



PICES HAB and Climate Change Scientific Symposium, May 19-22, 2015, Göteborg, Sweden

Red tides Are More Correlated with Climate Variability under Eutrophic Conditions in Hong Kong:

Time Series Analysis

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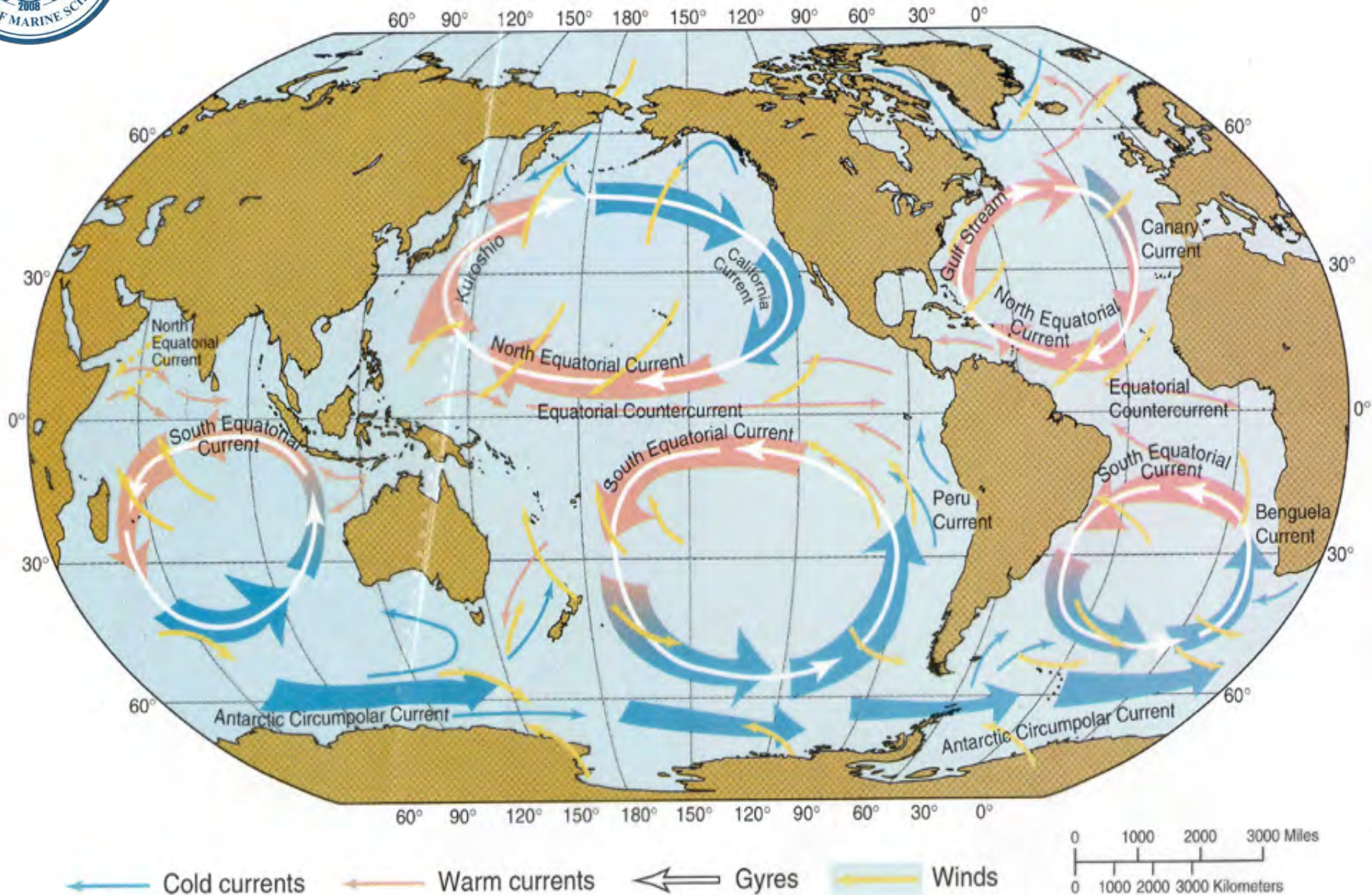
School of Marine Sciences

Sun Yat-sen University

Guangzhou, China



The World Oceans





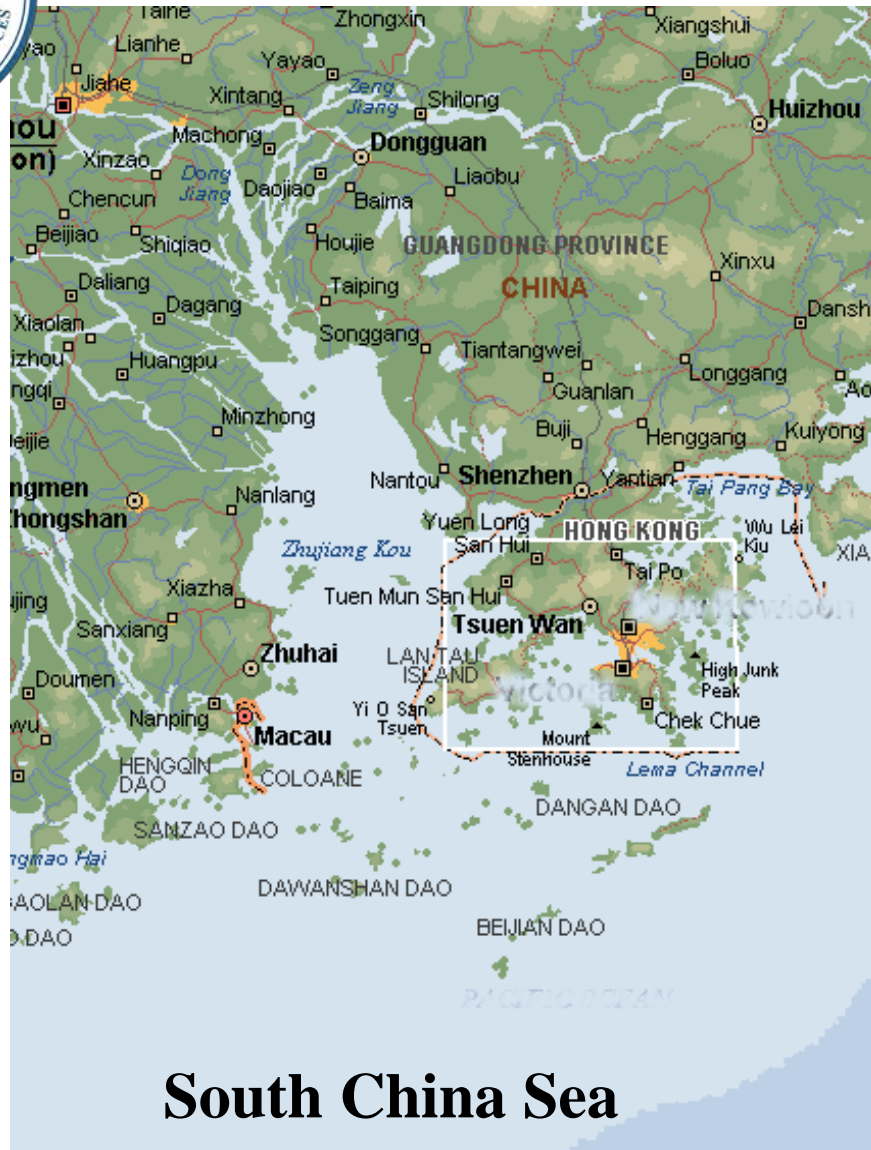
South China Sea



- 2.32 million km²
- Largest inland sea after 4 open Oceans
- 3 times as large as the total of other China coastal seas

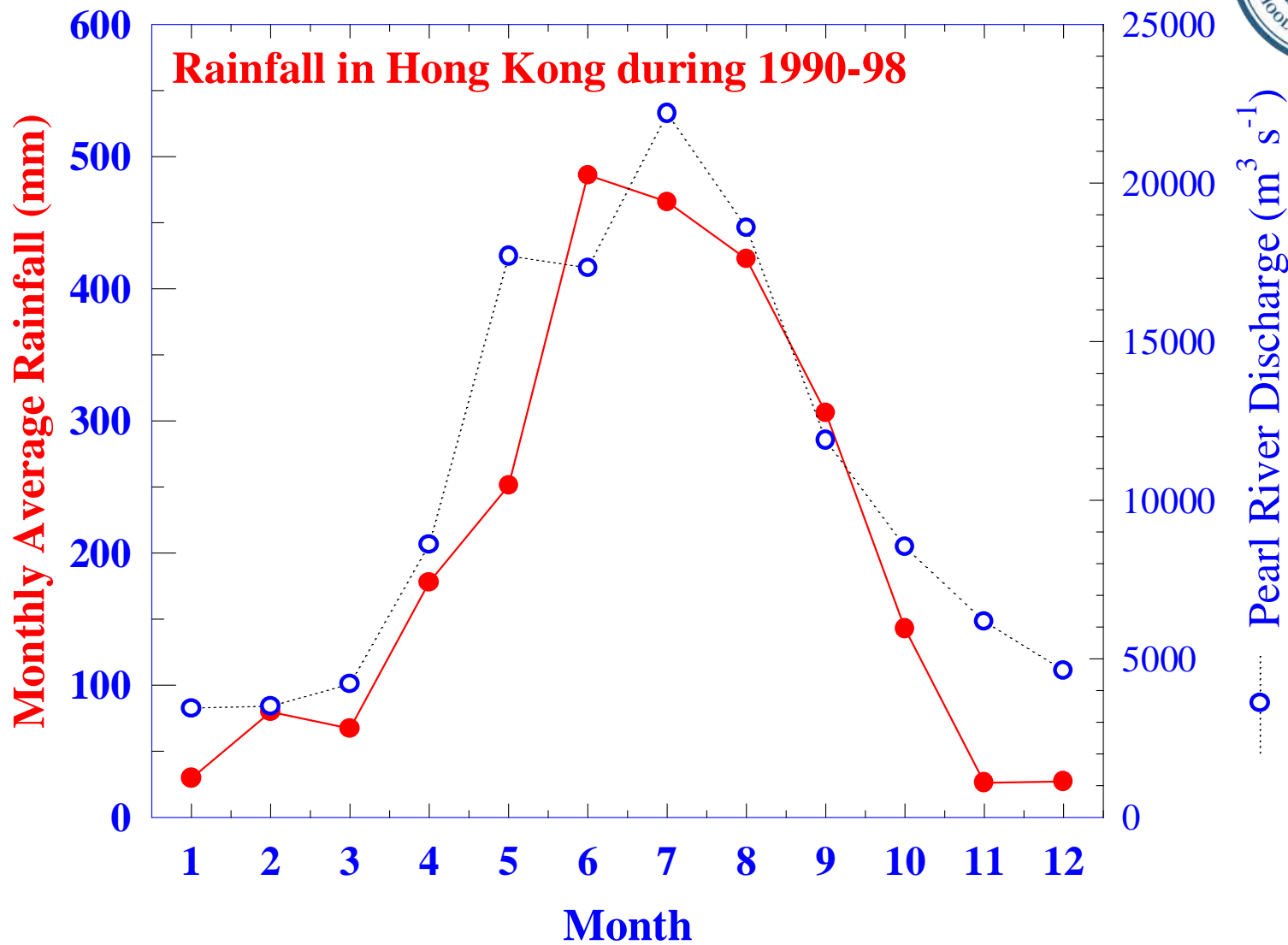


Pearl River Estuary



Pearl River

- The 2nd largest river in China
- The 13th largest river in the world
- 2,2 km long
- 454,000 km² drainage basin
- 100 million people





Pearl River Estuarine Coastal Plum

(Satellite Photos)



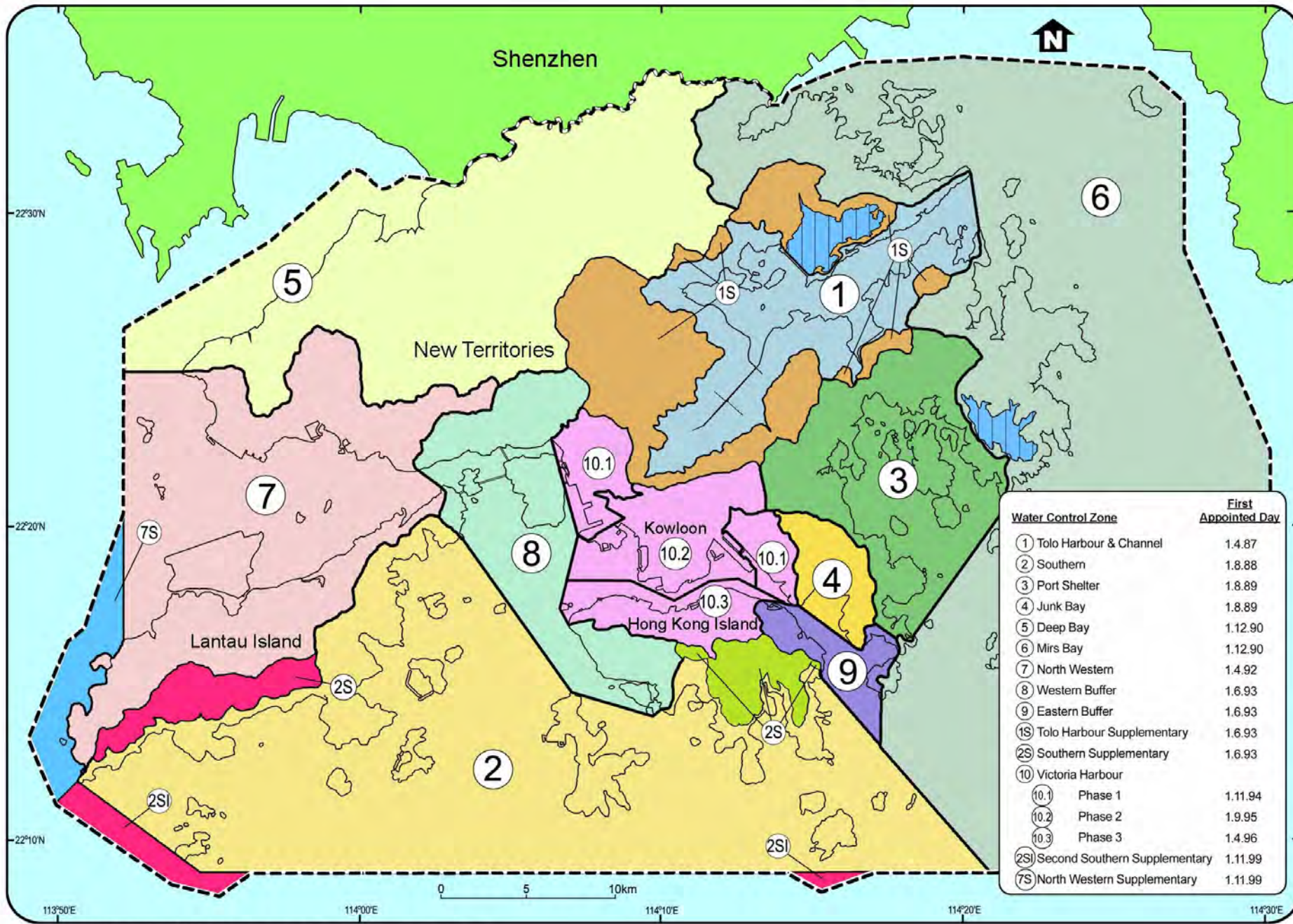
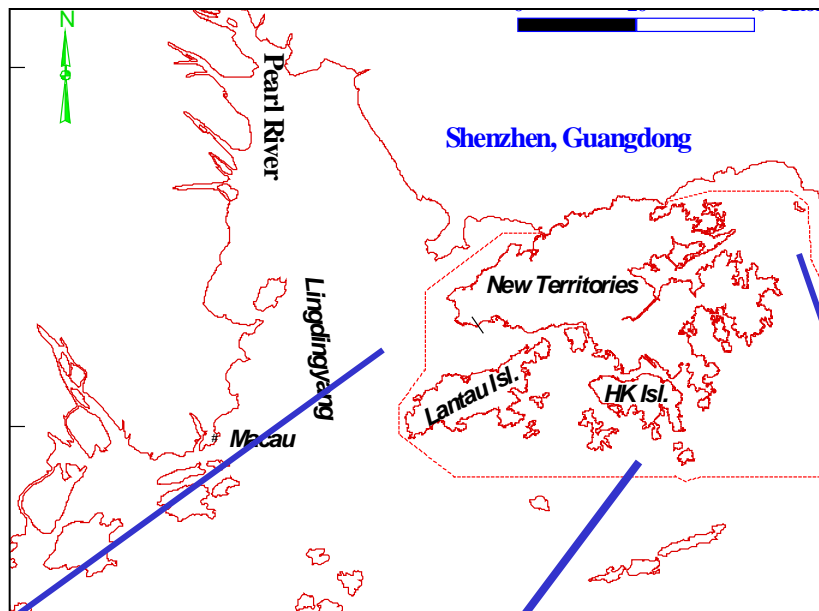


Figure 1.1 Water Control Zones in Hong Kong

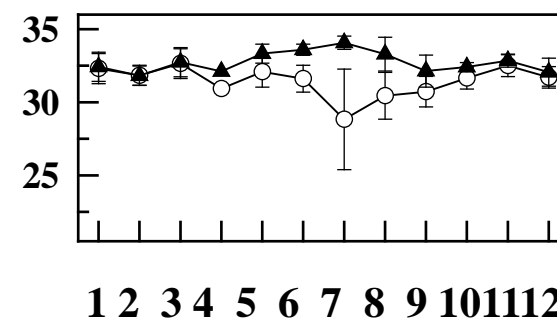
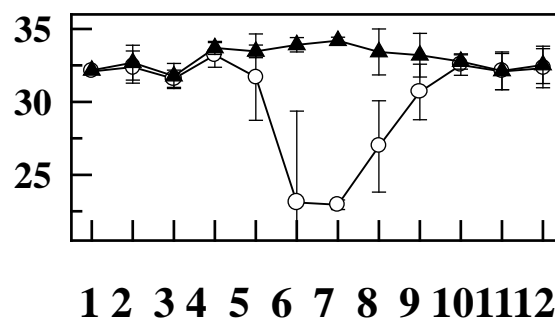
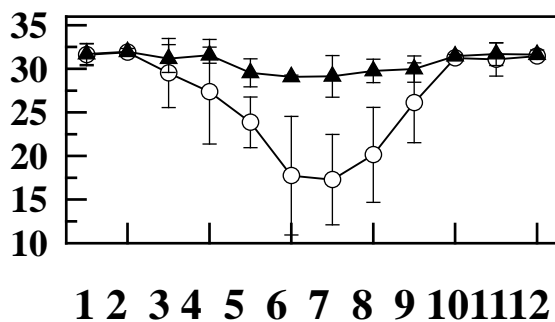


Western waters

Southern Water

Mirs Bay

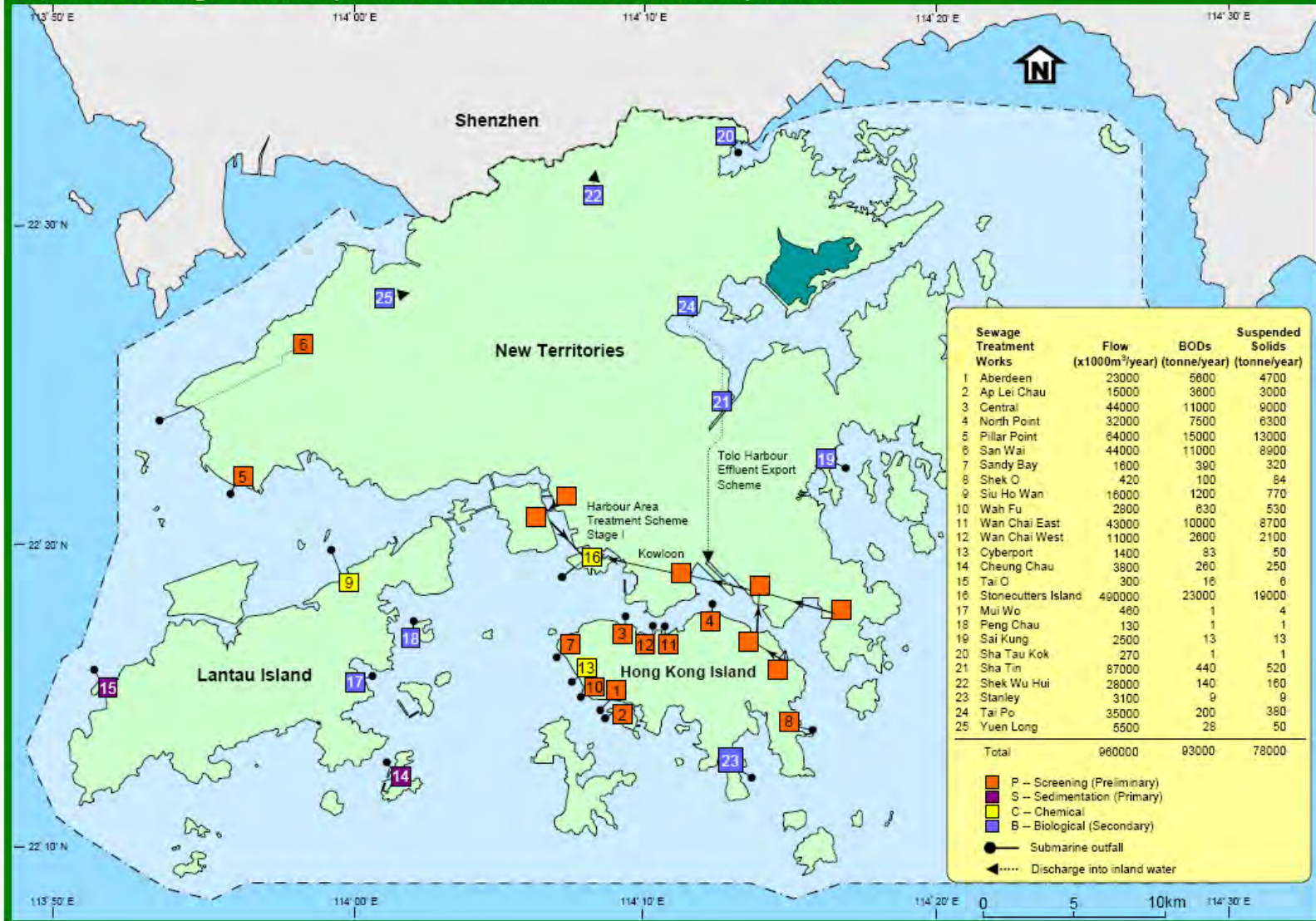
Salinity



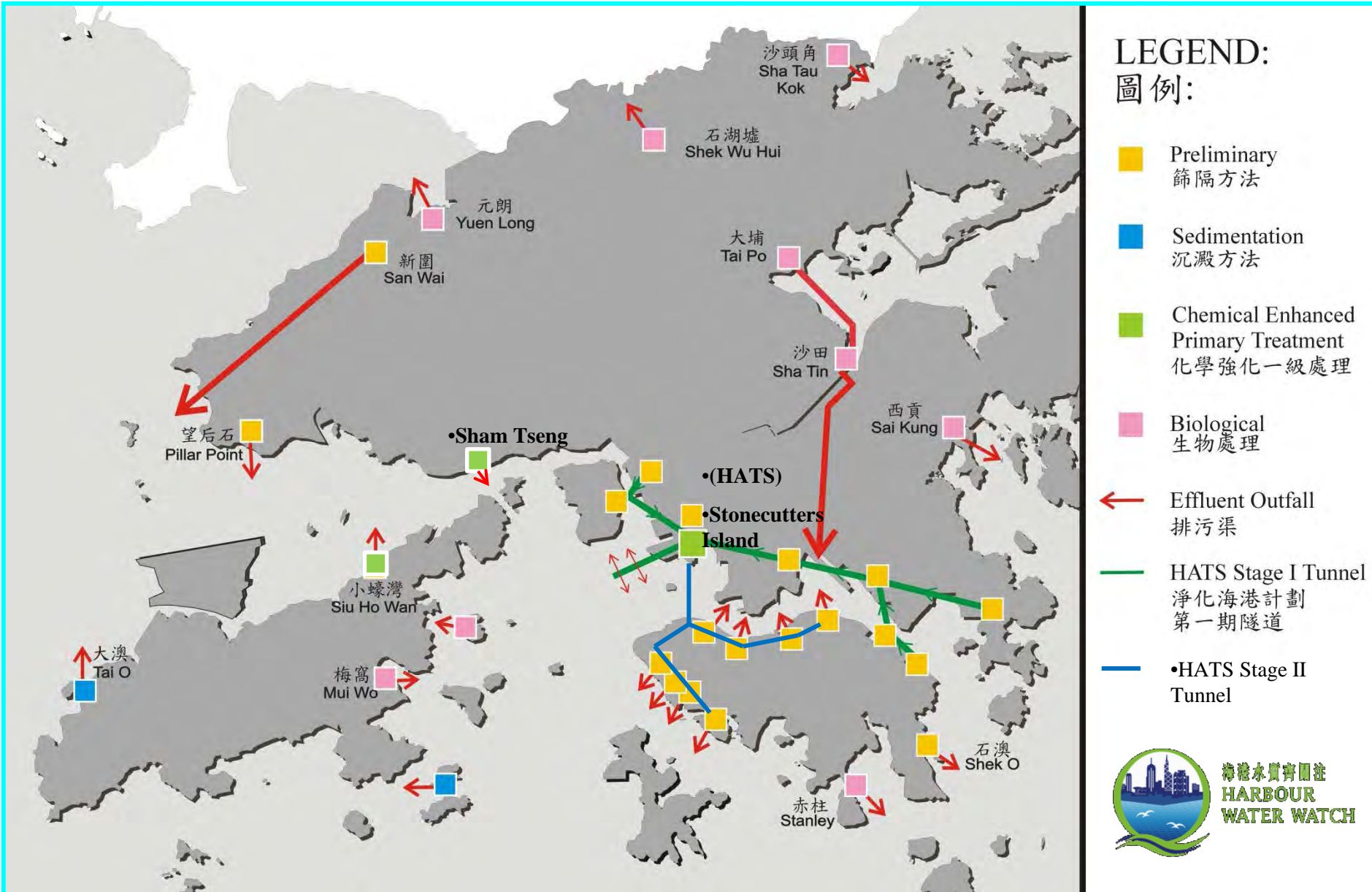
Month

Hong Kong Sewage Effluent Outfalls

Major public sewage treatment works, outfalls, and pollution load in Hong Kong in 2007
(sources: Drainage Services Department and Environmental Protection Department)



香港現時的污水收集及處理設施



LEGEND: 圖例:

- Preliminary 篩隔方法
- Sedimentation 沉澱方法
- Chemical Enhanced Primary Treatment 化學強化一級處理
- Biological 生物處理
- ← Effluent Outfall 排污渠
- HATS Stage I Tunnel 淨化海港計劃第一期隧道
- •HATS Stage II Tunnel

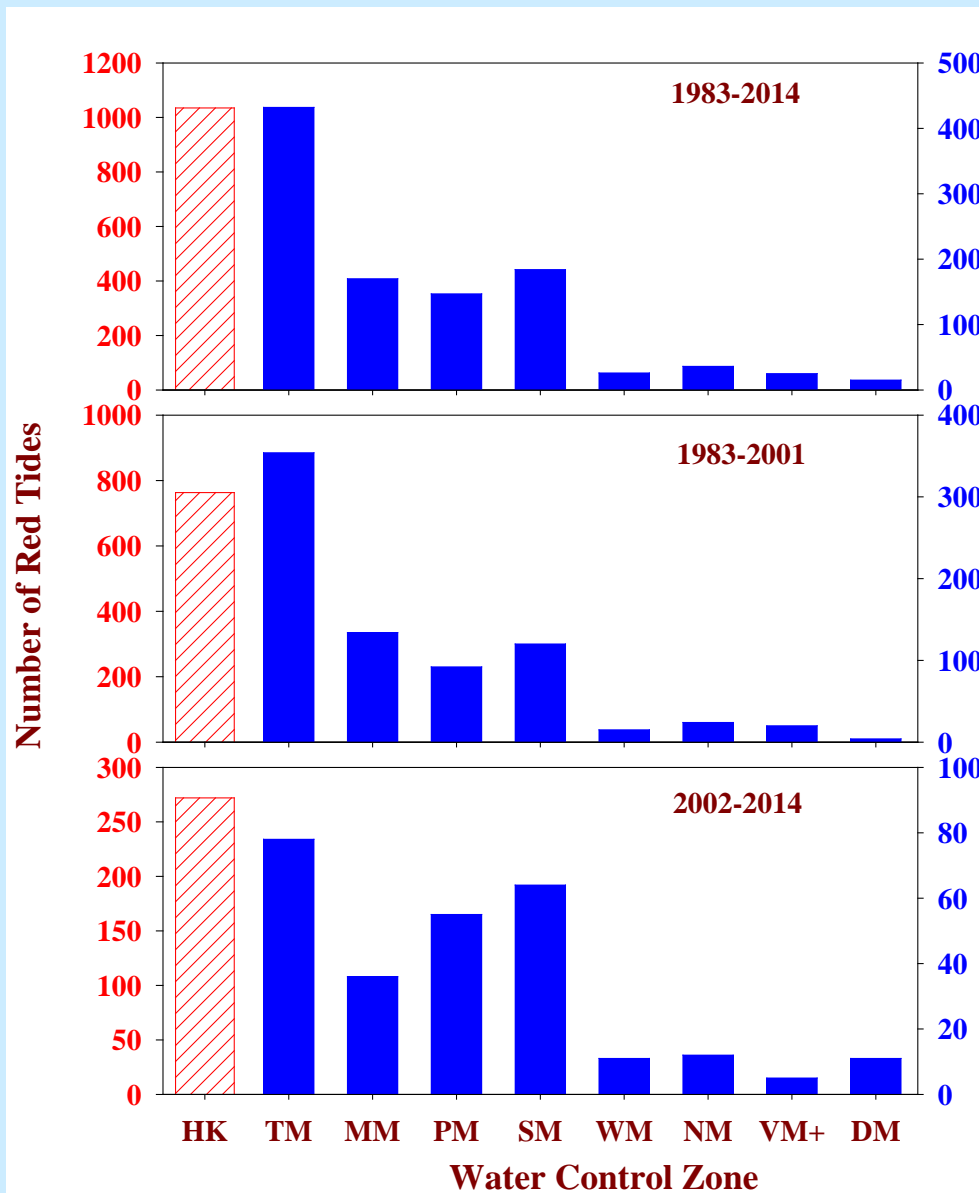




What are the temporal and spatial distribution of red tides in Hong Kong?

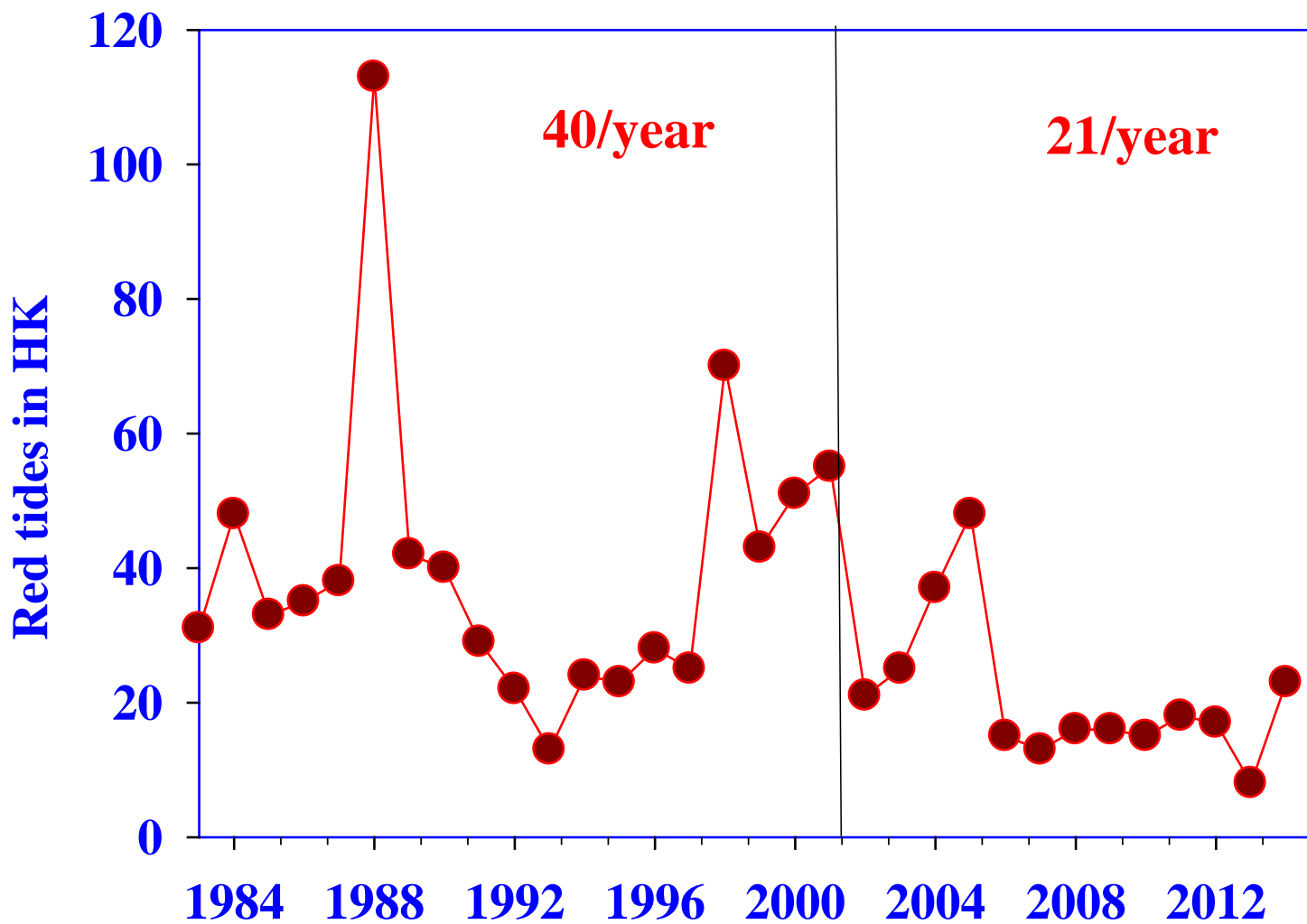
(Here, red tides are considered to be the color-visible type of harmful algal blooms)

Spatial distribution of red tides during 1983-2014.

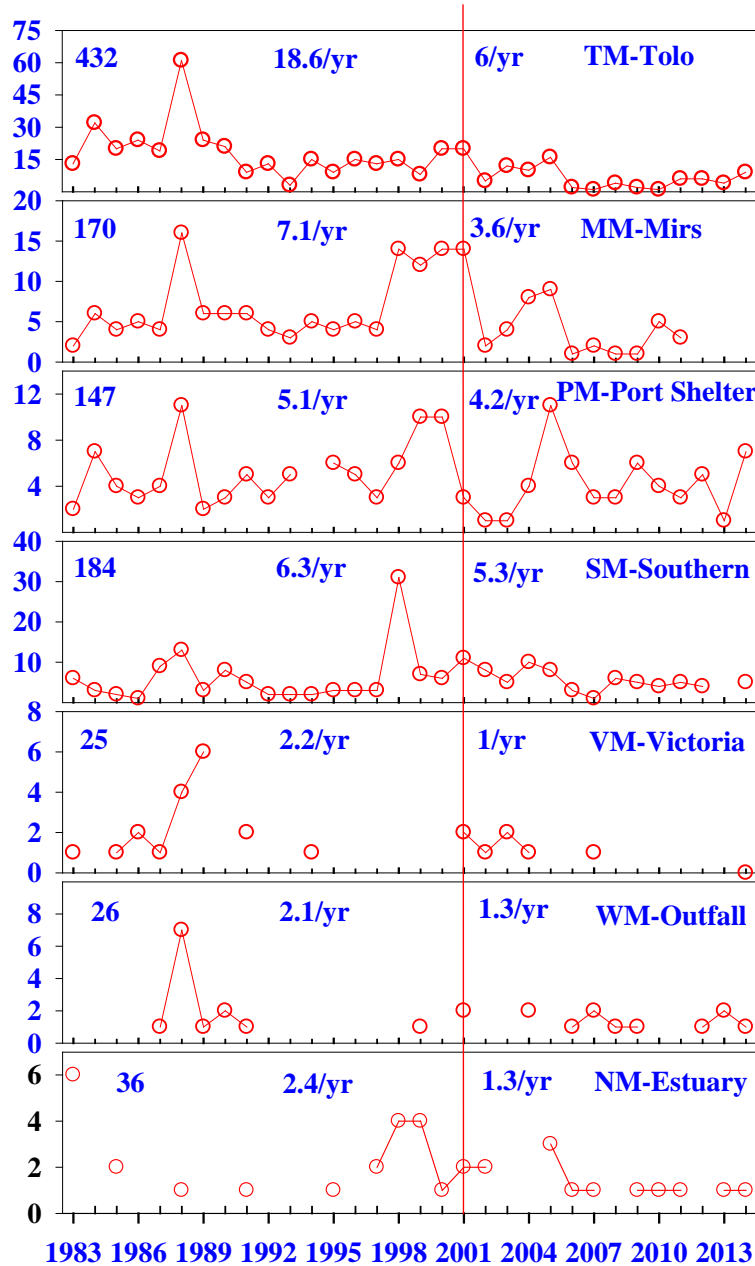




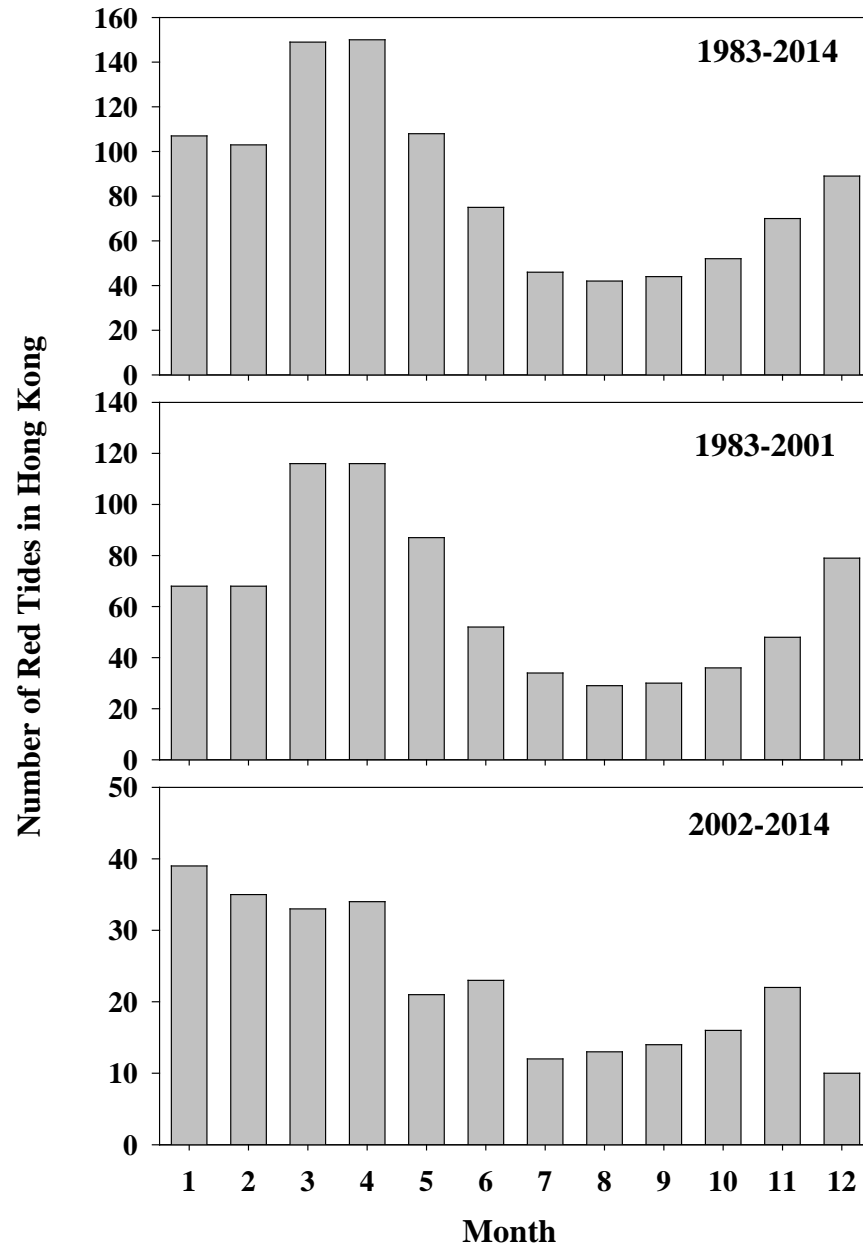
Total red tides 1035 over 32 years (1983-2014)



Yearly Red Tides During 1983-2014.



Monthly distribution of red tides





Findings:

- ❖ **Water quality improvement management reduced the total number of red tides**

The mechanisms proposed for explaining the formation of red tides



- Nutrient enrichment – eutrophication effect
- Stratification
- Residence time
- Physical processes (winds, tidal circulation, river outflow) plus biological behavior (vertical migration)
- Climate effect

All these mechanisms are found to operate in HK

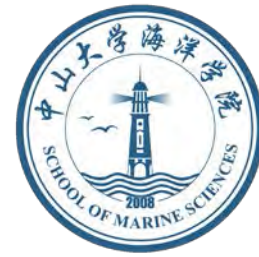
Different mechanisms appear to operate in different Water Control Zones (WCZs)



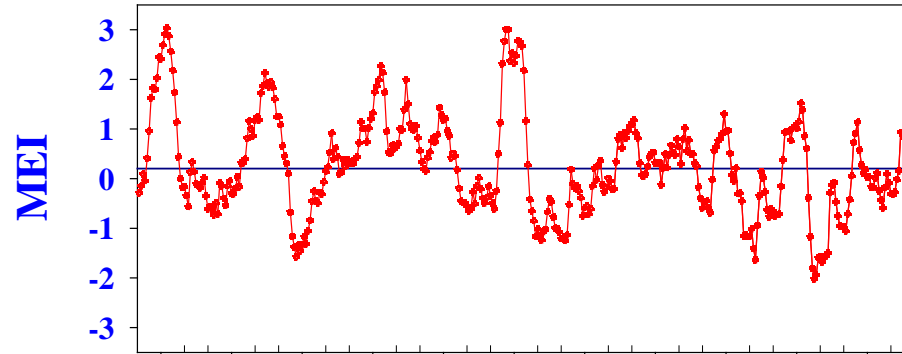
Are there any effects of climate variability on red tides in Hong Kong?

How does water quality improvement change their correlation?

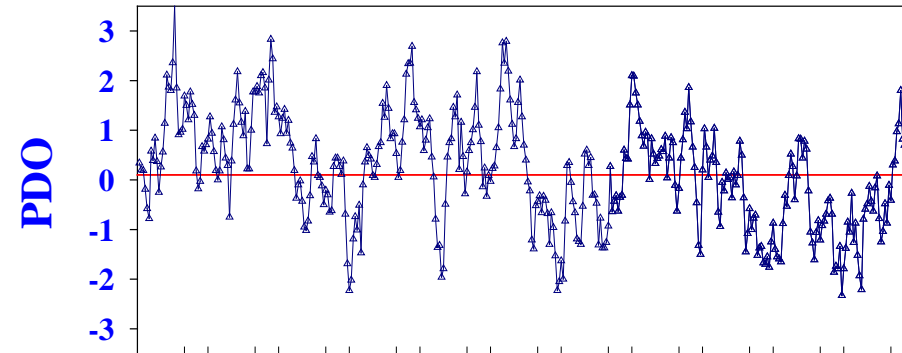
Climate Variability for the Pacific Ocean



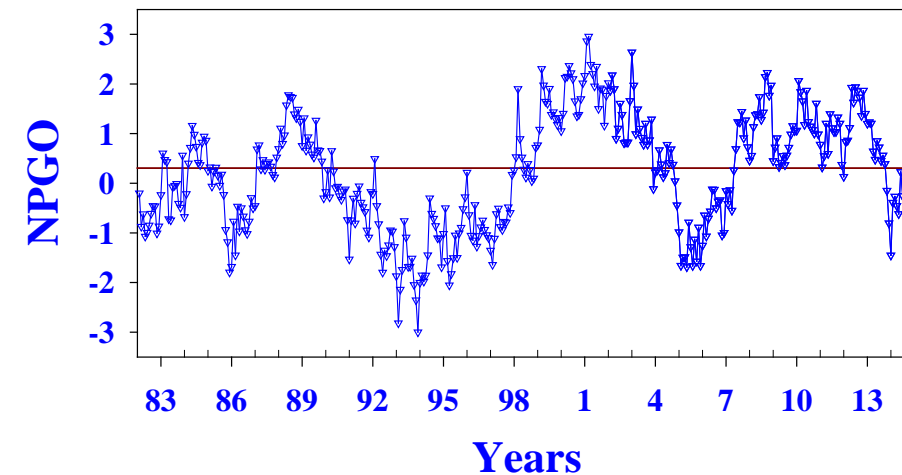
El Niño



Pacific Decadal
Oscillation



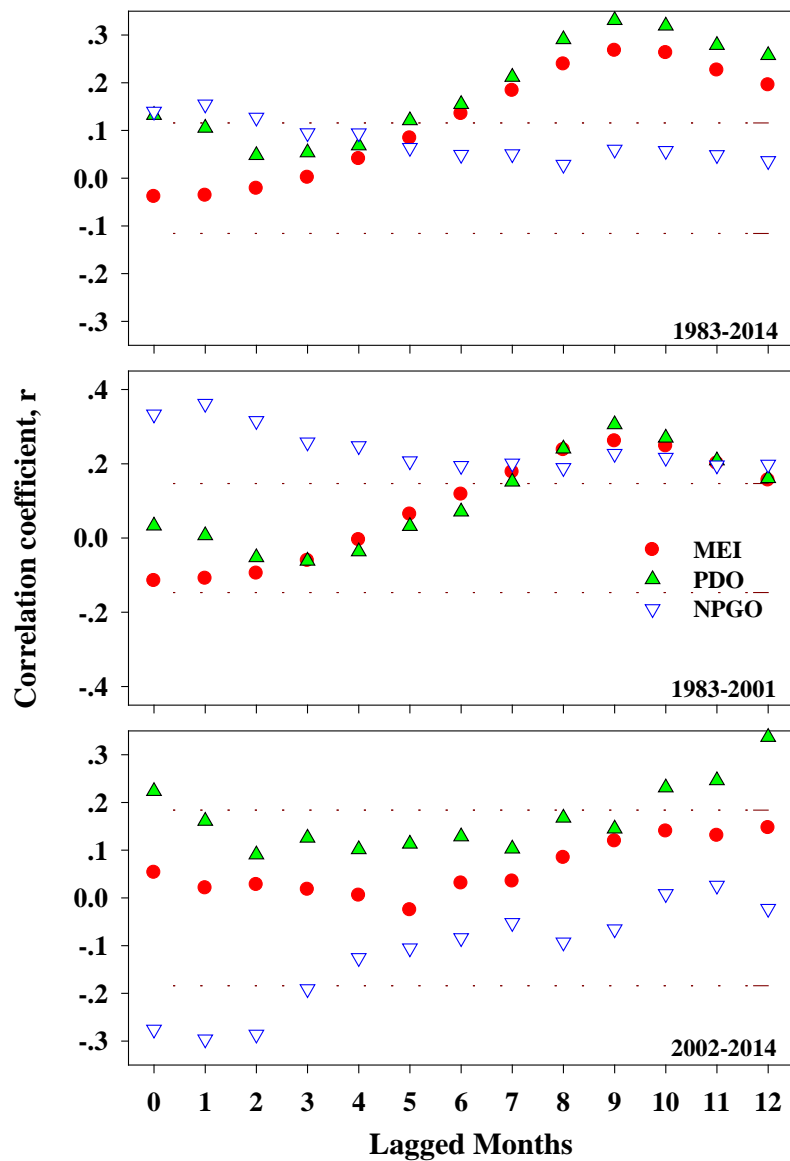
North Pacific
Gyre Oscillation



Hong Kong: Red Tides vs Climate Indices



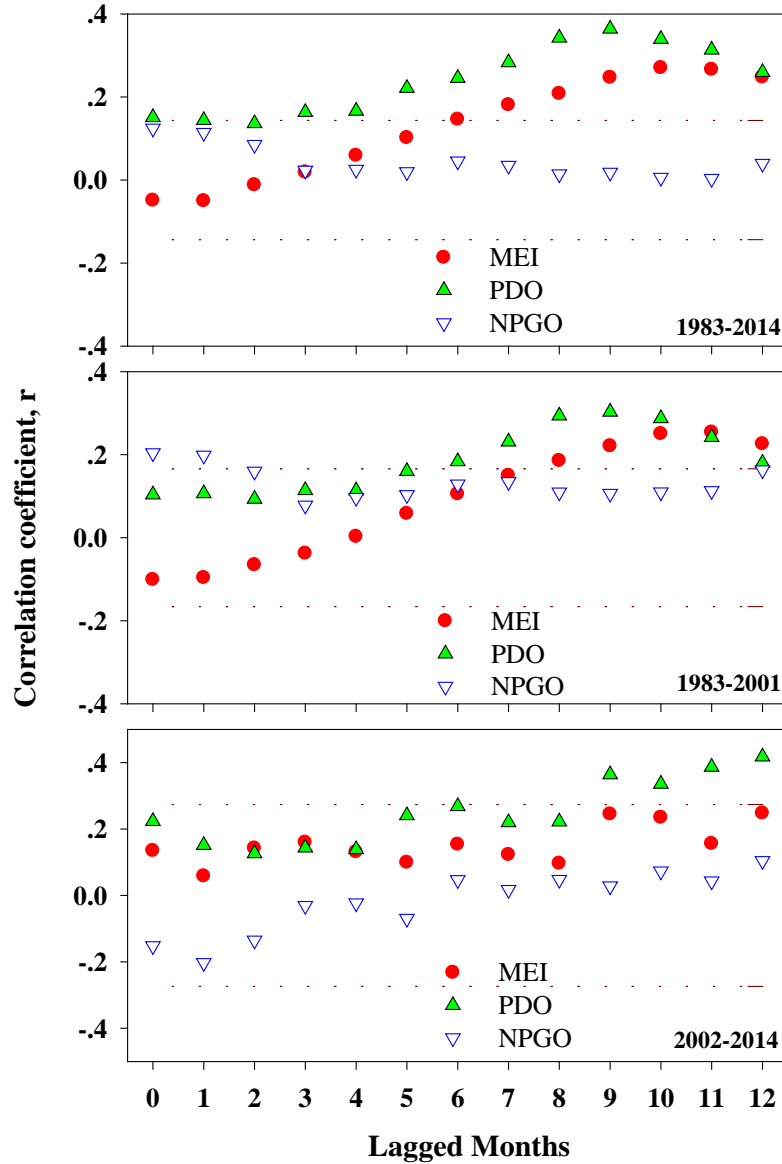
Month Series



Tolo: Red Tides vs Climate Indices

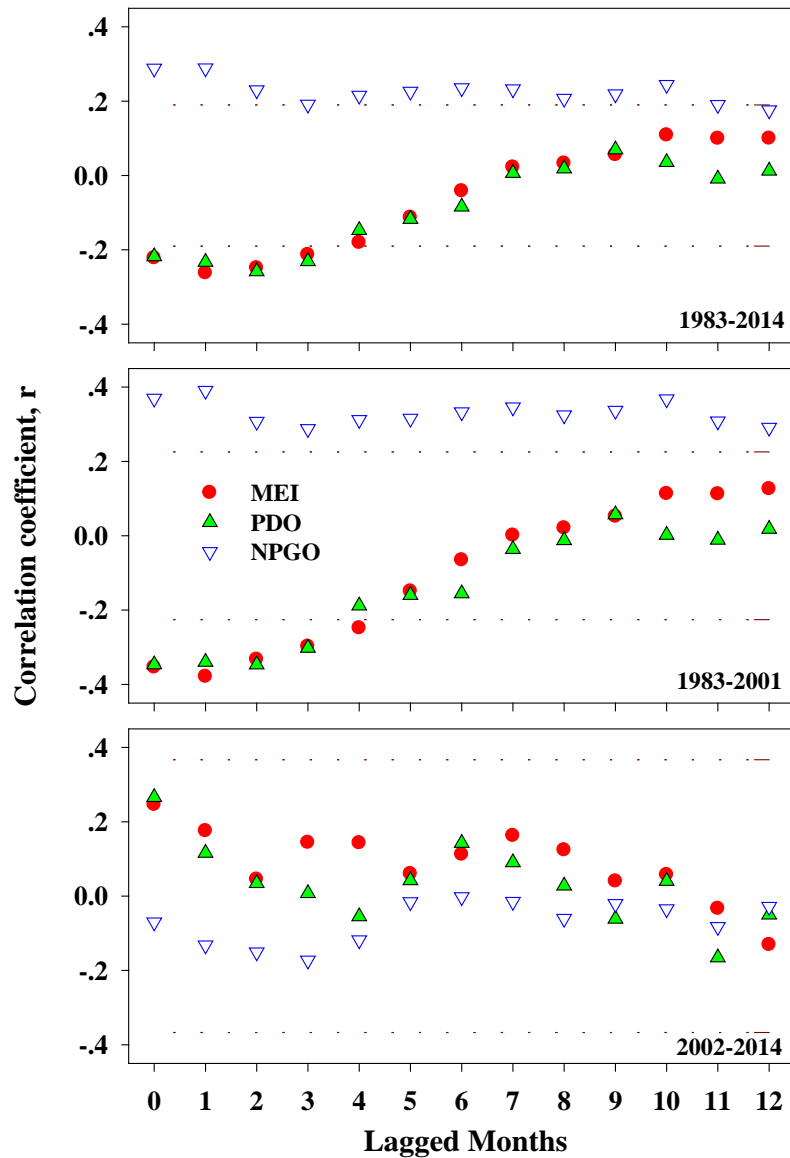


Month Series



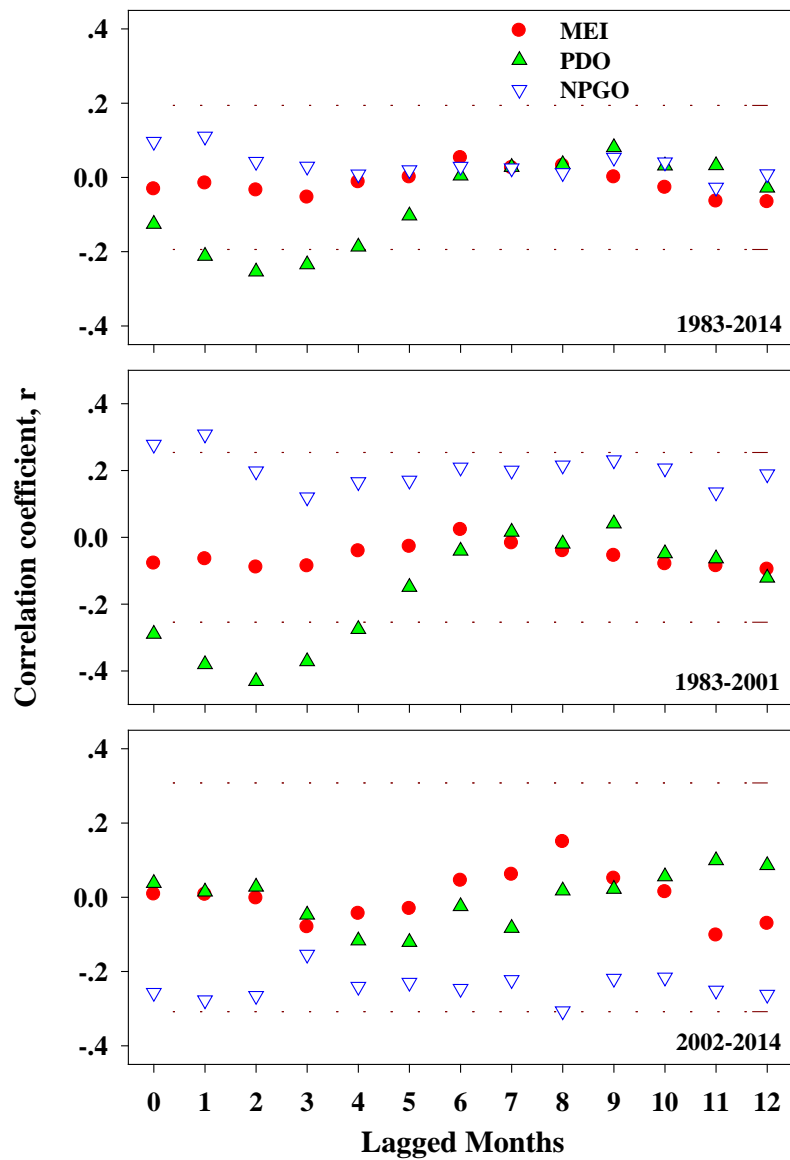
Mirs Bay: Red Tides vs Climate Indices

Month Series

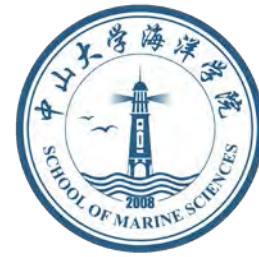


Port Shelter: Red Tides vs Climate Indices

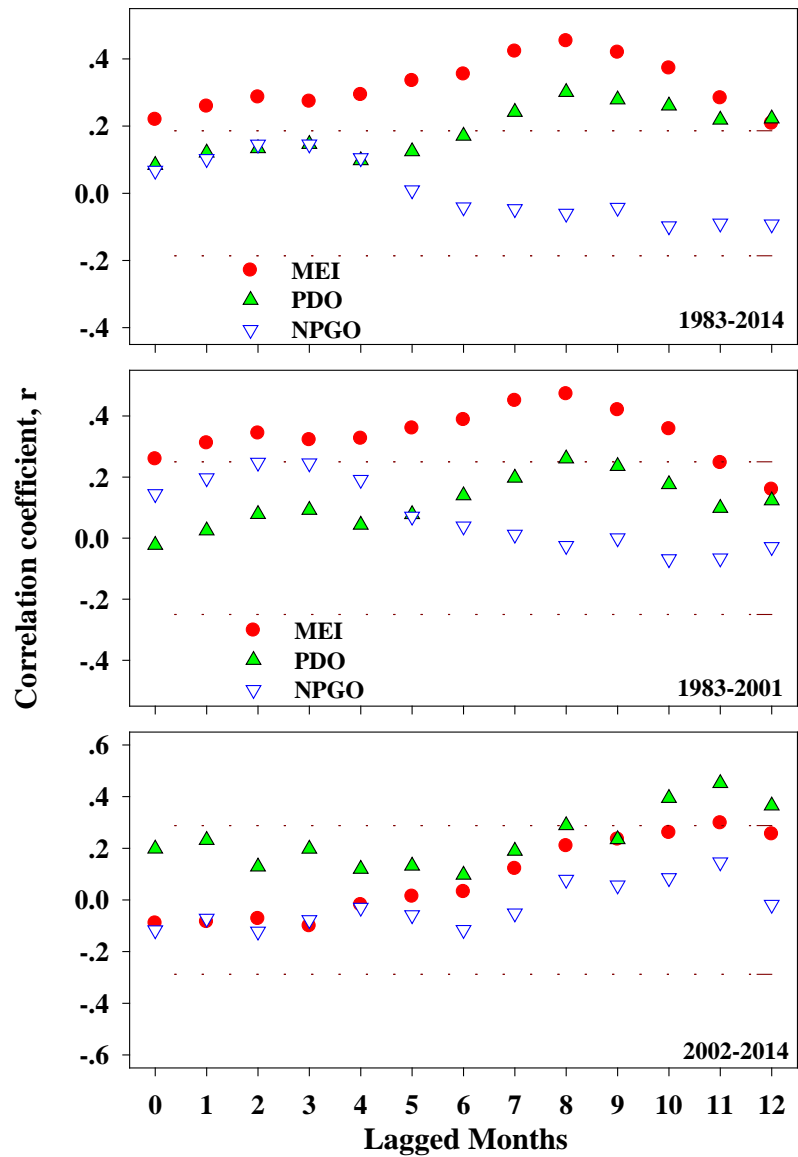
Month Series



Southern: Red Tides vs Climate Indices



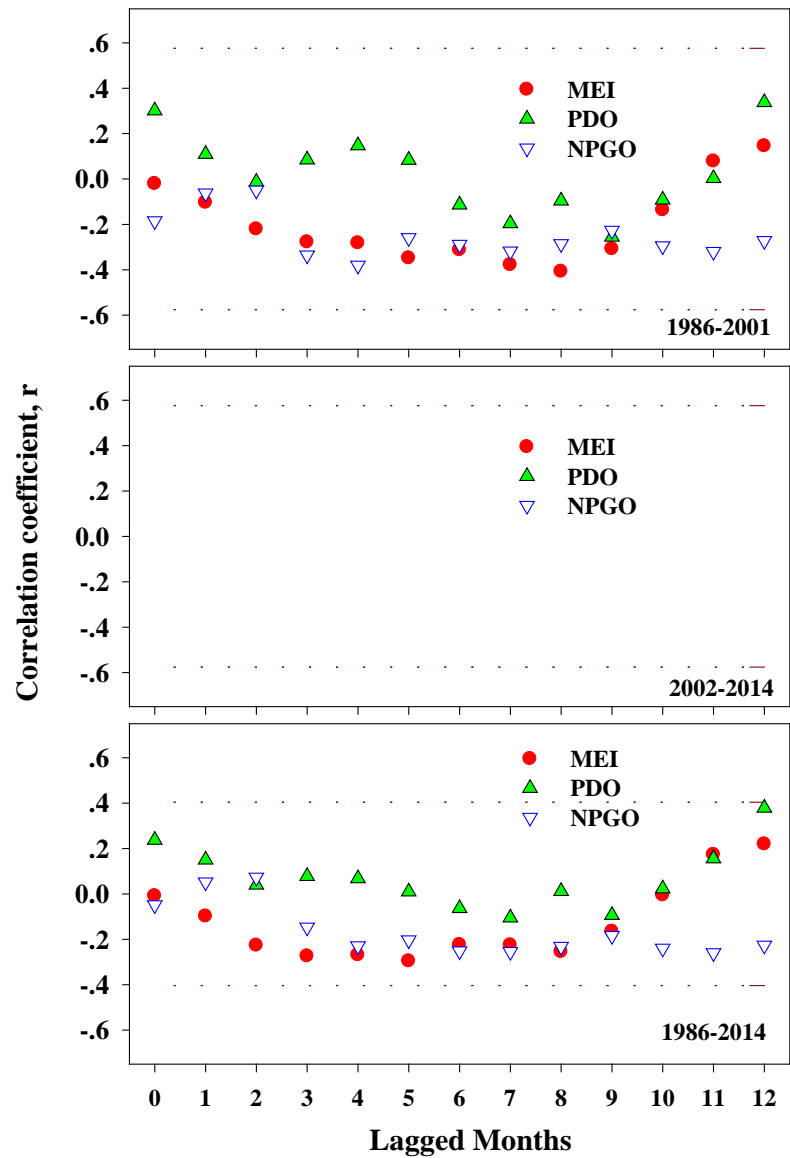
Month Series



Northwest: Red Tides vs Climate Indices



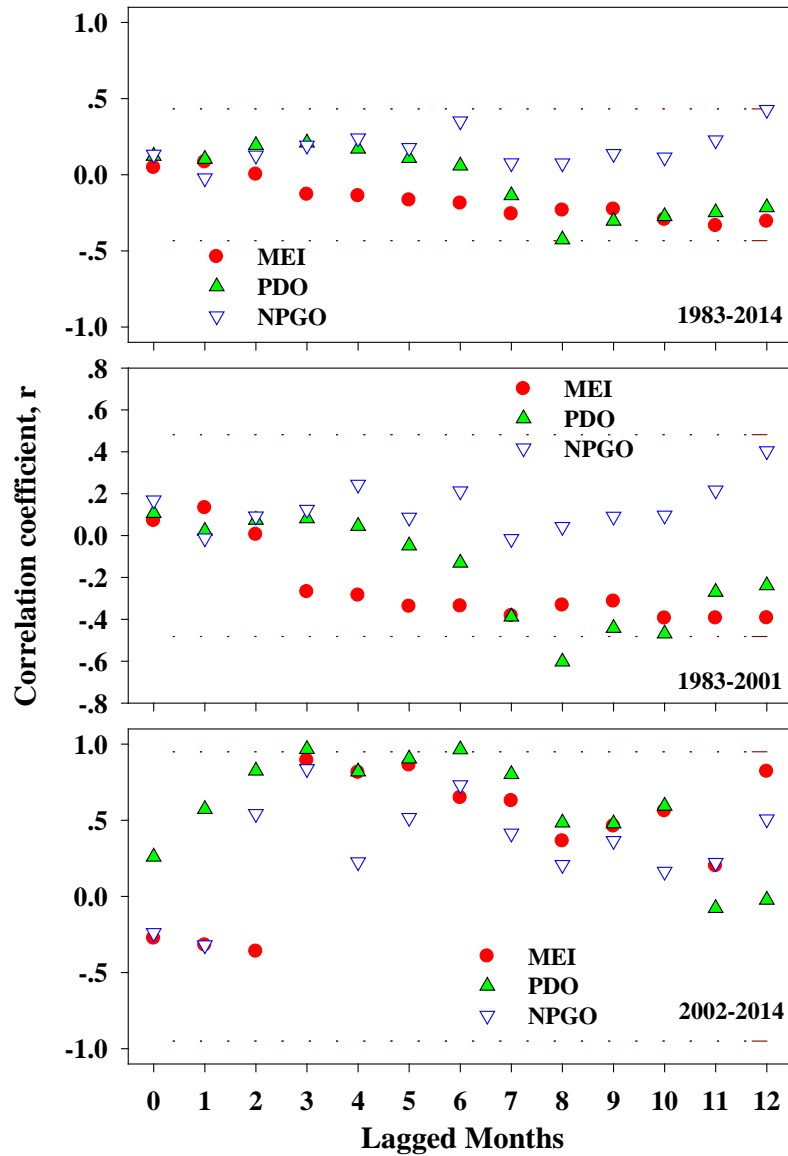
Month Series



Victoria Harbour +: Red Tides vs Climate Indices



Month Series

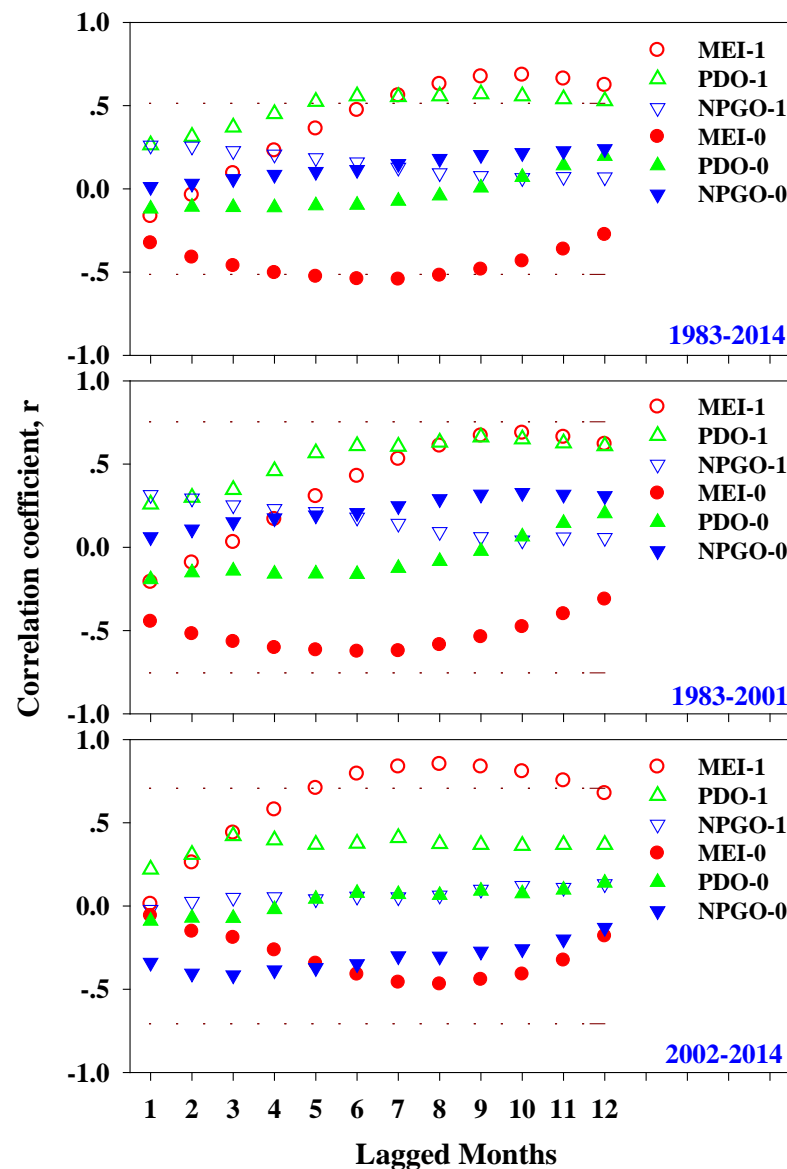
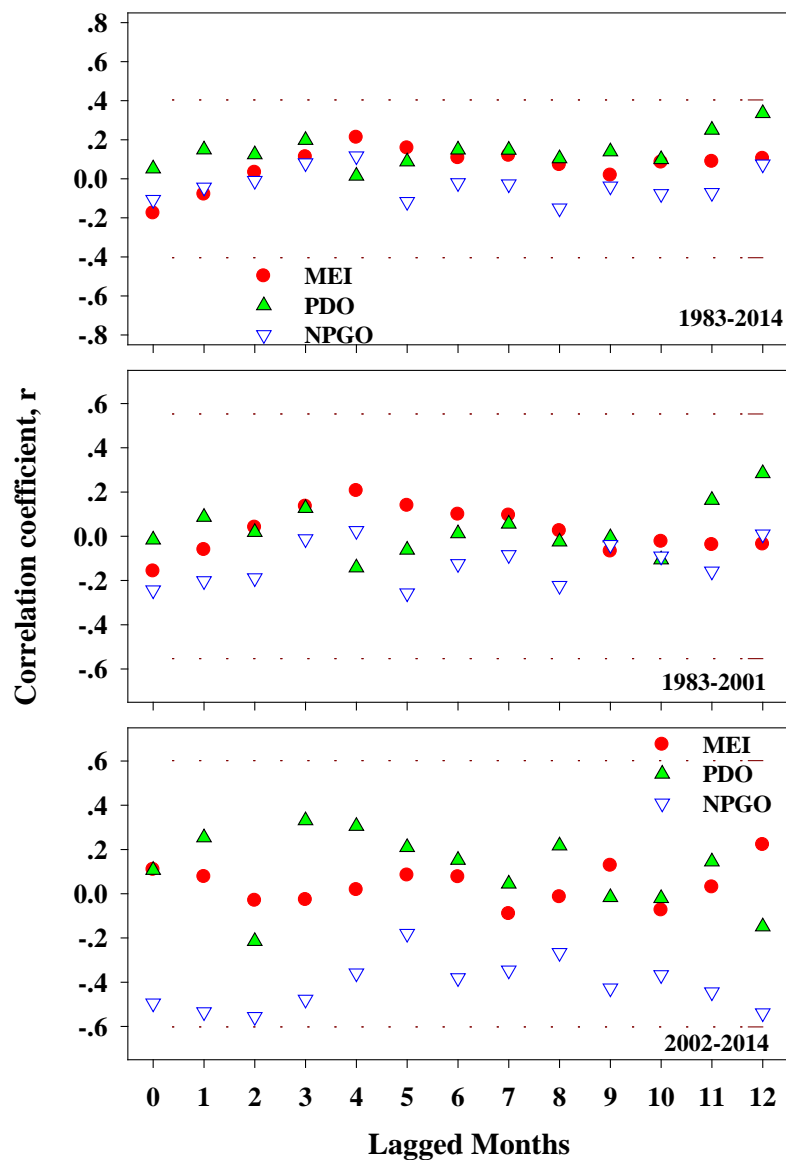


Western Buffer: Tides vs Climate Indices



Month Series

Yearly



Summary

- **Climate variability does show significant correlation effects on occurrences of red tides in Hong Kong, but often with some months lag**
- **Water quality improvement due to management reduced the number of red tides and also reduced climate effects**
- **Red tides in different water control zones respond differently to climate variability.**

Acknowledgement

Environmental Protection Department (EPD) for water quality data

Agriculture, Fisheries & Conservation Department (AFCD) for data on red tides

NSF China grant 91328203

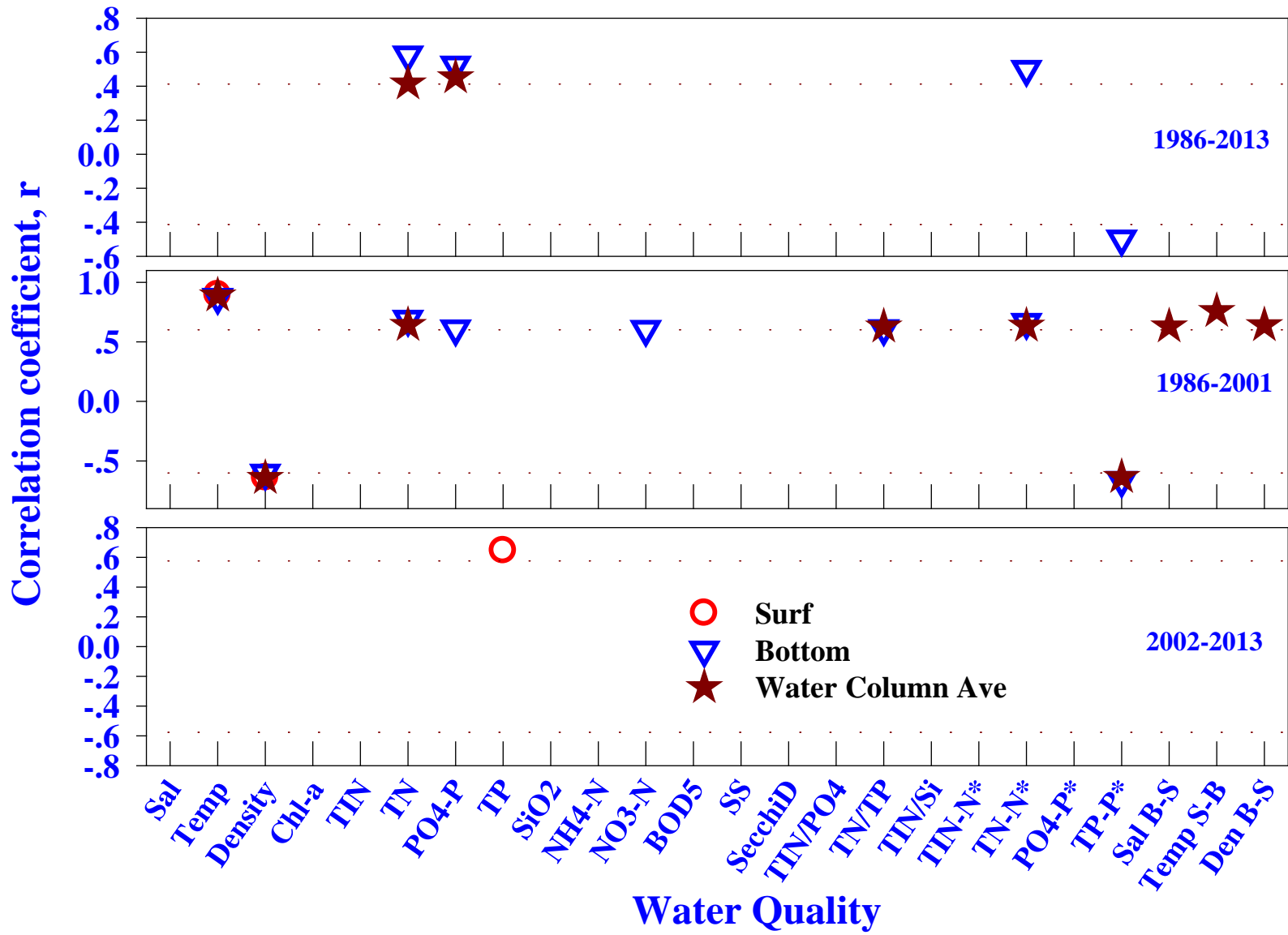
Guangdong KJT grant 2013B05100042



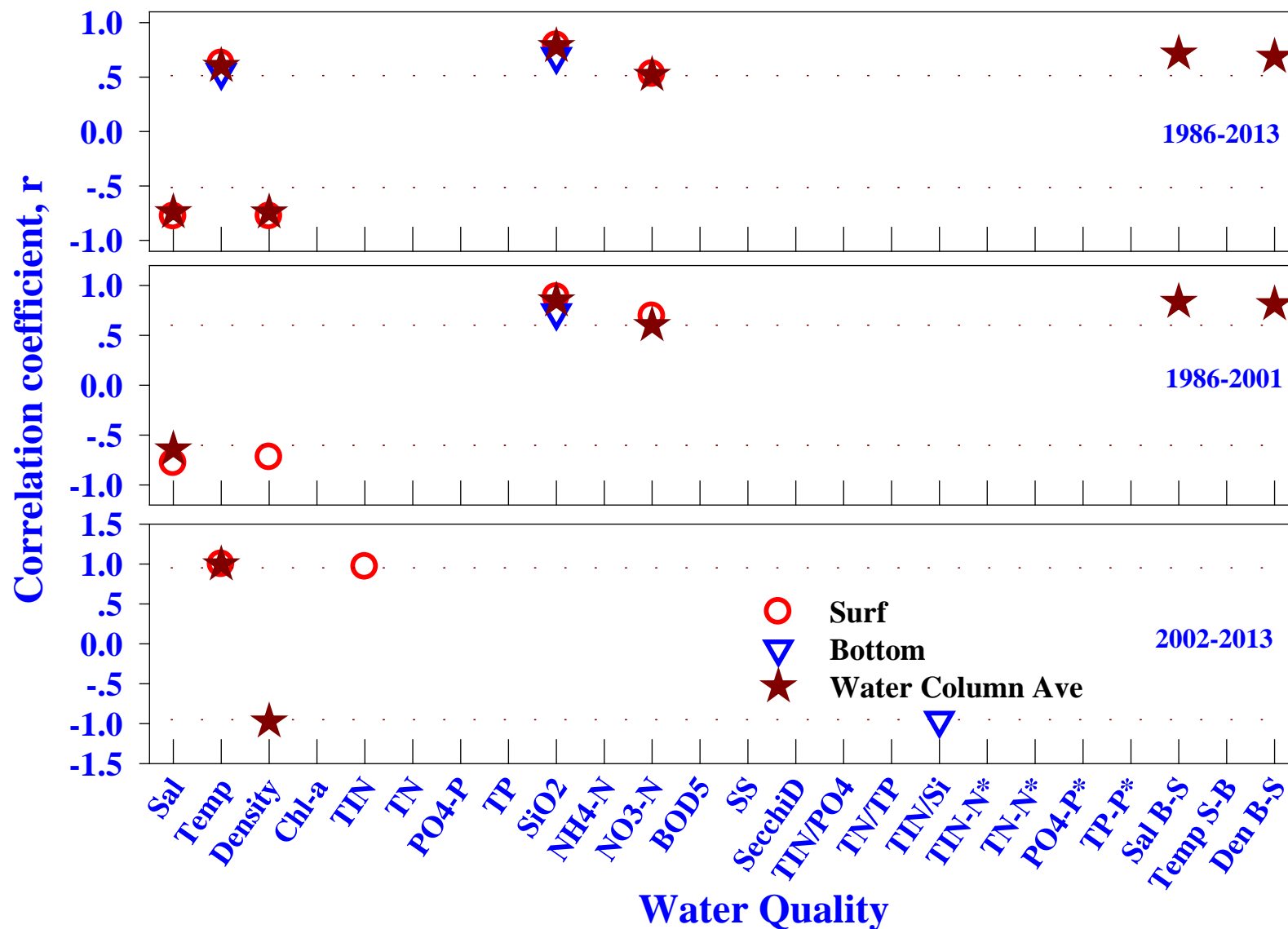
**Is the distribution of red
tides correlated with water
quality in HK?**



Northwest (Estuary): Month Series Red Tides vs WQ



Victoria Harbour: Month Series Red Tides vs WQs



End