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Does reduced sediment load contribute to increased outbreaks of harmful algal blooms off the Changjiang Estuary ?

Wang Baodong, Xin Ming

The First Institute of Oceanography, SOA

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# 1 Introduction

- Harmful algal blooms (HABs) are increasingly frequent in coastal waters around the world over the last several decades.
- **Influencing factors:**
  - > Nutrient conditions
  - > Algal species presence/abundance
  - > Degree of flushing or water exchange
  - > Weather conditions
  - > Presence and abundance of grazers
  - > Climate change
- **The accelerated coastal eutrophication is commonly assumed to be the primary cause of this increase.**

(e.g. Anderson et al., 2002; Heisler et al., 2008)

- The Changjiang River is ranked the fourth largest river in the world;
- The Changjiang Estuary is one of the high frequency occurrence areas of HABs in China Seas and even in the world oceans.



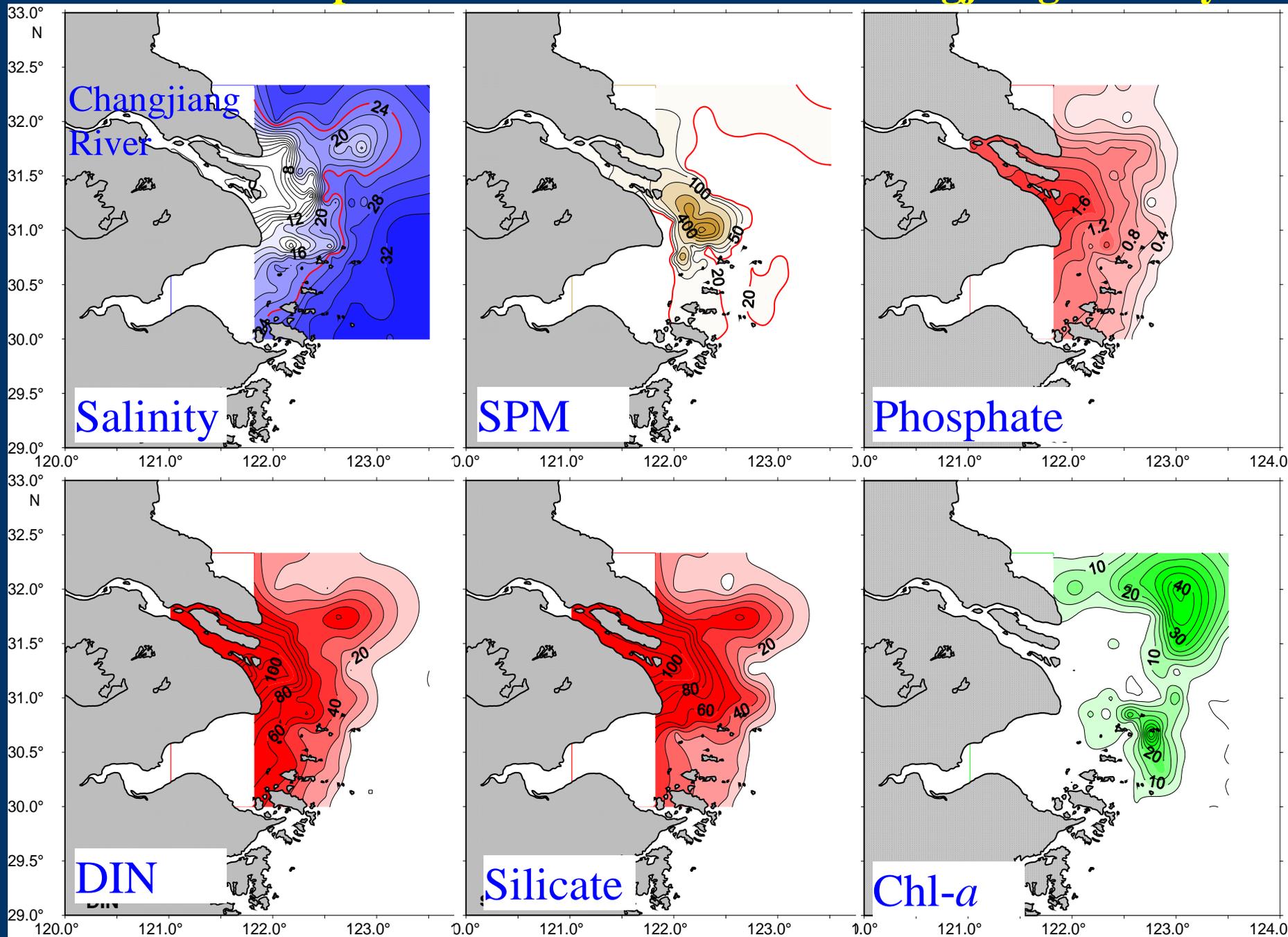
Could the increase of HABs be well-explained by accelerated coastal eutrophication off the Changjiang Estuary?

## **2 Examination of relationship between HABs and nutrient inputs off the Changjiang Estuary**

**Could the increase of nutrient inputs well-explain:**

- > Increase of frequency of HABs?**
- > Changes of occurrence area of HABs?**

# Distribution pattern of variables in the Changjiang Estuary



# Long term variations in riverine nutrient inputs and HABs in the Changjiang Estuary

Increased by 6-fold

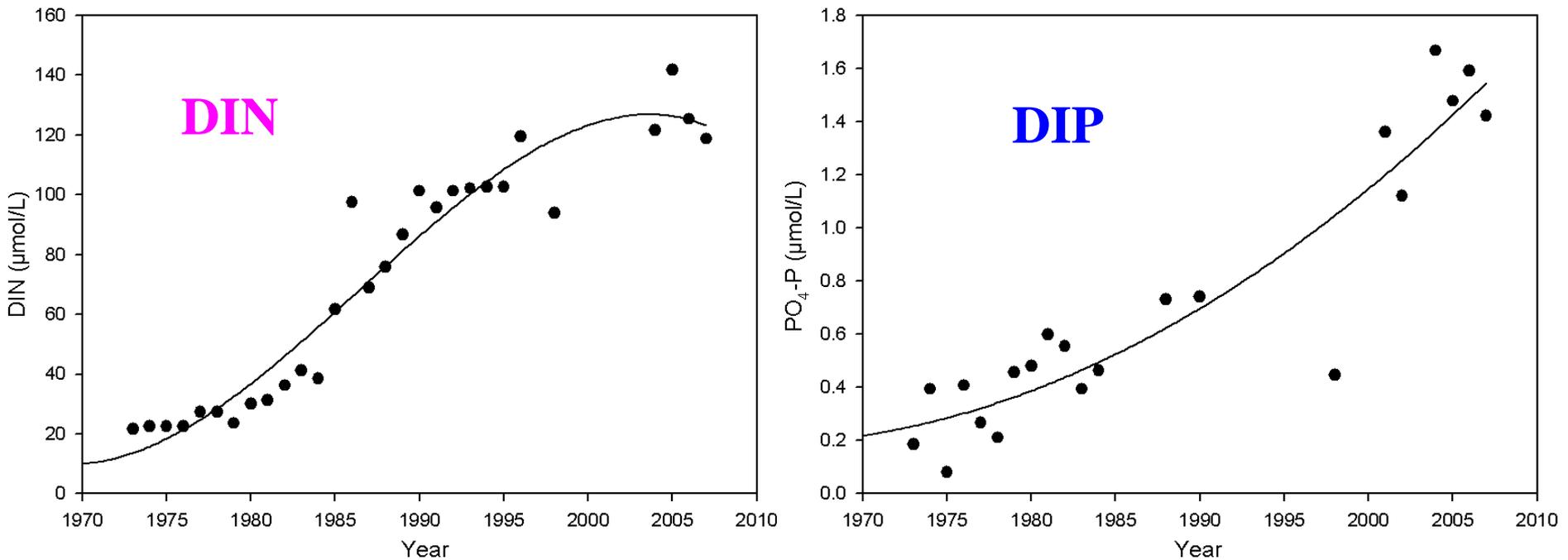


Fig. 1 Variations in nutrient concentrations in the Changjiang River freshwater over the past 40 years

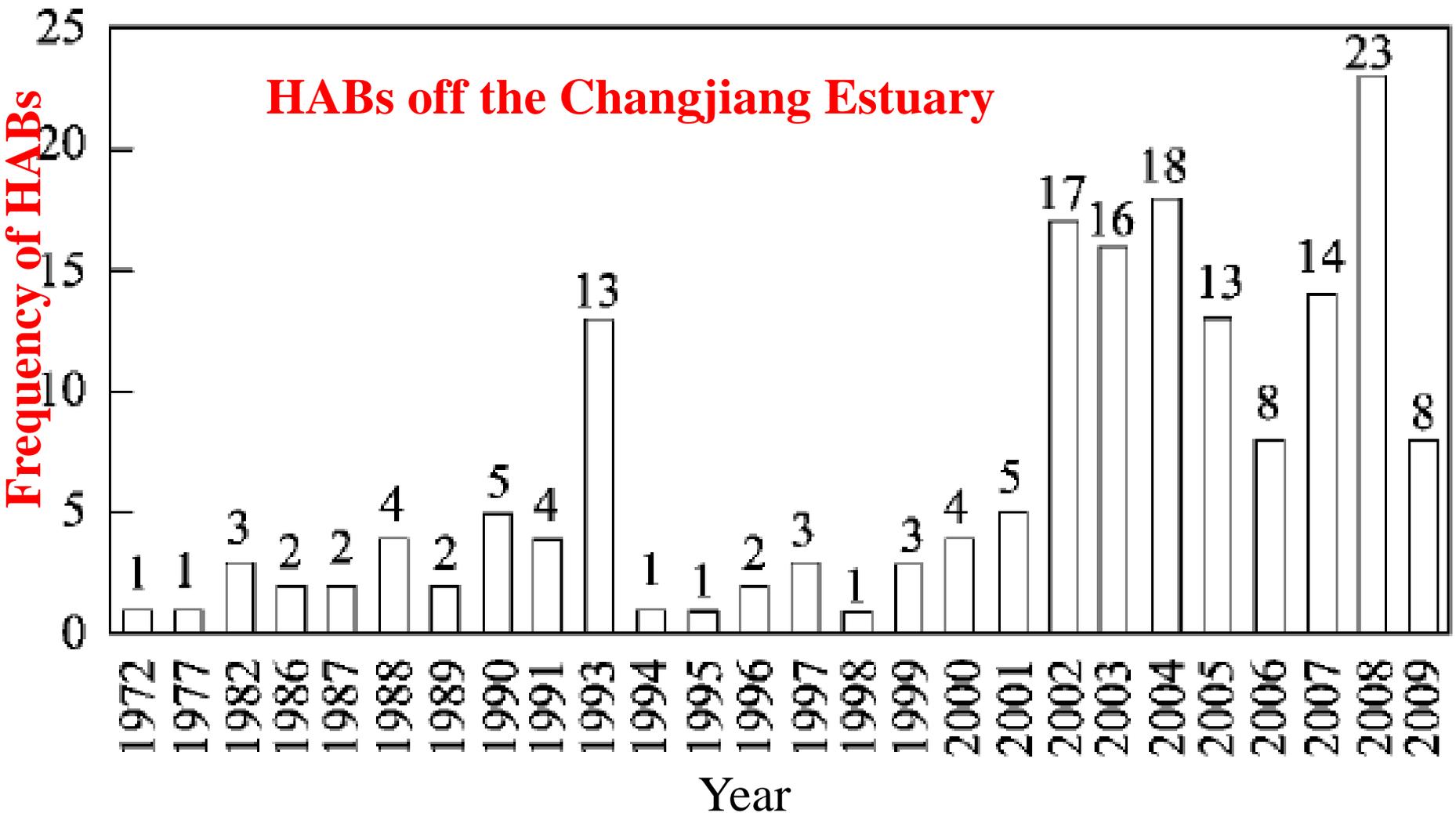
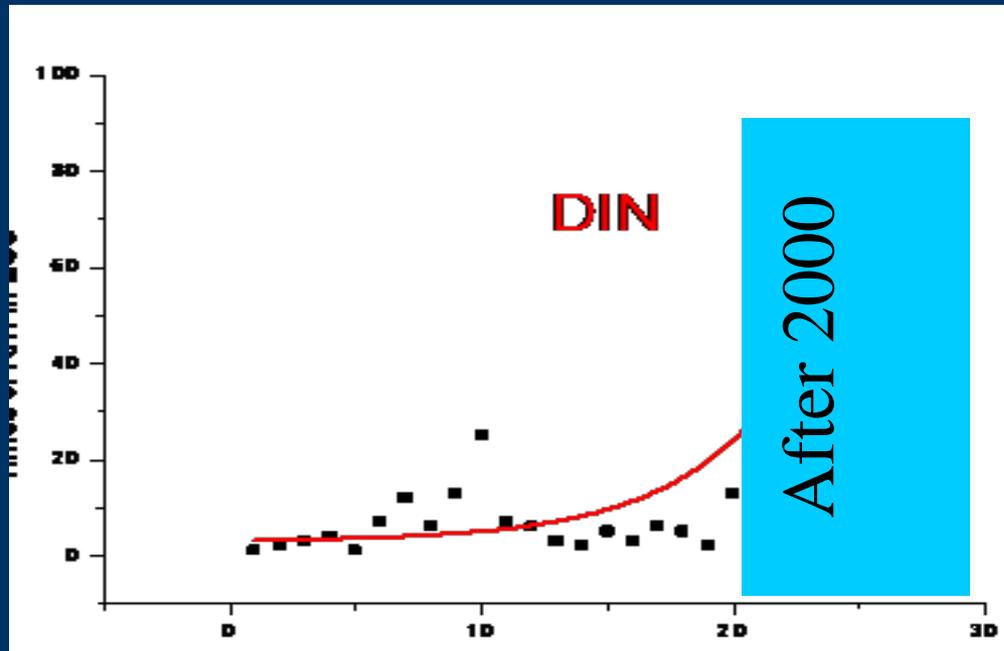


Fig. 1 Frequency of HABs off the Changjiang Estuary and adjacent coastal waters over the past 40 years (Liu et al., 2013)

# Correlation analysis between frequency of HABs and nutrient inputs off the Changjiang Estuary

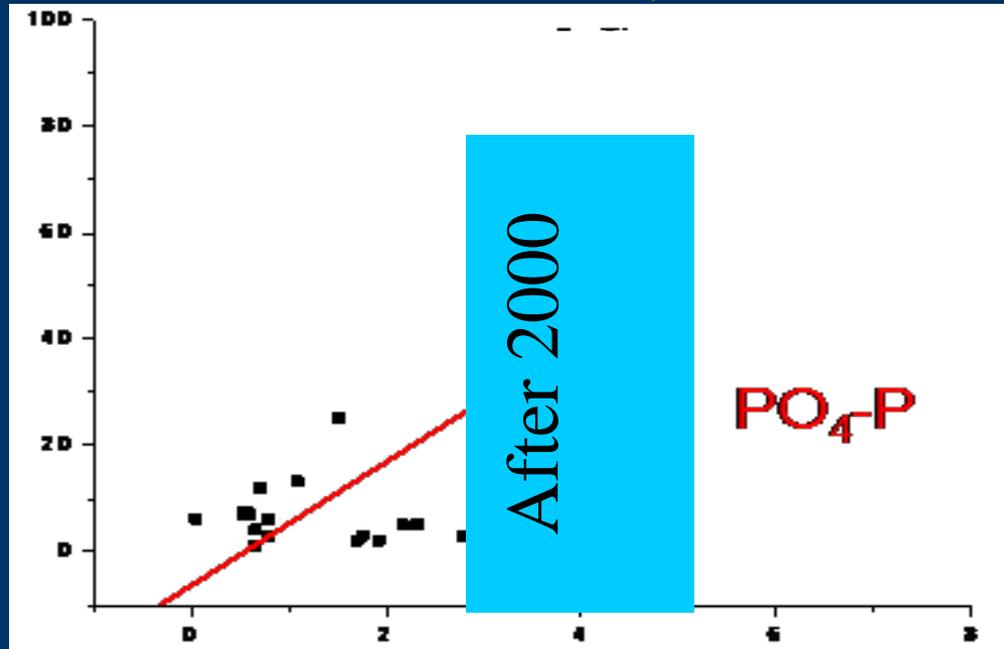
No. of HABs



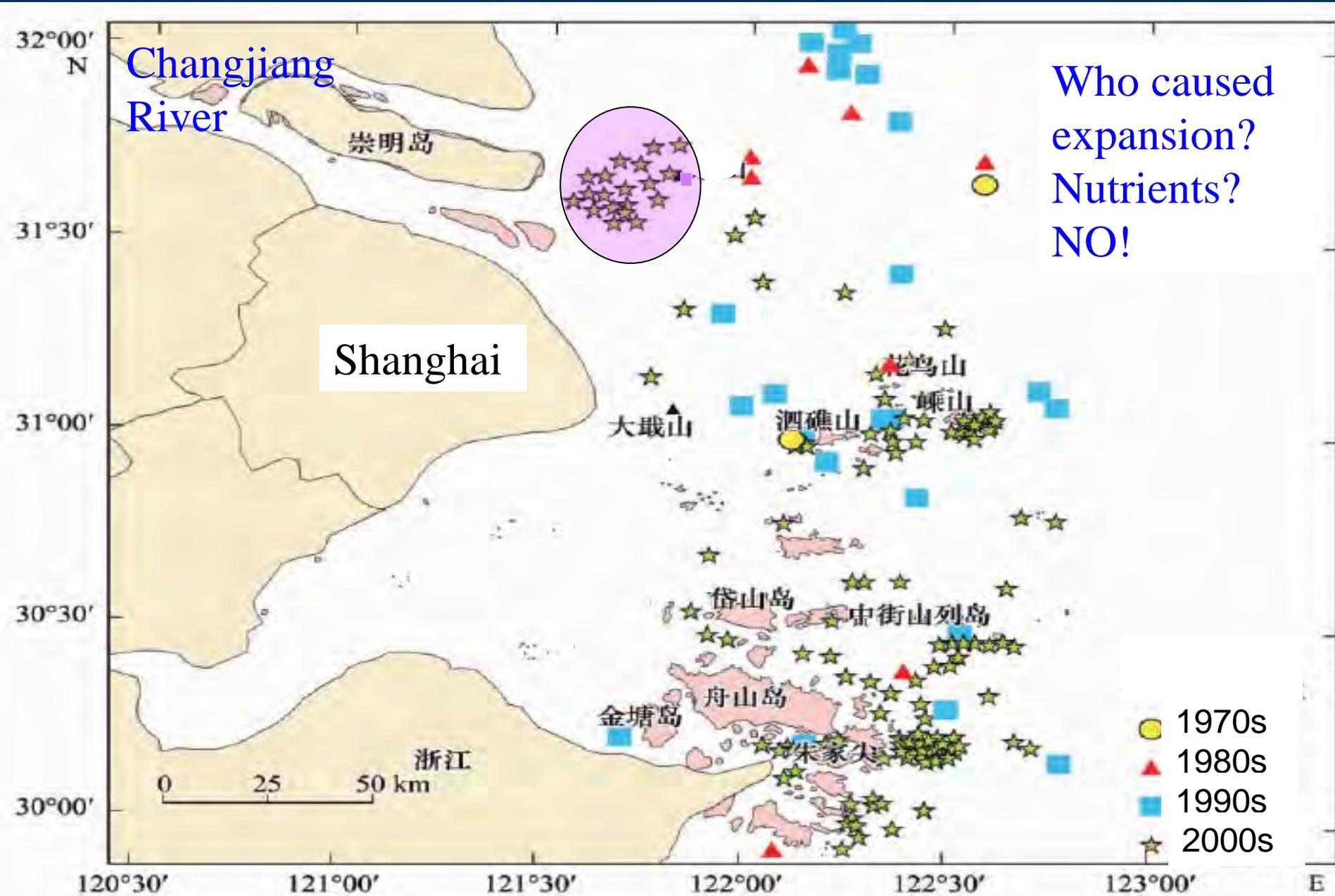
Flux of DIN ( $10^5$  t/yr)

Before 2000, no positive correlation between frequency of HABs and nutrient inputs.

No. of HABs



Flux of DIP ( $10^4$  t/yr)



Who caused expansion?  
Nutrients?  
NO!

Locations of HAB incidents off the Changjiang Estuary and adjacent coastal waters over the past four decades (Liu et al., 2013)

### 3 Contribution of reduced sediment load to increased HABs off the Changjiang Estuary

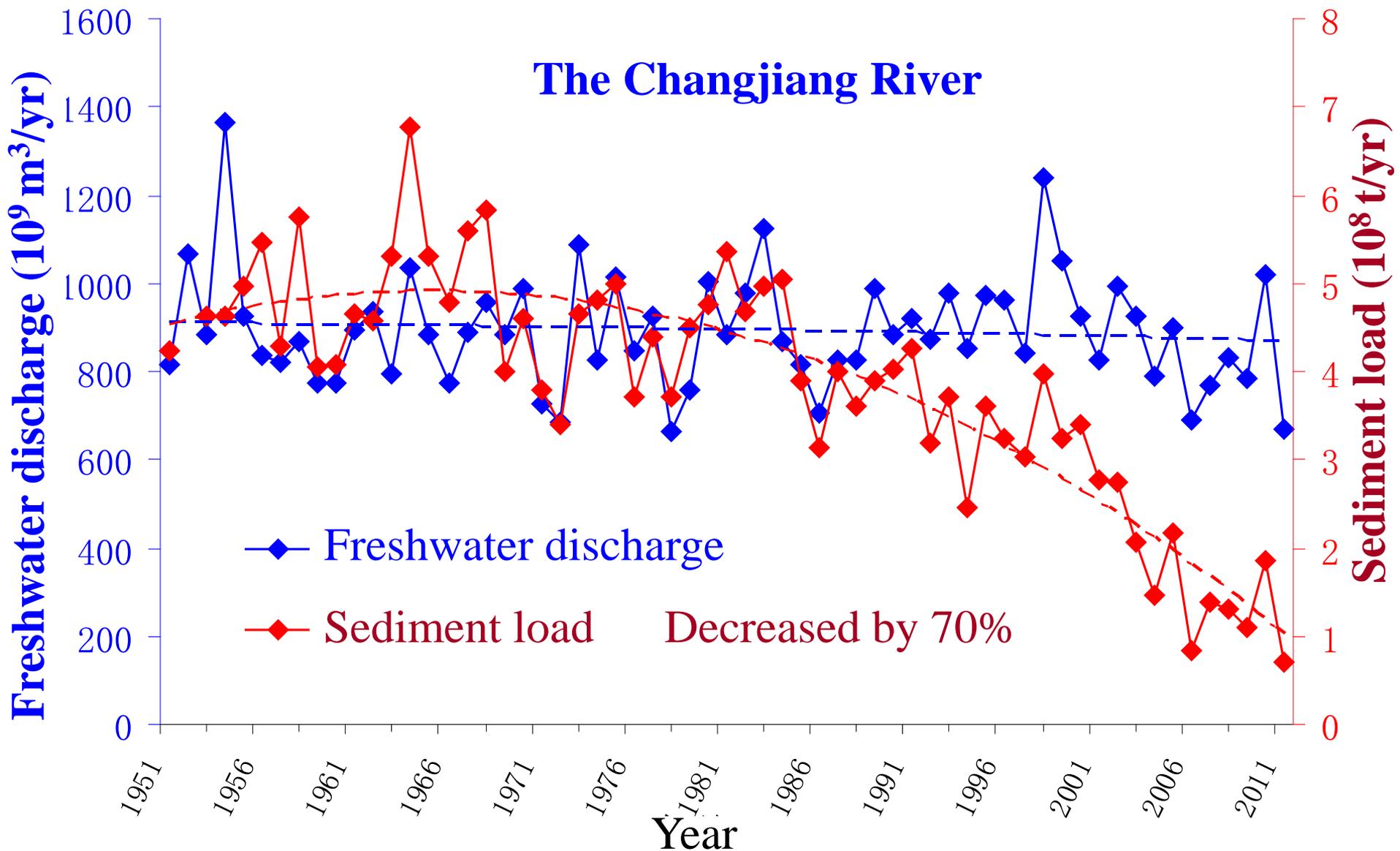
#### Problems:

- The variation in frequency of HABs could not be well-explained by those of nutrient inputs off the Changjiang Estuary.
- The expansion of HAB occurrence area to low salinity region could not be explained by variation in nutrient inputs off the Changjiang Estuary.

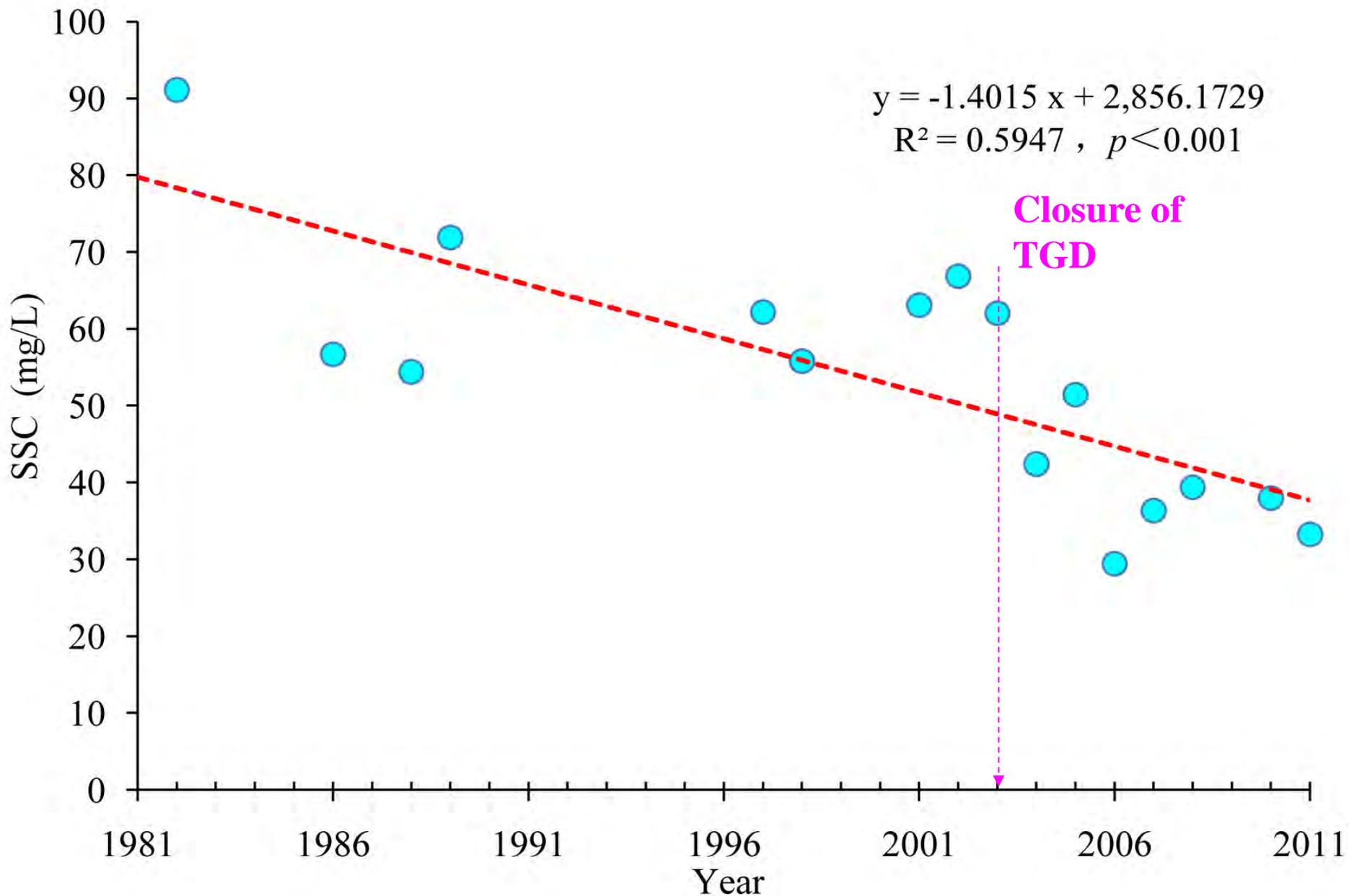
#### Question:

- Is there any changes in riverine material fluxes **other than nutrients** may significantly affect biological activities as well as HABs off the Changjiang Estuary?

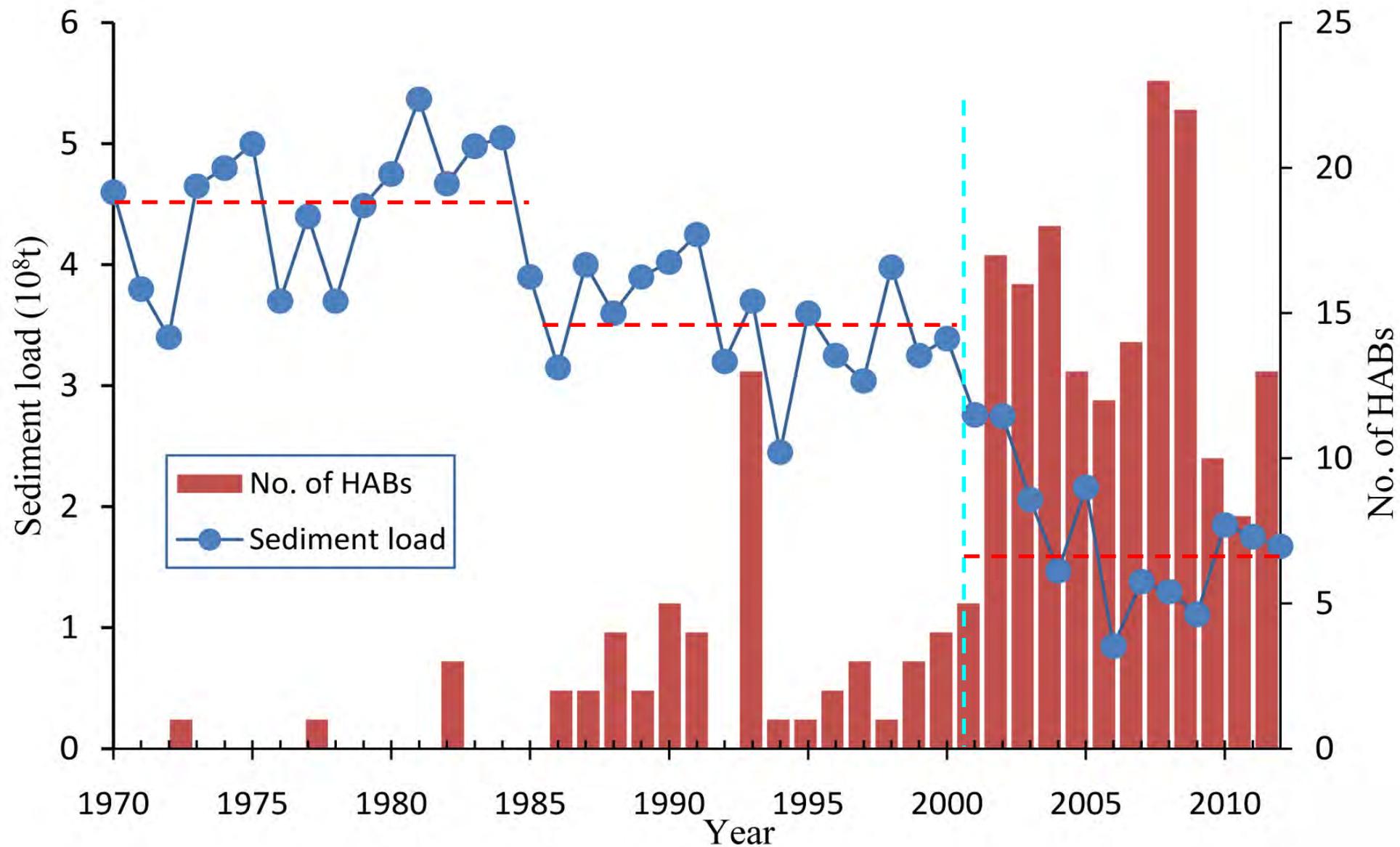
**Reduction of sediment load?**



Long term variations in freshwater discharge and sediment load from the Changjiang River



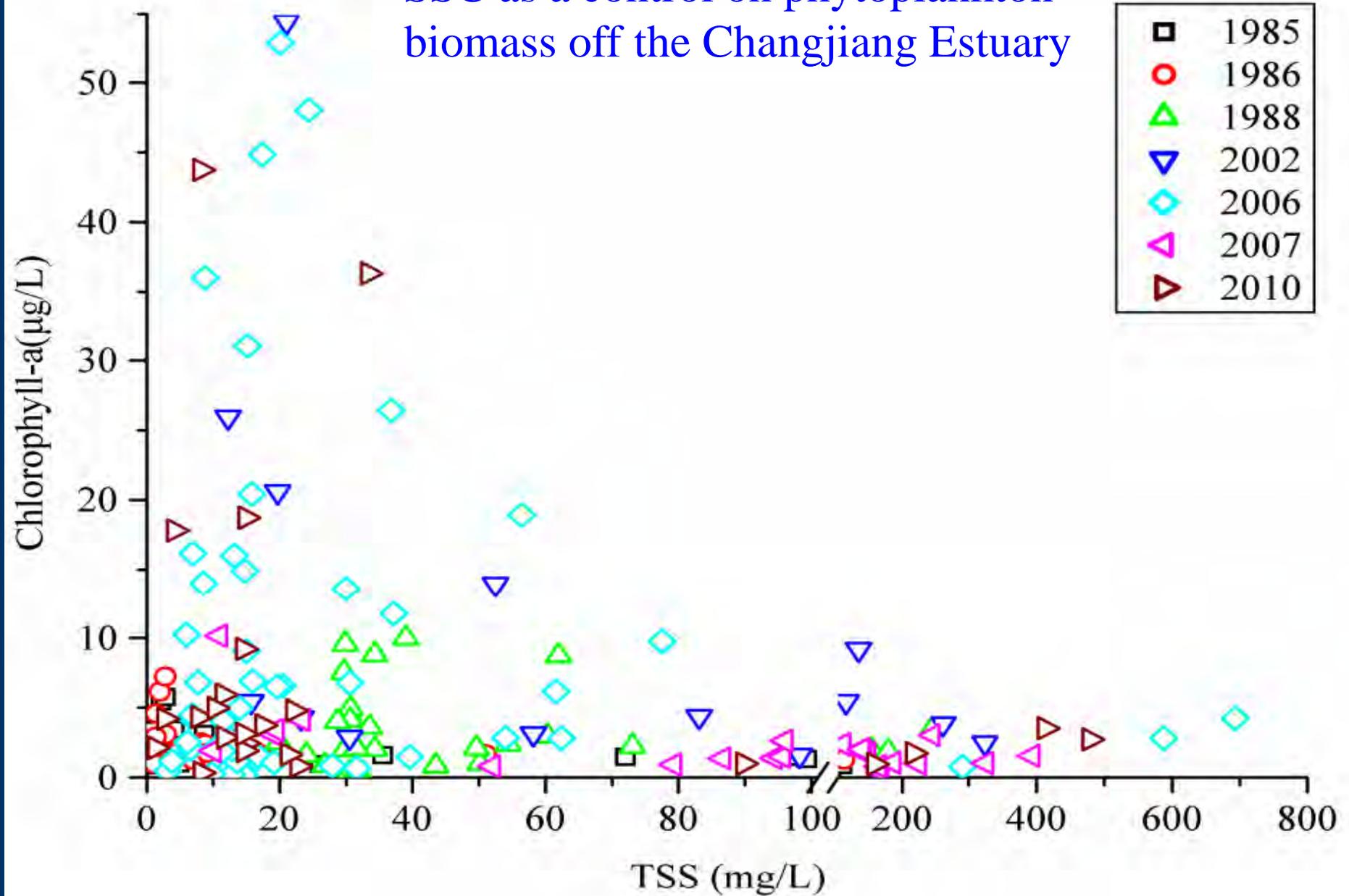
Long term variation in surface sediment concentration (SSC) off the Changjiang Estuary



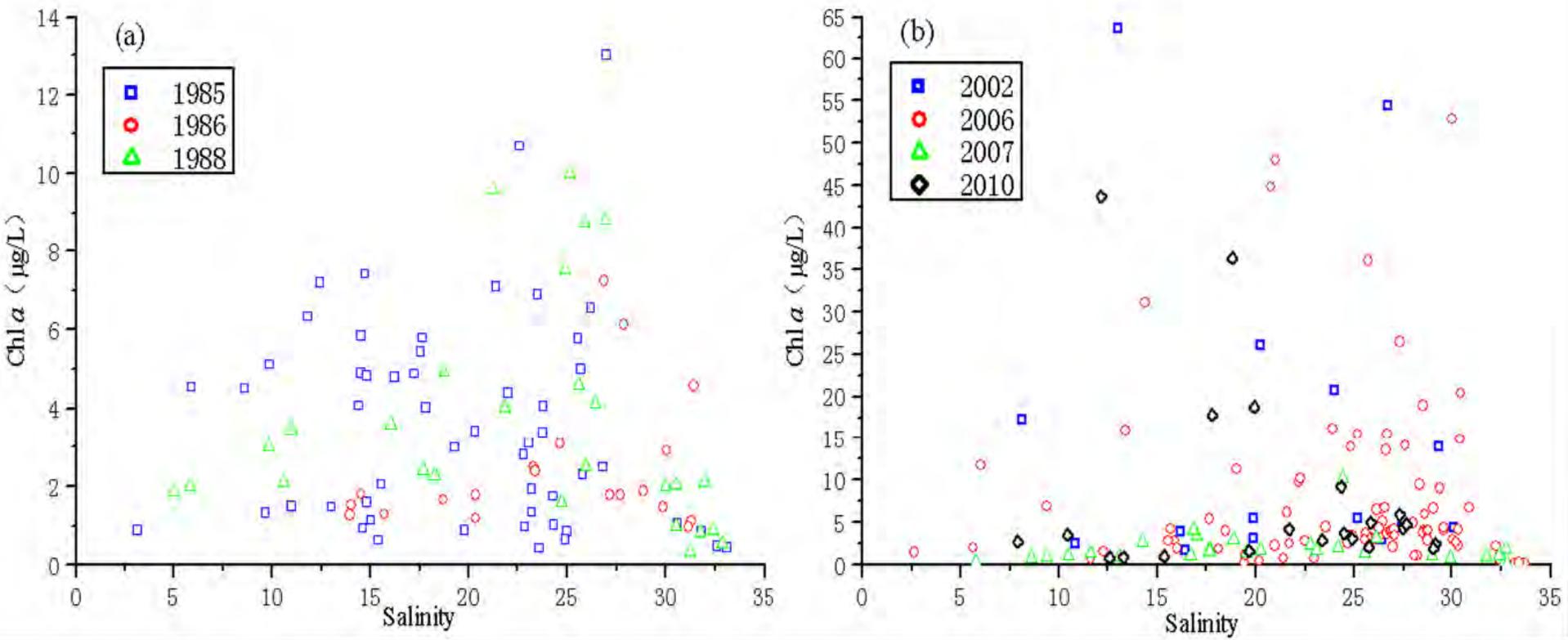
Long term variations of sediment load from the Changjiang River and frequency of HABs off the Changjiang Estuary

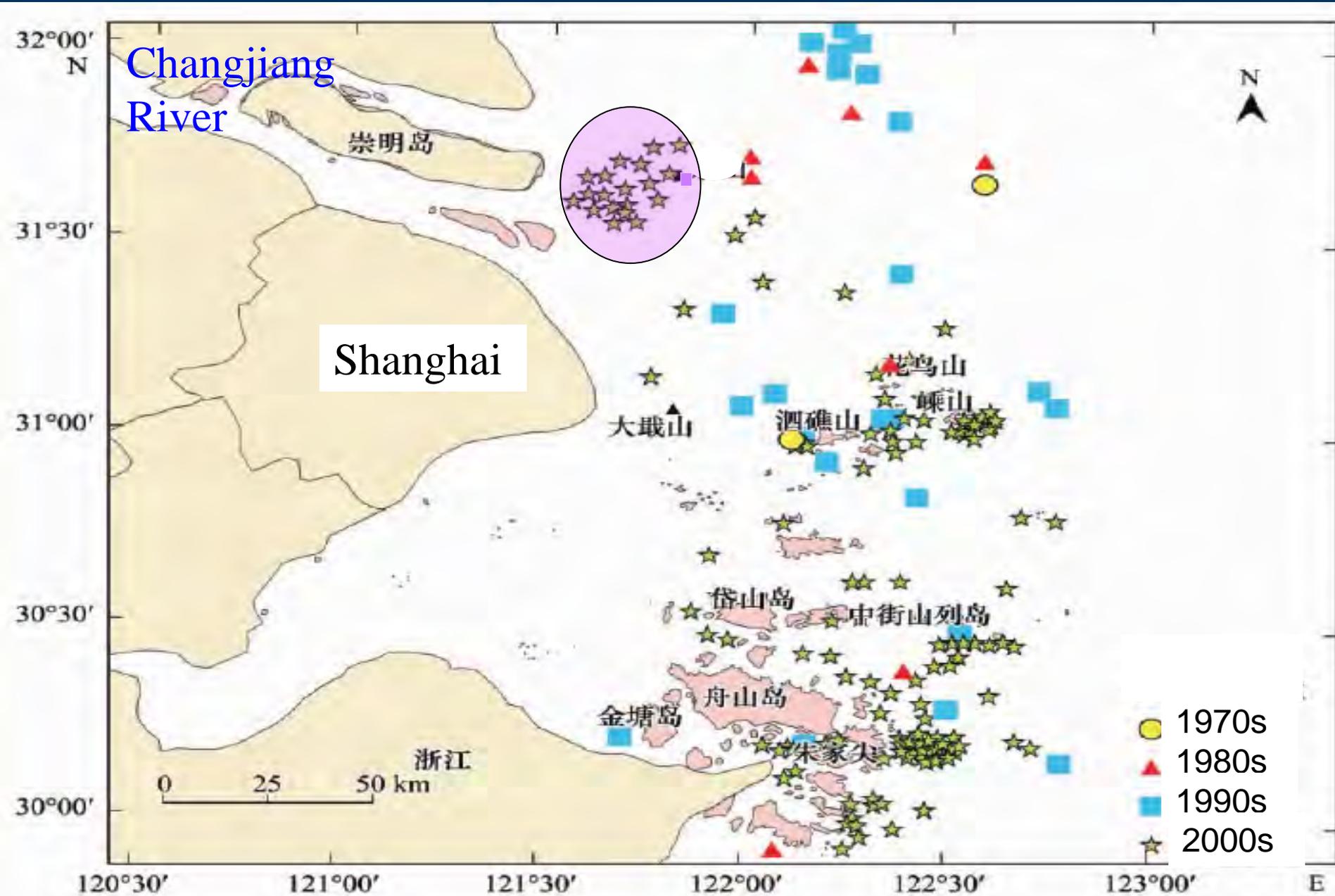
Correlation analysis between sediment load and frequency of HABs  
off the Changjiang Estuary

# SSC as a control on phytoplankton biomass off the Changjiang Estuary



# Distribution of Chl-*a* along salinity gradients off the Changjiang Estuary





Locations of HAB incidents off the Changjiang Estuary and adjacent coastal waters over the past four decades (Liu et al., 2013)

## 4 Summary

■ The variations in both **frequency** and **occurrence area** of HABs off the Changjiang Estuary **could not be well-explained** by those of riverine nutrient inputs.

■ The **drastic reduction in riverine sediment load** have led to expansion of the phytoplankton biomass maximum to a much lower salinity region, and thus **is responsible for expansion of HAB occurrence area** to low salinity region off the Changjiang Estuary.

■ Both the **increase in riverine nutrient inputs** and **reduction in sediment load** contribute to the increase of HAB frequency off the Changjiang Estuary.



Thanks for your attention