History of Total Pollution Load Control and Possible Future Coastal Management in Japan

Dr. Osamu Matsuda,
International EMECS Center
(Professor Emeritus, Hiroshima University)

St Petersburg, Russia, 26 August 2016
Outline of Topics

1. Increasing eutrophication
2. Introduction to TPLC system in Japan
3. Necessary change of management from passive conservation to active conservation
4. Approaches for holistic management
5. Possible future coastal management
Increasing Eutrophication in the World Coastal Areas
Classification based on the Common Procedures (NOWPAP CEARAC, 2009)

Reddish: high level of eutrophication
Bluish: less eutrophic
From Google Earth

Geography

Russia

China

Korea

Japan

Yellow Sea

Pacific Ocean

Giant jelly fish

Green tides

Hypoxia

Courtesy by Dr. G. Terauchi
# Common parameters and their tentative assessment results in selected areas

<table>
<thead>
<tr>
<th>Nation</th>
<th>Selected area</th>
<th>Sub-area</th>
<th>Eutrophication assessment results of common parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>DIN conc.</td>
<td>DIP conc.</td>
</tr>
<tr>
<td>China</td>
<td>Changjiang/Yangtze River estuary and adjacent sea</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>HI</td>
<td>LI</td>
</tr>
<tr>
<td>Japan</td>
<td>Northwest Kyushu sea area</td>
<td>A:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hakata Bay</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>HI</td>
<td>LN</td>
</tr>
<tr>
<td></td>
<td>B: Dokai Bay and Kanmon Strait</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>C: Intermediate area</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>LN</td>
<td>LD</td>
</tr>
<tr>
<td></td>
<td>D: Offshore area</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Toyama Bay</td>
<td>A: Coastal area</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>LN</td>
<td>LN</td>
</tr>
<tr>
<td></td>
<td>B: Intermediate area</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>LN</td>
<td>LN</td>
</tr>
<tr>
<td></td>
<td>C: Offshore area</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>LN</td>
<td>LN</td>
</tr>
<tr>
<td>Korea</td>
<td>Jinhae Bay</td>
<td>A:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Jinhae Bay</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>LD</td>
<td>LD</td>
</tr>
<tr>
<td></td>
<td>B: Masan-Haengum Bay</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>LD</td>
<td>LD</td>
</tr>
<tr>
<td>Russia</td>
<td>Peter the Great Bay</td>
<td>A:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Amursky Bay</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>HI</td>
<td>HI</td>
</tr>
<tr>
<td></td>
<td>B: Ussuriisky Bay</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>LN</td>
<td>LN</td>
</tr>
<tr>
<td></td>
<td>C: Southern part of the Peter the Great Bay</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>LN</td>
<td>LN</td>
</tr>
</tbody>
</table>

*Parameter identification of the winter DIN/DIP ratio was not used for category identification, because winter DIN concentration and winter DIP concentration were lower than reference concentrations.*

**Parameters:**
- DIN
- DIP
- DIN/DIP ratio
- Max Chl.a
- Mean Chl.a
- DO

*(NOWPAP CEARAC)*
Result of preliminary eutrophication assessment by satellite derived Chl–a

NOWPAP
CEARAC (UNEP)
Coastal water is facing to 4 interfaces:

1. Land
2. Sea bottom
3. Offshore water
4. Atmosphere
Effects of sea bottom, offshore water and atmosphere are very difficult to control or uncontrollable. While, effect from land is controllable to some extent. This is the base of TPLC.
Once, sea grass was harvested and used as natural fertilizer for agriculture in Japan (photo taken about 60 years ago)
# Outline of the Environmental Management System for Coastal Seas in Japan

## Type of Coastal Sea Areas

- **Enclosed Coastal Seas** (88 Coastal Sea Areas)
  - Seto Inland Sea
  - Tokyo Bay
  - Ise Bay
  - The Others

## Effluent Standards

<table>
<thead>
<tr>
<th>Human Health Items</th>
<th>Seto Inland Sea</th>
<th>Tokyo Bay</th>
<th>Ise Bay</th>
<th>The Others</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Living Environment Items</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>COD&lt;sub&gt;Mn&lt;/sub&gt;, SS etc.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>TN, TP</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>—</td>
</tr>
</tbody>
</table>

## Total Pollutant Load Control (TPLC)

<table>
<thead>
<tr>
<th></th>
<th>Seto Inland Sea</th>
<th>Tokyo Bay</th>
<th>Ise Bay</th>
<th>The Others</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulation for the construction of facilities</td>
<td>permission</td>
<td>notification</td>
<td>notification</td>
<td>notification</td>
<td></td>
</tr>
</tbody>
</table>

*(Ministry of the Environment)*
TPLC designated 3 areas in Japan including watershed.

Seto Inland Sea
- Hyogo
- Kyoto
- Okayama
- Osaka
- Nara
- Wakayama
- Hiroshima
- Yamaguchi
- Fukuoka
- Oita

Kyoto
Osaka
Nara
Wakayama
Hyougo
Hiroshima
Yamaguchi
Fukuoka
Oita

note
- Boundary of the Prefecture
- Boundary of TPLCS Area

Ministry of the Environment
Tokyo Bay area around the capital

Highly populated metropolitan area

Ise Bay area around Nagoya

Ise Shrine
Ise spiny lobster

CBD-COP10 was held in Nagoya in 2010
Seto Inland Sea area
(Osaka Bay and Hiroshima Bay are located)

Area: 23,203 km²
East-West: 450 km
North-South: 15~55 km
Coastline: 7,230 km
Mean Depth: 38.0 m
Islands: ca. 700

The largest enclosed coastal sea and one of the first national parks in Japan
Effect of TPLC (Trend of Pollutant Load: 1979-2009)

Total Nitrogen

COD

Total Phosphorus

(Ministry of the Environment)
Relation between TN load and water quality (TN) during FY 1979–2013

In general, water quality level has been improved by TPLC
Relation between TP load and water quality (TP) during FY1979–2013

In general, water quality level has been improving with TPLC.
Achievement rate (%) of environmental standard (TN, TP) is very high in the Seto Inland Sea except Osaka Bay.

TN and TP conc. in sea water are almost satisfied with official environmental standard in the Seto Inland Sea except Osaka Bay.

出典）平成25年度公共用水域水質測定結果（環境省）
Change of water quality (TN) in Osaka Bay

Average of FY1982–1984

Comparison of TN concentration in sea water (Osaka Bay)

Average of FY2009–2012

出典）昭和57～59年度は「広域総合水質調査（環境省）」、平成21～24年度は「広域総合水質調査（環境省）」及び「公共用水域水質測定結果（環境省）」より作成
Change of water quality (TP) in Osaka Bay

Average of FY1982–1984
Comparison of TP concentration in sea water (Osaka Bay)

Average of FY2009–2012

出典) 昭和57～59年度は「広域総合水質調査（環境省）」、平成21～24年度は「広域総合水質調査（環境省）」及び「公共用水域水質測定結果（環境省）」より作成
Simplified results of TPLC (TN and TP) and water quality

<table>
<thead>
<tr>
<th>Pollutant Load</th>
<th>Water Quality</th>
<th>Env. STD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tokyo Bay</td>
<td>decreased</td>
<td>improved</td>
</tr>
<tr>
<td>Ise Bay</td>
<td>decreased</td>
<td>improved</td>
</tr>
<tr>
<td>Seto I. Sea</td>
<td>decreased</td>
<td>improved</td>
</tr>
</tbody>
</table>

Present status: further reduction is necessary in Tokyo Bay and Ise Bay, but not necessary in the Seto Inland Sea. The Seto Inland Sea is now entering into new post-TPLC age.

“The special law” (Seto Inland Sea Law) and associated governmental basic plan were revised in 2015.
Water quality has been improved. However, ----

Land reclamation continued although it was restricted to some extent by “the special law”.

No natural coastline and shallow area at all in Osaka Bay
Artificial coastline at inner Hiroshima Bay
What does the loss of shallow area mean?

- Functions of shallow area were lost. (e.g. spawning ground, nursery ground, habitat, production, decomposition, tidal movement)
- Reproduction processes of living resources were seriously damaged.
- Damaged material cycling affected environmental conditions seriously.
Eutrophic Seto Inland Sea

Distribution of chlorophyll a concentration in the surface of the Seto Inland Sea.

High chl. a indicates high primary productivity.

(Oct 14, 2004)
Relationship between primary production (X) and fisheries yield (Y) in various world waters

★: Seto Inland Sea

(Nixon 1986+Tada)

Fig. 1. Fisheries yield (FY) per unit area as a function of primary production (PP) per unit area in a variety of estuarine and marine systems compared with the regression obtained by Oglesby (1977) for large lakes. Regression line for the marine systems is ln FY = 1.55 ln PP − 4.49. A summary of regressions relating gross plankton production from O₂ changes to fish harvest from various intensively managed ponds is given by Liang et al. (1981). The fisheries landings have been converted to carbon assuming C is 10% of fresh weight (Gulland 1970). Data sources for marine systems given by Nixon (1982) and Nixon et al. (1986b).
Fisheries production in the Seto Inland Sea

Total production (2012): ca. 380,000 ton
(fish catch: ca. 170,000 ton, aquaculture: ca. 210,000 ton)
Major aquaculture: oyster 65%, laver 21%

(SECA, 2015)
Biodiversity of the Seto Inland Sea also decreased

No systematic data are available.

800 sp. of flora and 3400 sp. of fauna

1. From mid 1960s
   Rapid decrease of species number and population of shore animals.
   Decrease of biodiversity and biological productivity.
   Deterioration of habitat condition.

2. From mid 1990s
   Species number is a little increasing but still far below the level of 1960s.
   (Yuasa)
Production of sea sand (m3) by sea sand mining in the Seto Inland Sea
Marine litter

Legal treatment in 2009 on shore litter
New management needs holistic approaches
“From clean water to bountiful sea”
What characterize Satoumi?

5 important elements of Satoumi:

3 objectives to be improved or restored

and

2 indicators on activities

(Sato-Umi net, MOE)
CBD - COP10: 10th Meeting of the Conference of the Parties of the Convention

Life in harmony, into the future

COP10/MOP5
AICHI - NAGOYA JAPAN 2010
Oct. 11-29
Informal meeting on Sustainable Ocean Initiative (SOI) on Oct. 24, 2010

Satoumi related event on Oct. 19, 2010

Satoumi related event on Oct. 19, 2010
Creating connections between *Satoyama* and *Satoumi* in management

- *Satoumi* is based on an understanding of the connections between the land and the sea.
- Thus, activities undertaken through *Satoyama* affect *Satoumi* areas further downstream.
- Understanding these intricate connections, and coordinating management approaches is important for the success of *Satoumi*.

Marjo Vierros, CBD specialist (2010)

This volume contains 10 case studies of Satoumi in Japan from Hokkaido to Okinawa.
Satoyama–Satoumi Ecosystem and Human Well-Being

Results of Satoyama–Satoumi Sub-global assessment in Japan
J–SGA

(United Nations University Press, 2012)
Numbers of dams constructed in rivers flowing into the Seto Inland reached to ca 600 (J-SGA)
Location of dams constructed in the watershed of the Seto Inland Sea (J-SGA)
Inter-linkage between environmental changes and ecosystem services in the Seto Inland Sea (J–SGA)

Driver (Economical Development or Life Style)
- Urbanization
- Industrialization
- Modernized Agriculture
- Disaster Control

Pressure to Environment
- Pollutant Load
- Land Use Transformation
- River Construction
- Coastal Construction

Effects
- Water Pollution
- Eutrophication
- Biodiversity Loss
- Habitat Loss

Effects on Ecosystem Services
- Food Supply Service
- Regulatory Service
- Cultural Service

Bountiful sea provides well-balanced ecosystem services (J–SGA)
“Bay Renaissance Project” (Multi-sectoral approach)

Improvement of enclosed coastal seas by collaboration of central government, local governments and related Organizations (MLIT)

Hiroshima Bay R. P.
2006.3 広島湾再生推進会議設置
中国地方整備局、第六管区海上保安本部、
中国四国農政局、近畿中国森林管理局、
中国経済産業局、中国四国地方環境事務所、
広島県、山口県、広島市
2007.3 「広島湾再生行動計画」策定

Osaka Bay R. P.
2003.7 大阪湾再生推進会議設置
内閣官房都市再生本部事務局、近畿地方整備局、
第五管区海上保安本部、近畿農政局、林野庁、水産庁、
近畿経済産業局、環境省、滋賀県、京都府、大阪府、
兵庫県、奈良県、和歌山県、京都市、大阪市、神戸市、
（財）大阪湾ベイエリア開発推進機構
2004.3 「大阪湾再生行動計画」策定
2004.4～ 行動計画に基づく取り組みを実施

Ise Bay R. P.
2006.2 伊勢湾再生推進会議設置
中部地方整備局、第四管区海上保安本部、
東海農政局、林野庁、中部地方環境事務所、
岐阜県、愛知県、三重県、長野県、名古屋市、
名古屋港管理組合、四日市港管理組合
2007.3 「伊勢湾再生行動計画」策定

※他の海域においても順次展開予定（図：MILT）
“Health Examination” of the Sea in brief
( A tool for holistic approach )

The frame is quite similar to that of ICM, ICARM, LOICZ, Satoumi and “Healthy Plan”.

Major view points:

(1) Stability of ecosystem
(2) Smoothness of material circulation

Method has been developed by OPRF(OPRI)
Structure of the coastal ecosystem and material circulation

Major view points:
(1) Stability of ecosystem
(2) Smoothness of material circulation
Flow chart of the "Health Examination"

Examination (2 stages)

Preliminary (simple & easy)
- Inspection: check of the health condition
- Diagnostic

Advanced (specialized)
- Inspection: find out causes
- Diagnostic

Health care

Elimination of anxiety

Medical treatment
Items for the “Health Examination” (1)

The extent of ecosystem stability

1. Species composition
   - Fish catch and the composition
   - Benthos distribution

2. Habitat space
   - Area of tidal flats and sea grass beds
   - Percentage of the artificial beach

3. Environment
   - Harmful substances
   - DO concentration in the bottom layer

Make use of available published data at stage 1
Items of the “Health Examination” (2)

The smoothness of material circulation

4. Load and Water exchange
   - Load amount
   - Residence time
   - Tidal amplitude

5. Primary production
   - Transparency
   - Red tide occurrence

6. Decomposition / Sedimentation
   - Benthic environment
   - DO concentration in the bottom layer

7. Removal
   - Demersal fish and shellfish

Make use of available published data at stage 1
Example of indicator and criteria: species composition

Item for the “Health Examination” (1)

The extent of ecosystem stability

Species composition

Fish catch and the composition

Indicator:
Change of the ratio of dominant group (F) = Mean of recent 3 years / Mean of past 20 years

Criteria and Classification:
0.8 < F < 1.2, and also steady or increasing for recent 3 years: Class A
0.8 < F < 1.2, and also decreasing for recent 3 years: Class B
F < 0.8, or 1.2 < F: Class C
A: healthy, B: warning (need inspection), C: unhealthy (deteriorated)
Result of the preliminary examination on Hakata Bay as an example

<table>
<thead>
<tr>
<th>視点</th>
<th>検索項目</th>
<th>検査基準</th>
<th>検査結果</th>
<th>診断</th>
</tr>
</thead>
<tbody>
<tr>
<td>生物組織</td>
<td>最高点複数群的波高量比F (過去3年間の平均/過去の平均)</td>
<td>0.8F&lt;1.2 かつ 最近3年間増多はみては標高傾向</td>
<td>0.82F または 1.2F</td>
<td>F= (0.68)</td>
</tr>
<tr>
<td></td>
<td>現在存在生物的出現状態比L (代表種の確率基準/代表種頭数)</td>
<td>0.7&gt;L</td>
<td>0.4&lt;L&lt;0.7</td>
<td>0.42L</td>
</tr>
<tr>
<td>生活空間</td>
<td>千波・強度複数比KXL (過去の平均値/過去の平均面積)</td>
<td>0.8K かつ 0.8L</td>
<td>0.8K かつ 0.8L または 0.8L かつ 0.8S</td>
<td>K= (0.88), 0.89</td>
</tr>
<tr>
<td></td>
<td>最新の人工構造の合計M (％)</td>
<td>20M</td>
<td>20M &lt; 50</td>
<td>50M</td>
</tr>
<tr>
<td>生活環境</td>
<td>息の物質分析配布の比P (過去の最大値/過去の基準値)</td>
<td>0.8</td>
<td>0.8≥P&lt;1</td>
<td>1≥P</td>
</tr>
<tr>
<td>魚類・動物の出現状態G (魚類・動物確認地点数/全確認地点数)</td>
<td>G≥0.5 かつ 最近3年間減少もしくは漸近傾向</td>
<td>G≥0.5 かつ 最近3年間増加傾向</td>
<td>0.6≥G</td>
<td>G= (0.25)</td>
</tr>
<tr>
<td>樹木被害</td>
<td>地形の定数D (過去20年間の平均/過去3年間の平均)</td>
<td>D≥20 かつ 最近3年間減退傾向</td>
<td>D≥20 かつ 最近3年間増加傾向</td>
<td>20≥D</td>
</tr>
<tr>
<td>疫病発生</td>
<td>疫病発生日数R (病害の発生年数/全発生年数)</td>
<td>R=0</td>
<td>0&lt;R&lt;1</td>
<td>R=1</td>
</tr>
<tr>
<td>疫病・水質</td>
<td>疫病の発生日数C (疫病の発生年数/全発生年数)</td>
<td>C=0.2 かつ CN≥0.2 かつ CP≥0.02</td>
<td>C=0.2 かつ CN≥0.2</td>
<td>C= (0.47)</td>
</tr>
<tr>
<td>水質傾向変化</td>
<td>水質傾向変化T (過去30年間の平均/過去3年間の平均)</td>
<td>T≥0.05 かつ 最近3年間減少傾向</td>
<td>T≥0.05 かつ 最近3年間減少傾向</td>
<td>T≥0.05</td>
</tr>
<tr>
<td>排出</td>
<td>澱水汚染度 (発物の最大値/SDmg/l)</td>
<td>SD≥0.2</td>
<td>0.2≥SD&lt;1</td>
<td>1≥SD</td>
</tr>
<tr>
<td></td>
<td>澱水の急激残存数標準</td>
<td>N≥(+l)</td>
<td>N≥(+l)</td>
<td>N≥(+l)</td>
</tr>
</tbody>
</table>

※注) ※印は一部またはすべてのデータがないため、診断でない部分を示す。
Diagnostic chart

Hakata Bay, Fukuoka pref.

Ecosystem Stability

- Species: C +
- Habitat: C +
- Environ.: A
- Removal: C

Smoothness of Material Circulation

- Primary Production: C +
- Load, Water Exchange: B
- Decomposition, Sediment: ※

Note: A, B, C indicate levels of assessment.
Load Residence Concentration (Relative Intensity of COD Load)

Relationship among COD load, type of coastline and health condition (OPRF)
Official and legal systems which support holistic and ecosystem based management in Japan

2007: National Environmental Strategy for 21C (CD)
2007: 3rd National Strategy for Biodiversity (CD)
2008: Basic Ocean Plan based on Basic Ocean Act (CD)
2014: 4th Basic Environmental Plan (CD)
2014-: Connecting “Forest-Village-River-Sea” Project

2015: Basic Plan for Environmental Conservation of the Seto Inland Sea (CD), Revision of the Seto Inland Sea Law (the Diet)
Recent conceptual change in the management of the Seto Inland Sea

**Passive conservation** such as:
- Total Pollution Load Control
- Restriction to land reclamation

**Active conservation** such as:
- Restoration of biodiversity, biological productivity, habitat and well balanced nutrient cycle between land and sea

**Single issue approach** such as: water quality control

**Holistic approach** such as: Satoumi, EBM, ICM including adaptive management
Possible 3 steps to promote new holistic approaches in the post-TPLC age

1. **The Seto Inland Sea**
   Initial mission of TPLC has been almost accomplished.
   New legal system has been almost enacted (post-TPLC age)

2. **Three TPLC and 4 Bay Renaissance Project areas**
   (Tokyo Bay, Ise Bay and Osaka Bay and Hiroshima Bay)

3. **Other enclosed coastal seas in Japan**
   Holistic approach such as: Satoumi, “Health Examination”
   EBM, ICM including adaptive management
Healthy Enclosed Coastal Seas for Next Generation!

Better Life through Holistic Approach in Near Future

Thank you very much for your attention!