decision principle of eutrophication level follows the table.

<table>
<thead>
<tr>
<th>Eutrophication Level</th>
<th>Decision Principle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slightly</td>
<td>( 1 &lt; E \leq 3 )</td>
</tr>
<tr>
<td>Medium</td>
<td>( 3 &lt; E \leq 9 )</td>
</tr>
<tr>
<td>Heavily</td>
<td>( E &gt; 9 )</td>
</tr>
</tbody>
</table>
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Status

Spring (71,560 km²) Summer (70,340 km²)

2016
Trends

- 97,890 km²
- Slightly, Medium, Heavily


- Bohai Sea, Yellow Sea, East China Sea, South China Sea

- Slightly, Medium, Heavily


- 97,890 km²

- Slightly, Medium, Heavily


2015
Correlation

Eutrophication

N

P

COD

2016
Correlation

EUTROPHICATION

HAB
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# Problems and suggestions

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Multiyear continuous monitoring</td>
<td>• Based on seawater function, not enough to consider the health of offshore ecosystem</td>
</tr>
<tr>
<td>• Seasonal monitoring per year</td>
<td>• The standard of eutrophication grade not enough to consider the difference of ecological environment</td>
</tr>
<tr>
<td>• Assessment method is simple, Less monitoring indicators, Easy to popularize</td>
<td></td>
</tr>
</tbody>
</table>
Suggestions

• **Nutrient** structure and its changes should be considered

• **Assessing** the comprehensive impact of eutrophication based on pressure-state-response model

• **Establish** eutrophication level scientifically

• **Keeping** up with the international advanced assessment method.

• **New** technologies will be applied, such as satellite inversion of chlorophyll data….
Suggestions

“Guideline for assessing status and trends of marine environmental quality”
Part 1: Sea water quality assessment (Unpublished)

Water quality
✓ N
✓ P
✓ COD

Eutrophication Assessment model

Ecological response
✓ primary productivity responses
✓ secondary responses (HAB, DO)

Suggested by Dr. Zhiming Yu & Dr. Zaixing Wu (Institute of Oceanology, Chinese Academy of Sciences)