Identification of eutrophic zones in the NOWPAP sea areas of China based on the Screening Procedure

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- Reviews of assessment methodology
- Assessment in the NOWPAP sea areas of China
- Major Problems in the assessment
- Suggestions
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● Reviews of assessment methodology

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● Major Problems in the assessment

● Suggestions
Assessment Method

Several methods based on PSR principle: NEEA/ASSETS (USA), OSPAR (EU)

The NOWPAP Common Procedure:
- Screening Procedure
- Comprehensive Procedure

According to CEARAC working scheme, we now focus on the identification of eutrophic zones through the Screening Procedure.
Screening procedure

According to the methodology of screening procedure, the three parameters will be detected for potential eutrophication assessment:

- COD/TOC
- HABs (red tide)/hypoxia
- Chl.a

When two of them show symptoms of eutrophication, the area will be detected as potential eutrophic zone.
Assessment criteria of eutrophication symptoms

- **COD/TOC:** Annual mean trend analysis. Increasing trend (by Mann-Kendall) will be regarded as symptom of eutrophication;

- **HABs/hypoxia:** One or more events of HABs (Diatom and flagellate sp.) or hypoxia recorded in the last 3 years.

- **Chl. $\alpha$:** Mean satellite Chl.$\alpha$ in the last 3 years exceeds 5 $\mu$g/L and an increasing/no trend of annual mean satellite Chl.$\alpha$. 
<table>
<thead>
<tr>
<th>Identification of eutrophic zones</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Eutrophic area</strong></td>
</tr>
<tr>
<td><strong>Potential eutrophic area</strong></td>
</tr>
<tr>
<td><strong>Non eutrophic area</strong></td>
</tr>
<tr>
<td><strong>Improved area</strong></td>
</tr>
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Assessment of NOWPAP area in China

- East coast of Liaodong Peninsula and North coast of Shandong Peninsula which belong to North Yellow Sea

- South coast of Shandong Peninsula and Jiangsu coast which belong to South Yellow Sea
Characteristics of this area

- Most density population area - more than 400 people/ km²
- High pressure of nutrient input from land sources (Riverine and Sewage Treatment Plant), such like Jiaozhou Bay, Sishili Bay, etc. (Gao et al., 2011; Sun et al., 2011)
- Eutrophic zones have been addressed by governmental bulletin of marine environment (SOA, 2014)

Eutrophic status by nutrient index method (SOA, 2014)
The typical coastal areas for screening procedure

<table>
<thead>
<tr>
<th>Region</th>
<th>Coastal areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>East coast of Liaodong Peninsula</td>
<td>Dalian Bay</td>
</tr>
<tr>
<td>North coast of Shandong Peninsula</td>
<td>Sishili Bay</td>
</tr>
<tr>
<td>South coast of Shandong Peninsula</td>
<td>Rushan coast, Jiaozhou Bay, Qingdao coast, Haizhou Bay</td>
</tr>
</tbody>
</table>
Collection of assessment data

- 8 years of COD data (2005-2012, spring, summer and autumn data) was collected from the CNEMC (Environmental Monitoring Center of China)

- The occurrences of HAB events (2009-2014) were collected from published national/regional reports.

- The occurrences of hypoxia were collected from literatures.

- Chl a was from satellite analysis and provided by CEARAC.
Assessment of parameters — COD

- Only one site, Sishili Bay, showed increasing trends in annual COD, with positive S statistics in Mann-Kendall test.

- Others showed no trends or decreasing trends in annual COD, with negative S statistics in Mann-Kendall test. No symptoms of eutrophication according to the criteria of COD.
Dalian Bay, Sishili Bay, Qingdao coast and Haizhou Bay were recorded one or more HAB events (diatom sp. and flagellate sp.) in the last 3 years (2013-2015) and regarded as areas with symptom of eutrophication according to the assessment criteria.
A high and increasing trend of Chl-a detected in Dalian Bay by satellite.

5 mg m\(^{-3}\) against three years mean (2013 to 2015)

Pixel wise trend in annual maximum From 1998 to 2015
## Assessment results

<table>
<thead>
<tr>
<th>coast/bay</th>
<th>COD trend</th>
<th>Eutrophic symptom</th>
<th>HABs/hypoxia in last 3 years</th>
<th>Eutrophic symptom</th>
<th>Satellite Chla</th>
<th>Eutrophic symptom</th>
<th>Final eutrophic status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dalian Bay</td>
<td>No trend</td>
<td>Not</td>
<td>8 red tide incidents</td>
<td>Yes</td>
<td>High and increasing</td>
<td>Yes</td>
<td>Potential eutrophic</td>
</tr>
<tr>
<td>Sishili Bay</td>
<td>Increasing</td>
<td>Yes</td>
<td>4 red tide incidents</td>
<td>Yes</td>
<td>Low and increasing</td>
<td>Not</td>
<td>Potential eutrophic</td>
</tr>
<tr>
<td>Rushan coast</td>
<td>No trend</td>
<td>Not</td>
<td>No incident</td>
<td>Not</td>
<td>Low and No trend</td>
<td>Not</td>
<td>Non eutrophic</td>
</tr>
<tr>
<td>Jiaozhou Bay</td>
<td>No trend</td>
<td>Not</td>
<td>No incident</td>
<td>Not</td>
<td>Low and No trend</td>
<td>Not</td>
<td>Non eutrophic</td>
</tr>
<tr>
<td>Qingdao coast</td>
<td>No trend</td>
<td>Not</td>
<td>2 red tide incidents</td>
<td>Yes</td>
<td>No data available</td>
<td>–</td>
<td>Non eutrophic</td>
</tr>
<tr>
<td>Haizhou Bay</td>
<td>No trend</td>
<td>Not</td>
<td>4 red tide incidents</td>
<td>Yes</td>
<td>High and decreasing</td>
<td>Not</td>
<td>Non eutrophic</td>
</tr>
</tbody>
</table>
Dalian Bay and Sishili Bay are identified as “potential eutrophic” bays which are consistent with the Government report (SOA, 2014), and others are no “eutrophic areas” identified.
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There is a difference between assessment and real status.
## Assessment parameters in screening procedure

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<tr>
<th>PSR Category</th>
<th>ASSETS</th>
<th>OSPAR</th>
<th>Screening Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pressure: nutrient enrichment</strong></td>
<td>Nutrient inputs (DIN, DIP)</td>
<td>Nutrient inputs (DIN, DIP)</td>
<td>No nutrients COD, instead</td>
</tr>
<tr>
<td><strong>Status (major)</strong></td>
<td>Direct effects</td>
<td>Chl-α, Phytoplankton species etc</td>
<td>Chl-α/COD</td>
</tr>
<tr>
<td>Indirect effects</td>
<td>DO, HAB events; Submerged aquatic vegetation etc</td>
<td>DO; HAB events, Fish kills; Organic carbon/Organic matter etc</td>
<td>HAB events and DO</td>
</tr>
<tr>
<td>Response</td>
<td>√</td>
<td>√</td>
<td>neglected</td>
</tr>
</tbody>
</table>
Assessment parameters don’t include nutrients in screening procedure, instead, COD is one of the four major parameters.

Nutrients are “pressure” and “cause” of eutrophication, and cannot be neglected.

COD have no correlation with nutrients and cannot replace nutrients.
Criteria of parameters should be considered besides trend analysis.

**e.g. COD:** Annual mean trend analysis. Increasing trend (by Mann-Kendall) will be regarded as symptom of eutrophication.

Both COD of Rushan and Qingdao coasts showed no trend and no symptom of eutrophication, however, the concentration in Rushan coast (2 mg/L) is one time higher than that of the Qingdao coast (1 mg/L). Apparently their degree of eutrophic status should not be the same.
Criteria of Hypoxia

• The criteria of hypoxia in this screening procedure should be specified. For example, the hypoxia refers to >0, but ≤2 mg/L in the ASSETS methodology in the USA.

• No specification of criteria of hypoxia may also impact the result of assessment, since all DO concentration lower than 5 mg/L could be regarded and called as low oxygen event in current literatures.
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Nutrients should be included in screening procedure.

Chl.a data from satellite should be corrected through field samples.

Harmonized and universal reference or criteria of parameters should be recommended and specified in order to compare each other in different areas.

A second assessment (comprehensive) should be implemented in the future.

Targeted studying area should be further selected according to data available.
Thank You!