Nutrition management inferred from the marine environmental changes in Osaka Bay, Japan

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Introduction:

In Japan, people have long been suffered from the damage of red tide. Osaka Bay is especially a sea area that is closely related to the living infrastructure. And people have been suffering from the occurrence of red tide for many years.

In 1978, the The Total Pollutant Load Control System and the Setouchi Law were amended to improve the water quality of eutrophicated closed sea areas, and COD was targeted for reduction in Osaka Bay. In 2002, Total Nitrogen (T-N) and Total Phosphorus (T-P) were added to the target items.

The purpose of this study is to classify Osaka Bay by sea area and clarify the transition of red tide occurrence factors from a statistical point of view.

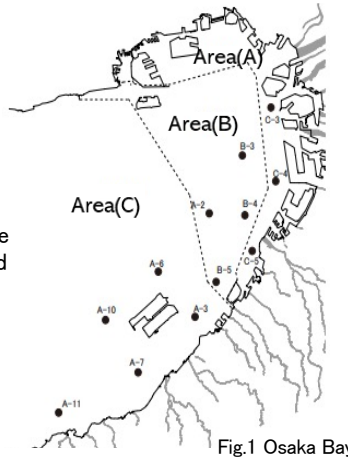
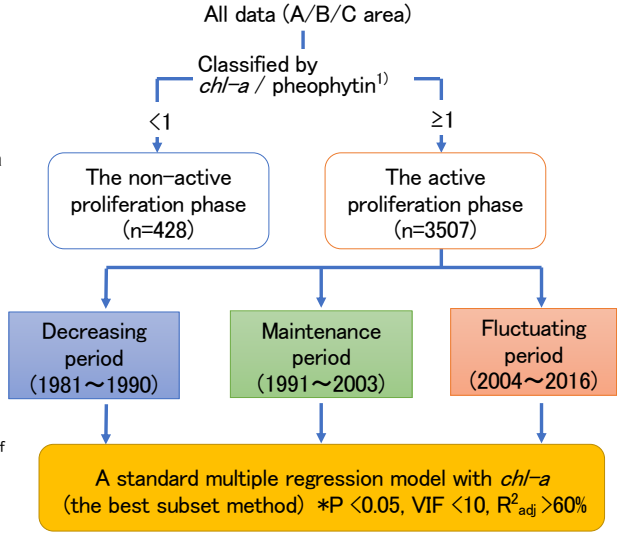


Fig.1 Osaka Bay

Method:

・Target area:
12 points in Osaka Bay (Fig.1), classified into the A/B/C area (the water quality standard water area for T-N and T-P in Japan)

・Data:
The results of the water quality measurement survey of Osaka Pref. (1972 to 2016)
*1972-1980 and 1994-1999 were excluded



1) Suzuki, C. (2016). Assessing change of environmental dynamics by legislation in Japan, using red tide occurrence in Ise Bay as an indicator. Marine pollution bulletin, 102(2), 283-288.

Result & Discussion

1. The decreasing period

・COD, DO, and T-P were selected as explanatory variables in all areas.
→COD has a strong influence on red tide occurrence.

・The adjusted explanatory rate decreases to the maintenance period.
→The model cannot explain the situation in the decreasing period due to changes in the ocean environment.

2. The maintenance period

・There was no model that met the adoption criteria in area C.
・COD was not selected.
→The reduction by The Total Pollutant Load Control System is affecting the factors that cause red tide.

・T-P had a strong influence instead in area A/B.
→Suspension particle swarms released from the Yodo River[2] (the largest basin area and the largest COD among the rivers flowing into Osaka Bay).

3. The fluctuating period

・The model was not valid for any of the areas.
→The change in limiting factors due to the regulation of T-P and T-N since 2002.

4. Future task

・The shortage of nutrients has become a problem in area C due to The Total Pollutant Load Control System.
→To investigate the impact on the fishing industry.

2) Ecological Engineering Study Group, Osaka Bay-Environmental Transition and Creation, Hoshisha Welfare Pavilion, 2009 (in Japanese)

Table.1 Standard partial regression coefficients by each area in the decreasing and maintenance period

Items	Decreasing period			Maintenance period		
	Area A	Area B	Area C	Area A	Area B	Area C
n	221	321	398	268	361	428
COD	0.5500	0.5971	0.6403	—	—	
DO	0.1785	0.1938	0.3622	0.1907	0.4544	
T-P	0.1203	0.1701	0.2773	0.9641	0.5981	
PON	0.1575	0.1498	—	—	-0.0916	
T-N	-0.1389	—	-0.1325	-0.2526	—	failure
pH	—	-0.1281	-0.1846	0.1805	—	
Sal.	—	—	0.0835	—	0.2167	
W.temp.	—	—	0.1447	—	-0.1367	
$R^2_{adj.}$	64.06%	75.65%	68.85%	83.66%	68.48%	

*The normality, data order, and variance of the model for each area were fine in each model.

Table.2 Changes in $R^2_{adj.}$ in each area

	Area A	Area B	Area C
Decreasing period	64.67%	75.96%	69.32%
Maintenance period	39.47%	51.82%	27.49%
Fluctuating period	47.21%	38.20%	26.61%

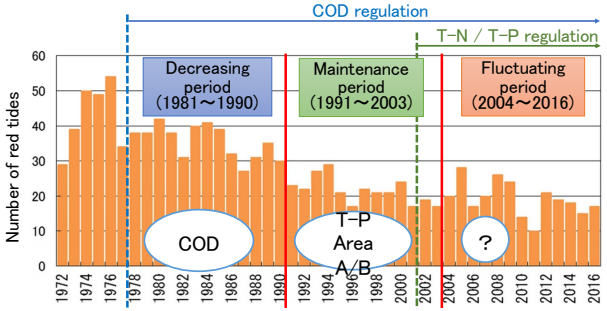


Fig.2 The number of red tide outbreaks in Osaka Bay

Conclusion:

The factors that cause red tide in Osaka Bay were changing with the regulation by The Total Pollutant Load Control System.