A Novel Indicator of Anthropogenic Infuence on the Fluctuability and Stability of Phytoplankton Community Composition

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Background

➢ Using ecological indicators for nutrient conditions can be more sustainable to indicate a good environment;

➢ Water quality in Tolo Harbour and Channel (Tolo) has been improved since 1998 after the diversion of sewage effluent.

➢ We developed Areal Phytoplankton Community Index, APCI, and applied to 28 years data (1991-2018) at two stations in Tolo;

➢ APCI can be used as a quantitative index for water quality criteria

Messages

➢ An areal phytoplankton community composition index (APCI) was proposed and tested.

➢ APCI itself bears an ecological meaning of the community fluctuability

➢ A temporal change in APCIs indicates the stability of community composition

➢ The temporal stability of APCIs indicates changes in water quality over time

Objectives

➢ To examine if an area-based phytoplankton community index of phytoplankton groups indicates an improvement of water quality in coastal waters

Figure 1. Conceptual model for ecology of Aeral Phytoplankton Community Index (APCI), indicating the Fluctuability and Stability of a phytoplankton community composition，represented by functional group 1 (diatoms) and functional group 2 (dinoflagellates)
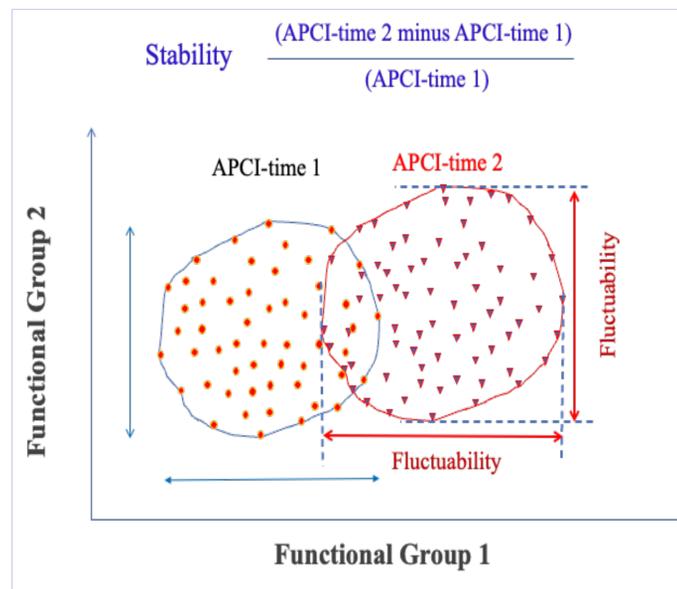

Fig. 2. Monitoring Stations TM4 and TM8 in Hong Kong

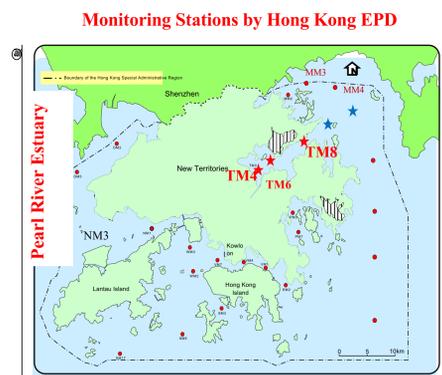Monitoring Stations by Hong Kong EPD

Fig. 3 . Fig. 3. Time series of annual means of (a) total phytoplankton abundance, (b) abundance ratio of dinoflagellates / diatoms, (c) DIN, (d) DIP and (e) DSi during 1991-2018 at TM4 and TM8. Solid lines: significant regression (p<0.05) and dashed lines： not significant.
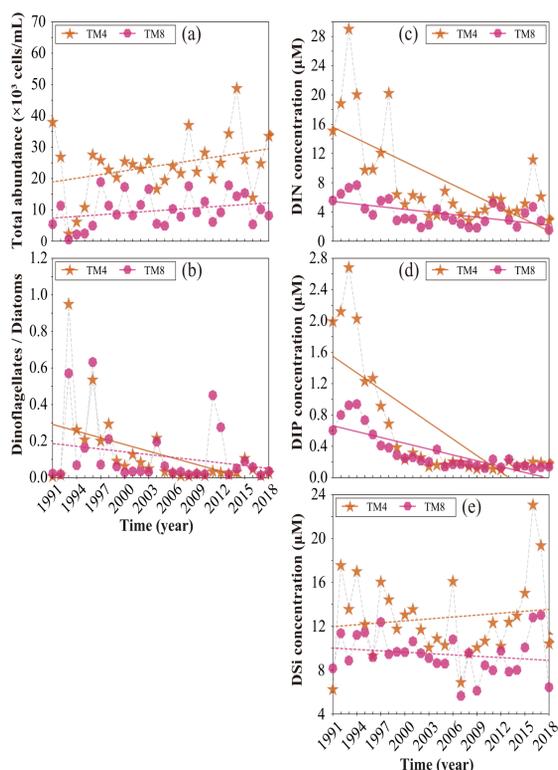

Fig. 4. Areal envelopes (calculated areas) (APCI) of the scatter plots of dinoflagellates versus diatoms for a given period of data: yearly 2018 (a), two years 2017-2018 (b) and three years 2016-2018 (c) at stations TM4 and TM8.
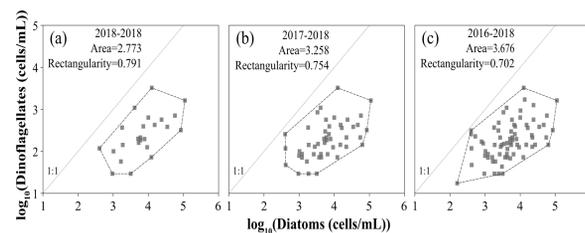

Fig. 6. Temporal changes (%) between consecutive APCIs in the time series of APCI-1y, -2y and -3y during 1991-2018 for a) TM4 and b) TM8, which are the difference between one APCI and next APCI divided by their average; colored dashed lines indicate 5 and 95 percentiles of the temporal changes in the respective time series: -80% to 90% for APCI-1y, -60 to 50% for APCI-2y and -50 to 30%; c) and d) rain-clouds, box-and-whisker plots and normal distribution of temporal changes between two neighbouring APCIs in the time serios of APCI-1y, -2y, and -3y for TM4 and TM8; the vertical column represents 25-75% and the vertical line, 0.35-99.65%.
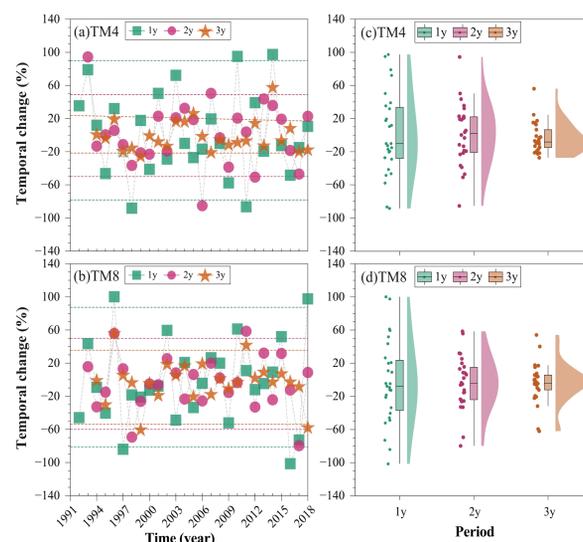

Fig. 5. Time series of APCI-1y, APCI-2y and APCI-3y at TM4 and TM8. The X-axis label, e.g. 2018, represents 2018 (yearly), 2017-2018 (2 years) and 2016-2018 (3 years), respectively. Solid lines indicate significant regression at p < 0.05; dashed lines not significant.
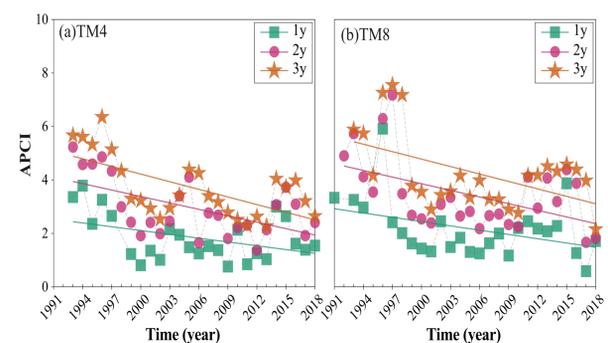

Table 1. Correlations between APCIs and averaged nutrients for the same time windows at TM4 and TM8 are significant and hence, temporal changes in APCI can be used to indicate a change in water quality and environment conditions.

Station	APCI	DIN		DIP		DSi	
		r	p- value	r	p- value	r	p- value
TM4	APCI-1y	0.40	<0.05	0.48	<0.05	0.16	>0.05
	APCI-2y	0.53	<0.01	0.61	<0.001	0.13	>0.05
	APCI-3y	0.74	<0.0001	0.82	<0.0001	0.2	>0.05
TM8	APCI-1y	0.34	>0.05	0.45	<0.05	-0.08	>0.05
	APCI-2y	0.51	<0.01	0.60	<0.01	0.21	>0.05
	APCI-3y	0.65	<0.001	0.65	<0.001	0.37	>0.05

Conclusions

APCI is a stand-alone index and bears an ecological meaning of the quantified fluctuability of a community. Thus, APCI is potentially a more advanced indicator that can be used to make spatial comparisons between different water bodies without having to use a reference from many different sites. The use of APCI has an advantage to be rationally correlated with environmental variables. These features of APCI not only give a new approach to assess changes in community composition in a natural ecosystem, but also enable it to become a useful method for assessment of disturbances by anthropogenic influences in aquatic environments.