Runoff and sand transport flux' variability in Changjiang, its influence on the ecosystem and resources of East China sea

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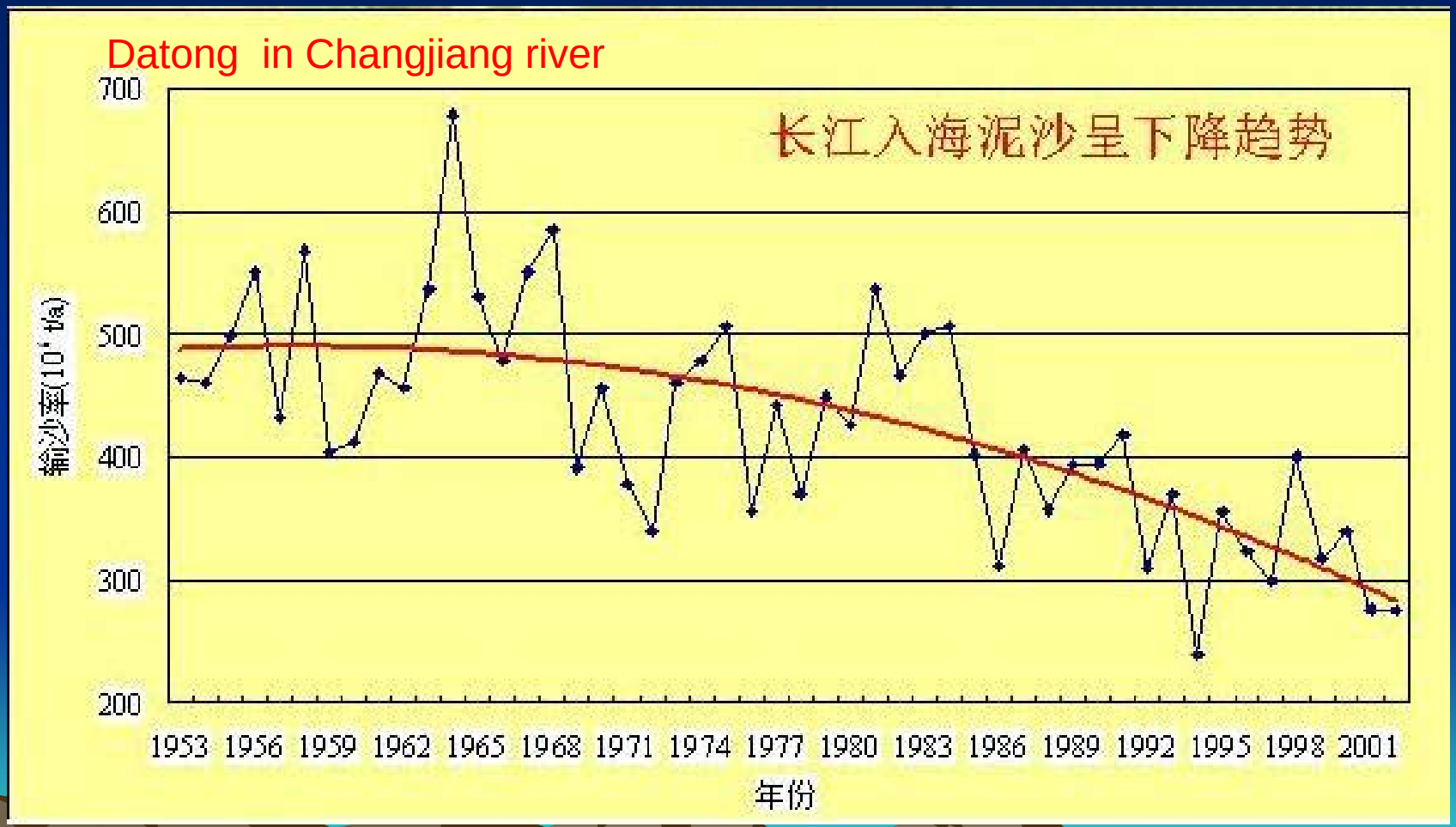
Background

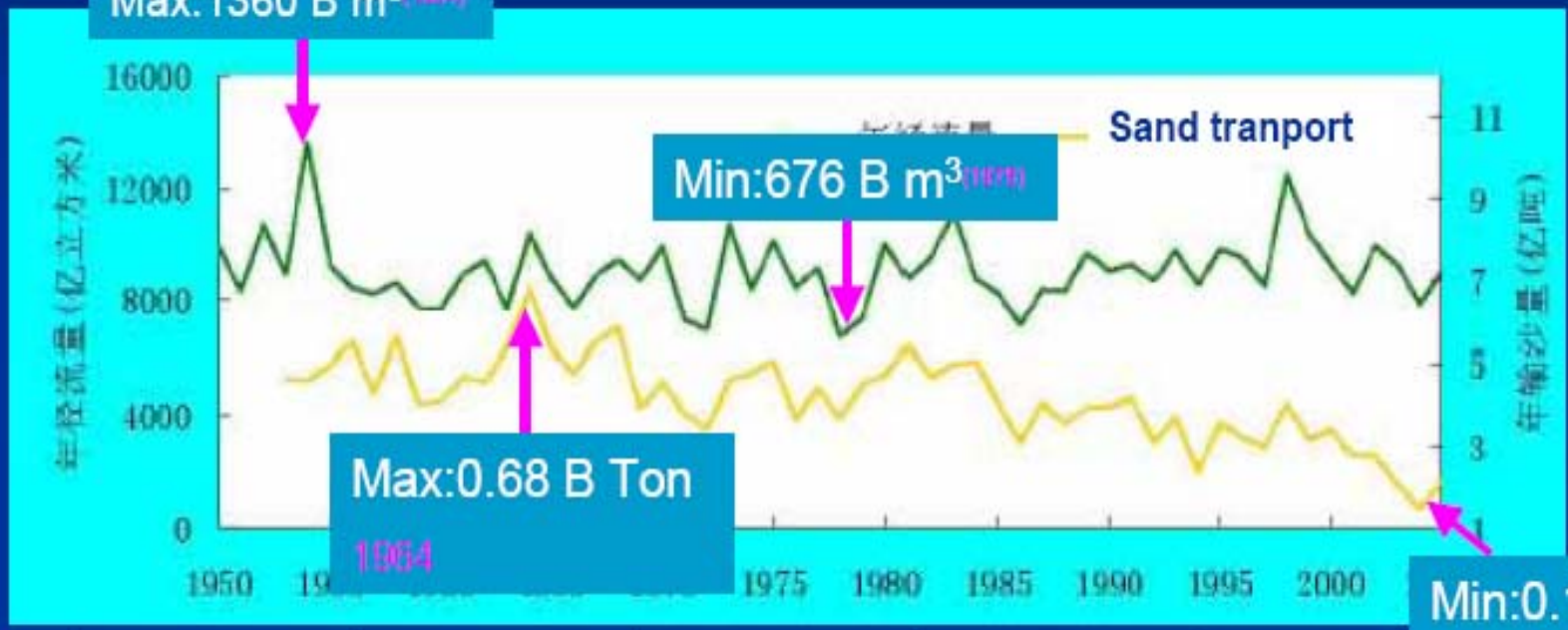
Sediment load decrease more obviously since 1960s



The sand transport flux and Runoff of Changjiang Estuary

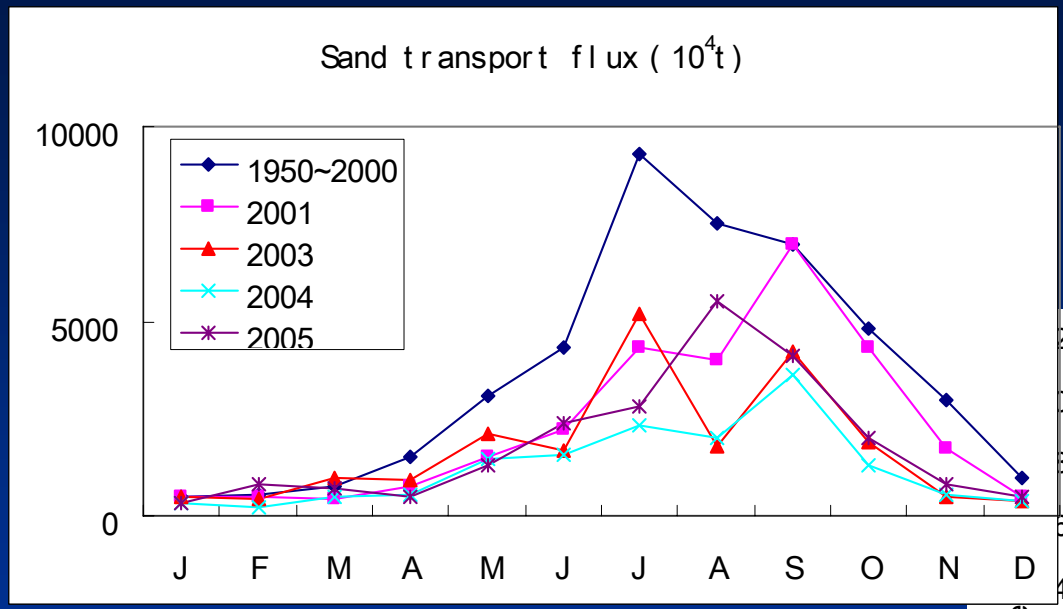
The average annual runoff of Changjiang Estuary is 905 billion m3 (1950~2005)

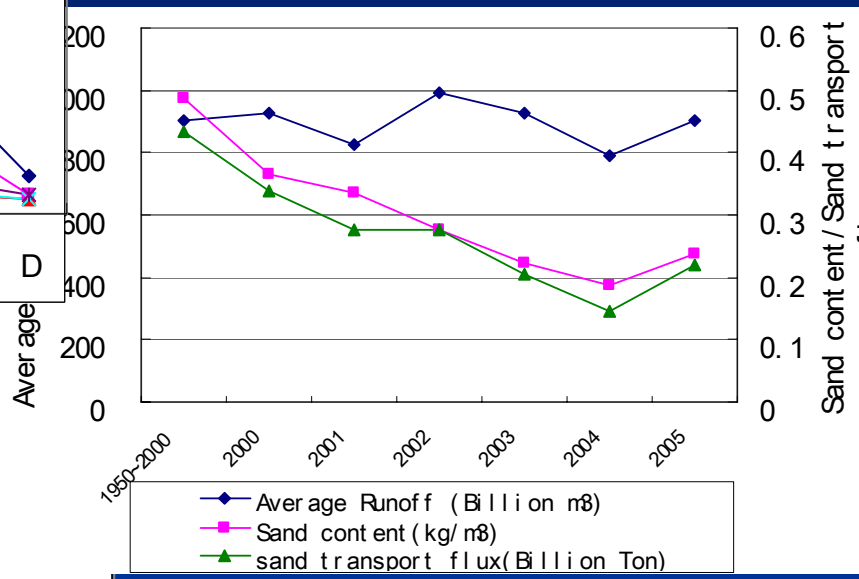
The average annual sand transport flux is about 0.43 billion ton (1950~2005)

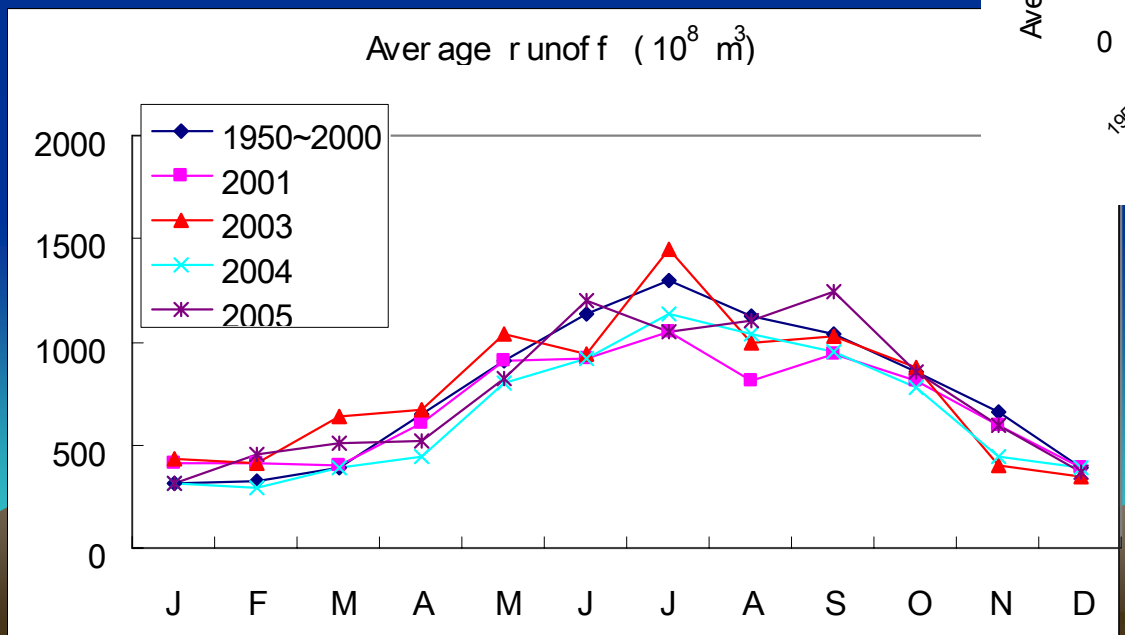


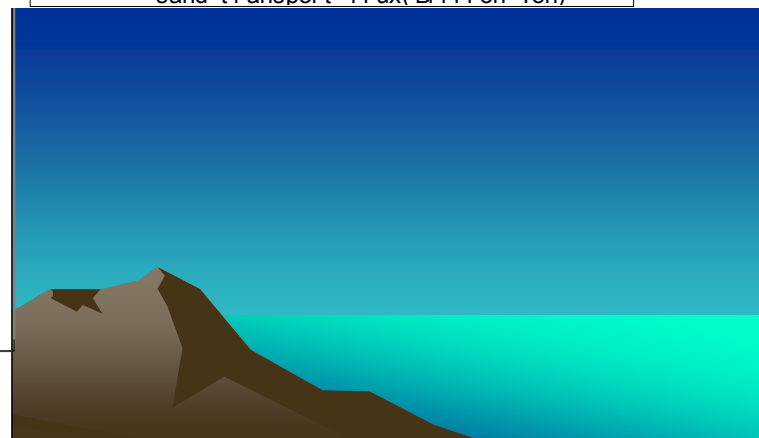
Year	Average Runoff (Billion m3)	Compared with Average	Sand content(kg/m3)	Compared with Average	sand transp flux(Billion Ton)	Average
1950~2000	905		0.486		0.43	
2000	927	2.4%	0.366	-24.7%	0.34	-21.7%
2001	825	-8.9%	0.336	-30.9%	0.28	-36.3%
2002	993	9.7%	0.277	-43.0%	0.28	-36.5%
2003	925	2.2%	0.223	-54.1%	0.21	-52.4%
2004	788	-12.9%	0.186	-61.7%	0.15	-66.1%

Seasonal variation









The reason for the change of sand transport flux

1. Soil and forest protection along the changjiang river
2. Dam construction

Table 2
Distribution of 162 major dams (>0.1 km^3) and silicon fixed in reservoirs in YRDB. V_{fr} – volume of constructed dam; V_{frYR} – total volume of reservoirs in YRDB; N_{fr} – number of constructed dams; N_{frYR} – total number in the drainage basin; FC_{fr} – carbon trapped by reservoirs; FSi_{fr} – silicon trapped by reservoirs; V_{pr} – volume of programming dam; N_{pr} – number of programming dams. Letters in BOLD were discussed in text (data sources: Changjiang River General Thesaurus Compilation Committee, 1999; Changjiang River Statistical Almanac Committee, 1992–2004)

River/Tributaries	V_{fr} km^3	V_{fr}/V_{frYR} %	N_{fr} No.	N_{fr}/N_{frYR} %	FC_{fr} 10^9 mol	FSi_{fr} 10^9 mol	FSi_{fr} 10^3 t	V_{pr} km^3	N_{pr} Number
Main channel:									
Three Gorge Dam	39.30				30.29	**4.57**	**6.40**		
Gezhouba Dam	1.58				1.44	0.22	0.30		
Total Main channel	40.88	26.30	2	1.06	31.73	4.79	6.70		
Tributaries of JSH:									
Yalong Jiang	6.46	4.15	2	1.06	2.21	0.33	0.47	30.71	19
Pudu He	0.78	0.50	3	1.59	0.67	0.10	0.14	0.54	2
Niulan Jiang								1.23	8
Heng Jiang								0.51	9
Other tributaries of JSH			2	1.06				89.64	12
Tributaries of Upper YR:									
Min Jiang	1.93	1.24	13	6.88	2.77	0.42	0.58	22.02	26
Tuo Jiang	0.23	0.14	1	0.53	4.97	0.75	1.05	0.00	
Jialing Jiang	7.94	5.11	10	5.29	9.53	1.44	2.01	9.18	6
Wu Jiang	9.00	5.79	10	5.29	24.00	3.62	5.07	9.14	8
Other tributaries of Upper YR	1.36	0.88	5	2.65	1.10	0.17	0.23	0.08	1
Total Upper Changjiang	27.70	17.82	46	24.34	45.25	6.83	9.56	163.04	91
Tributaries of Middle YR:									
Xiang Jiang	11.88	7.64	12	6.35	8.26	1.25	1.75	3.00	9
Zi Shui	2.44	1.57	6	3.17	1.83	0.28	0.39	1.44	12
Yuan Shui	5.07	3.26	5	2.65	2.63	0.40	0.56	7.64	13
Li Shui	3.34	2.15	7	3.70	3.09	0.47	0.65	7.20	14
Total DTL	22.72	14.62	30	15.87	15.81	2.39	3.34	19.27	48
Gan Jiang	5.09	3.27	13	6.88	4.69	0.71	0.99	20.66	8
Xiu Shui	8.25	5.31	3	1.59	3.92	0.59	0.83	0.68	2
Wu He	0.93	0.60	1	0.53	0.84	0.13	0.18	1.90	4
Xin Shui	0.19	0.12	1	0.53	0.27	0.04	0.06	0.53	4
Other tributaries of PYL	0.28	0.18	4	2.12	0.53	0.08	0.11	4.38	6
Total PYL	14.74	9.48	22	11.64	10.26	1.55	2.17	28.14	24
Han Jiang	25.46	16.38	21	11.11	17.03	2.57	3.60	5.85	16
Other tributaries of Middle YR	12.28	7.90	20	10.58	14.74	2.22	3.11	5.13	2
Total Middle YR	75.20	48.38	93	49.21	57.83	8.73	12.22	58.40	90
Total tributaries of lower YR	11.66	7.50	21	11.11	12.99	1.96	2.744	1.40	3
Total YR	**155.44**	100.00	**162**	85.71	147.79	22.31	**31.23**	**222.83**	**184**

Dam

◆**Three Gorges Project (TGP), as one of the biggest hydropower-complex project in the world, ranks as the key project for improvement and development of Changjiang River.**

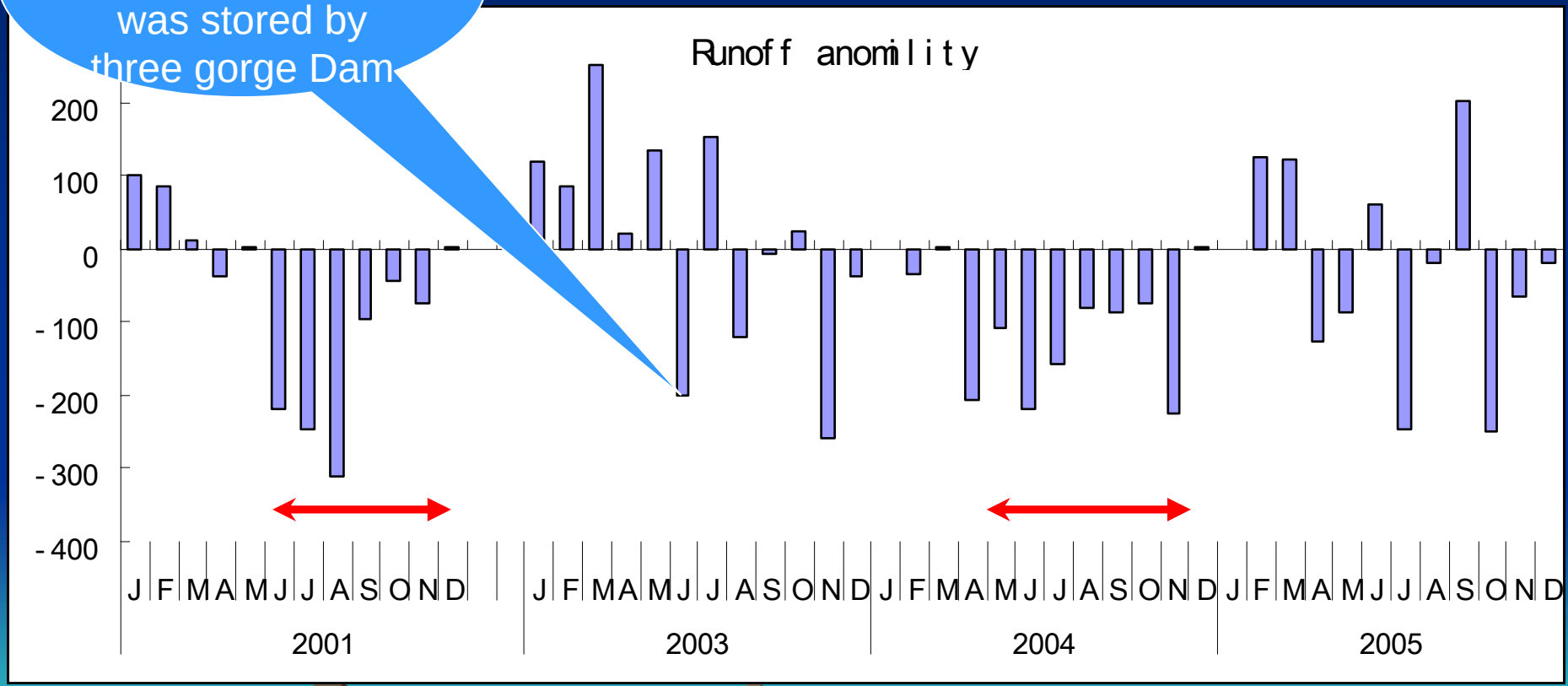
◆**O*n 1st June 2003*, the reservoir began its storage.**

◆**On 20 July 2007, to reduce the pressure on the middle and lower reaches of the Changjiang River, the TGP Reservoir began to retain floods, playing its role in flood control .**

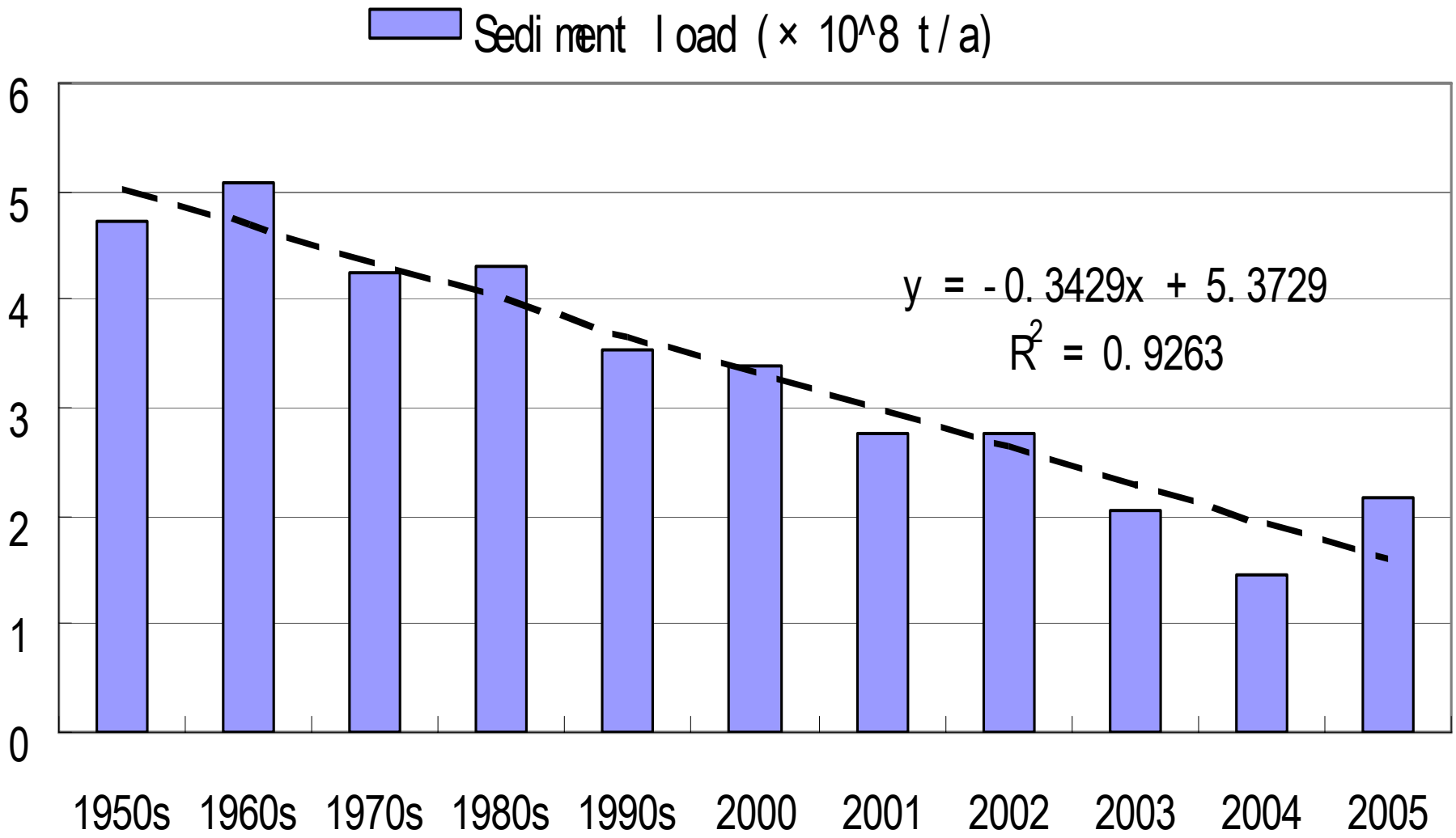
The Yangtze River basinwater will receive additional 184 new big programming dams to prevent floods and generate electricity, to meet rapid growth of population and economic development over the whole drainage basin. This plans the volume of programming dams of 222.83 km3, and will induce further decrease in DSiC and DSi flux into the sea. The dams have also resulted in a decrease in sediment flux to the sea.

sand flux changed greatly in recent year

1~10 Jun, 10 billion ton water was stored by three gorge Dam



The yearly sediment load recorded at Datong station has verified this sharp reduction since the 1950s. Long before the Dam construction



Water and Soil restoration project changed sand flux change

◆During 2001~2005, the area of water and soil regulation completed was 21, 000 km^2,

◆ The area of Ecological Restoration was 2,060 km^2 ;

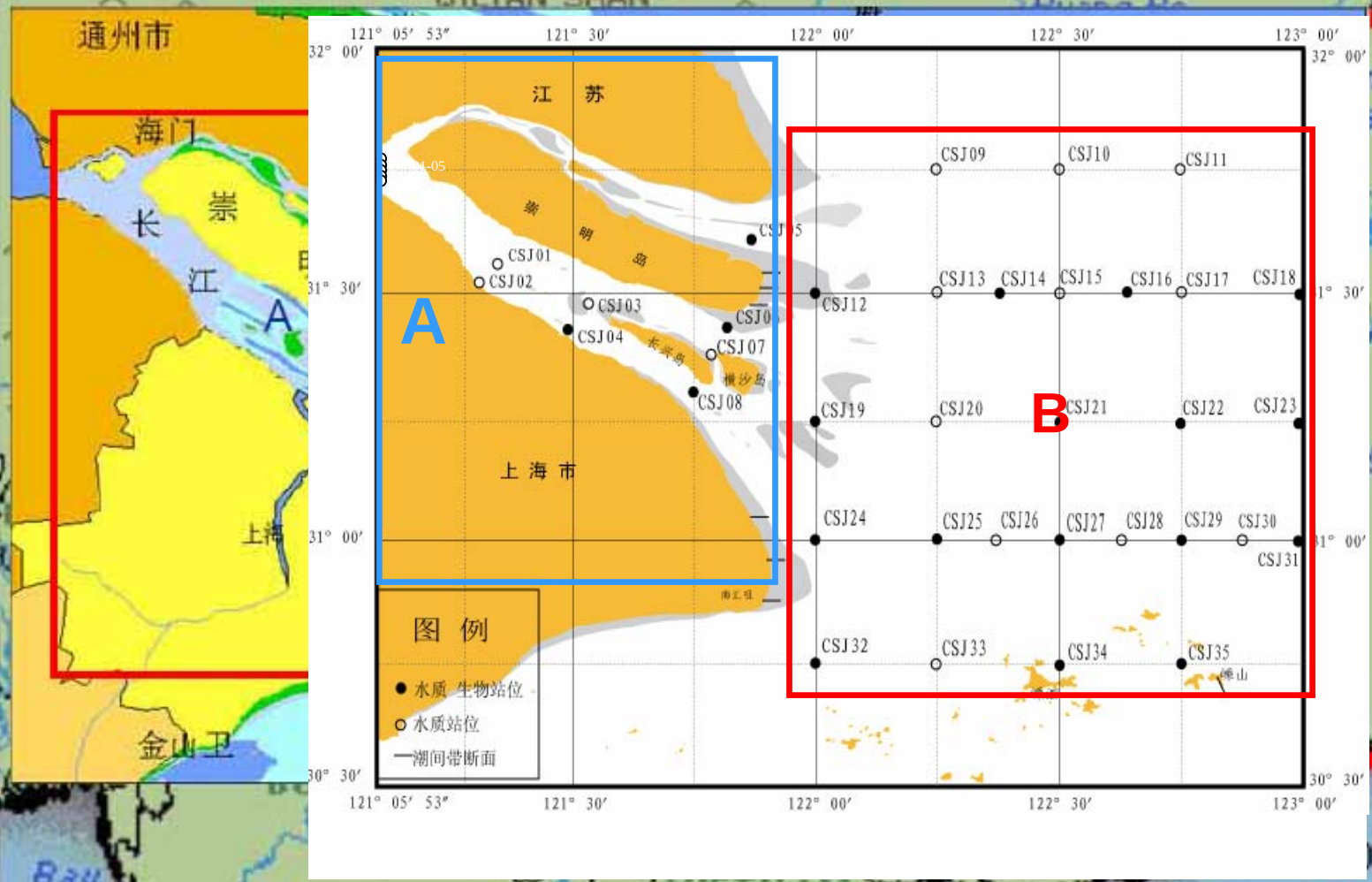
◆Moreover, the area of precaution and protection in head-stream of Changjiang River and waterhead of Dan Jiang Kou Reservoir at the middle engineer of South-to-North Water Diversion was 110,000 km^2.

◆the restoration of Water and Soil are the main reason of sand flux change

Question

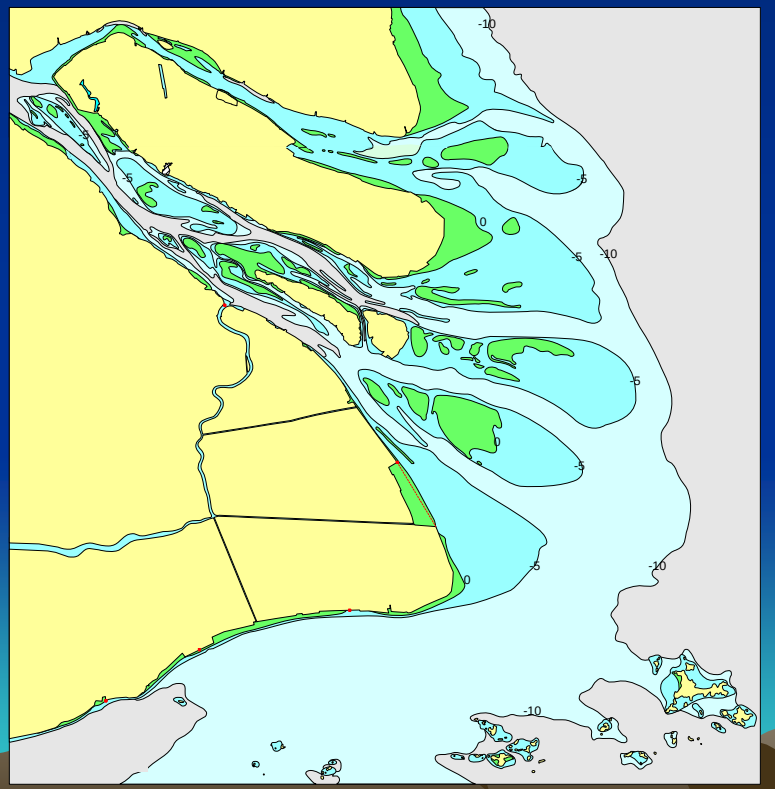
- What’s effects have been observed ?
- What other effects can be expected in longer term?

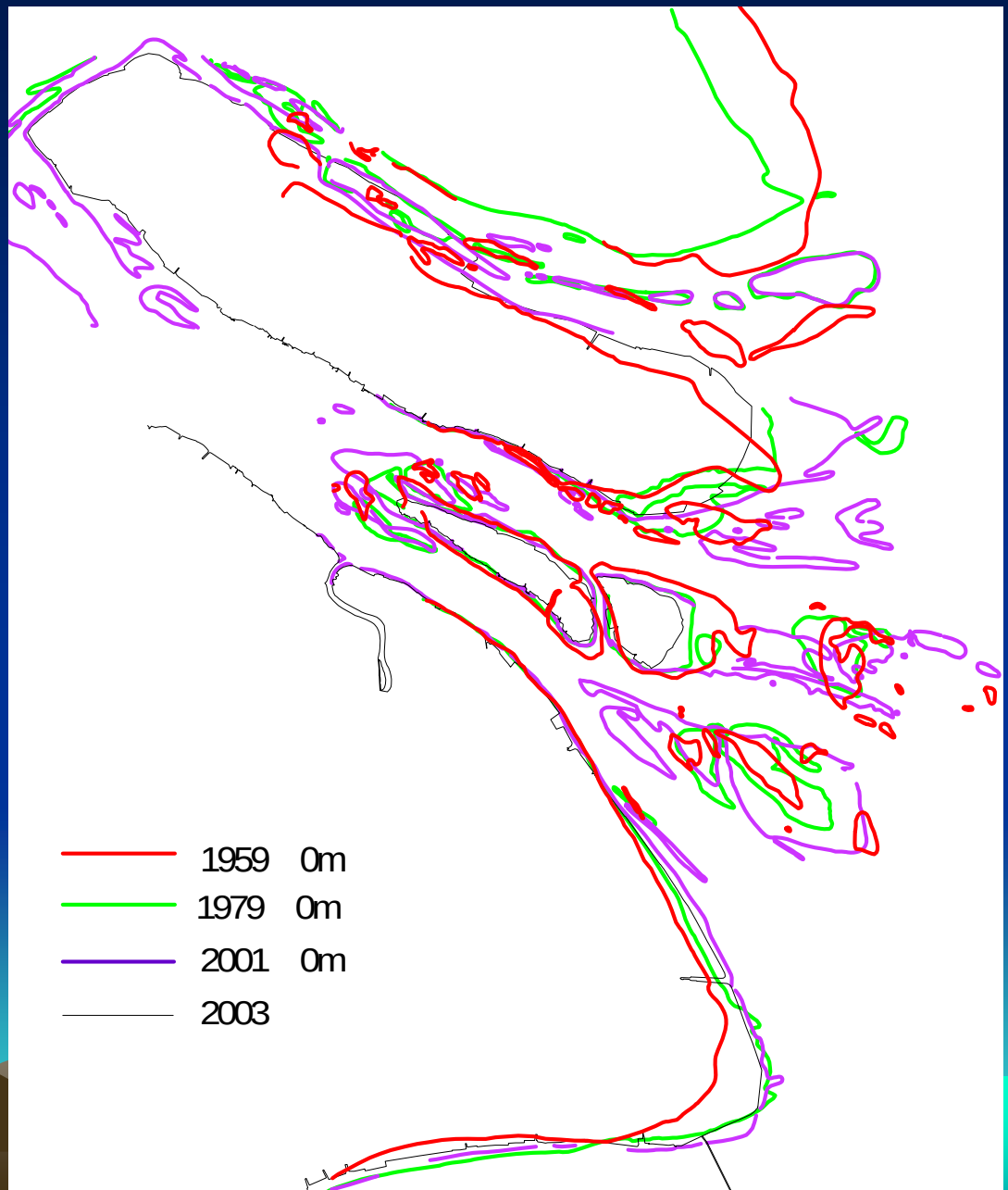
Content


通州市
海门
长
江
崇
A
上海
金山卫
江 苏
上 海 市
A
B
CSJ01
CSJ02
CSJ03
CSJ04
CSJ05
CSJ06
CSJ07
CSJ08
CSJ09
CSJ10
CSJ11
CSJ12
CSJ13
CSJ14
CSJ15
CSJ16
CSJ17
CSJ18
CSJ19
CSJ20
CSJ21
CSJ22
CSJ23
CSJ24
CSJ25
CSJ26
CSJ27
CSJ28
CSJ29
CSJ30
CSJ31
CSJ32
CSJ33
CSJ34
CSJ35
图 例
水质 生物站位
水质站位
潮间带断面
121° 05′ 53″
121° 30′
122° 00′
122° 30′
123° 00′
32° 00′
31° 30′
31° 00′
30° 30′

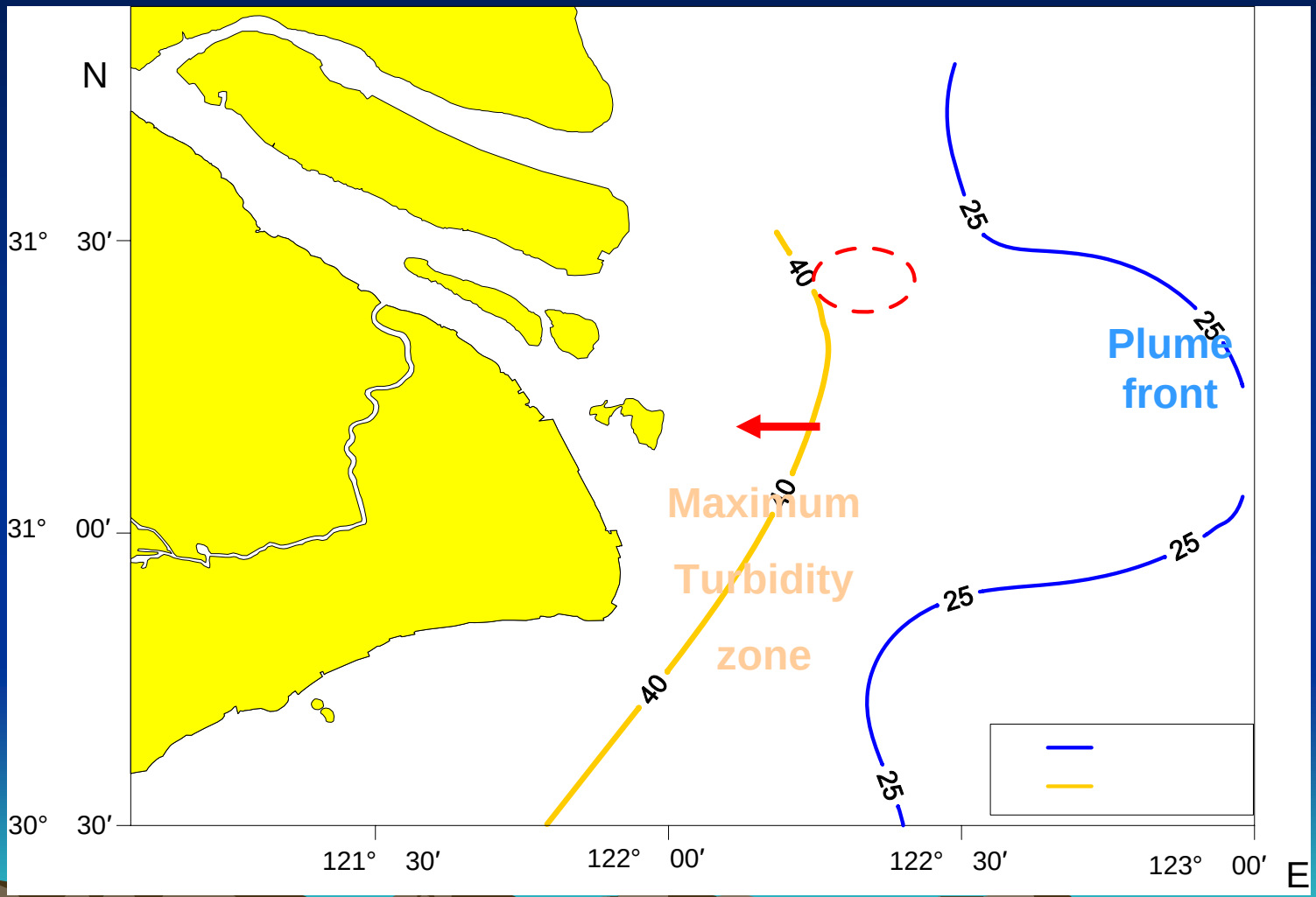
The sand flux influence the stability of coastline

The estuary coast line face collision in some specific place

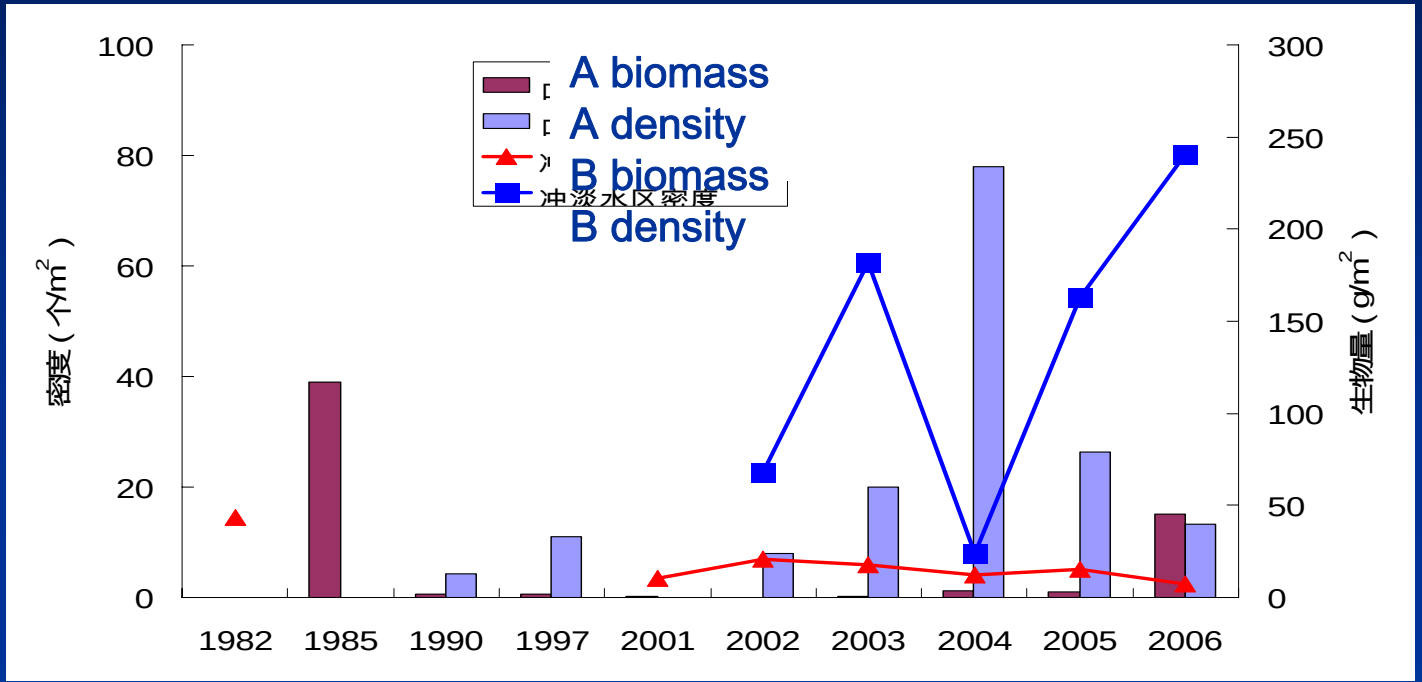




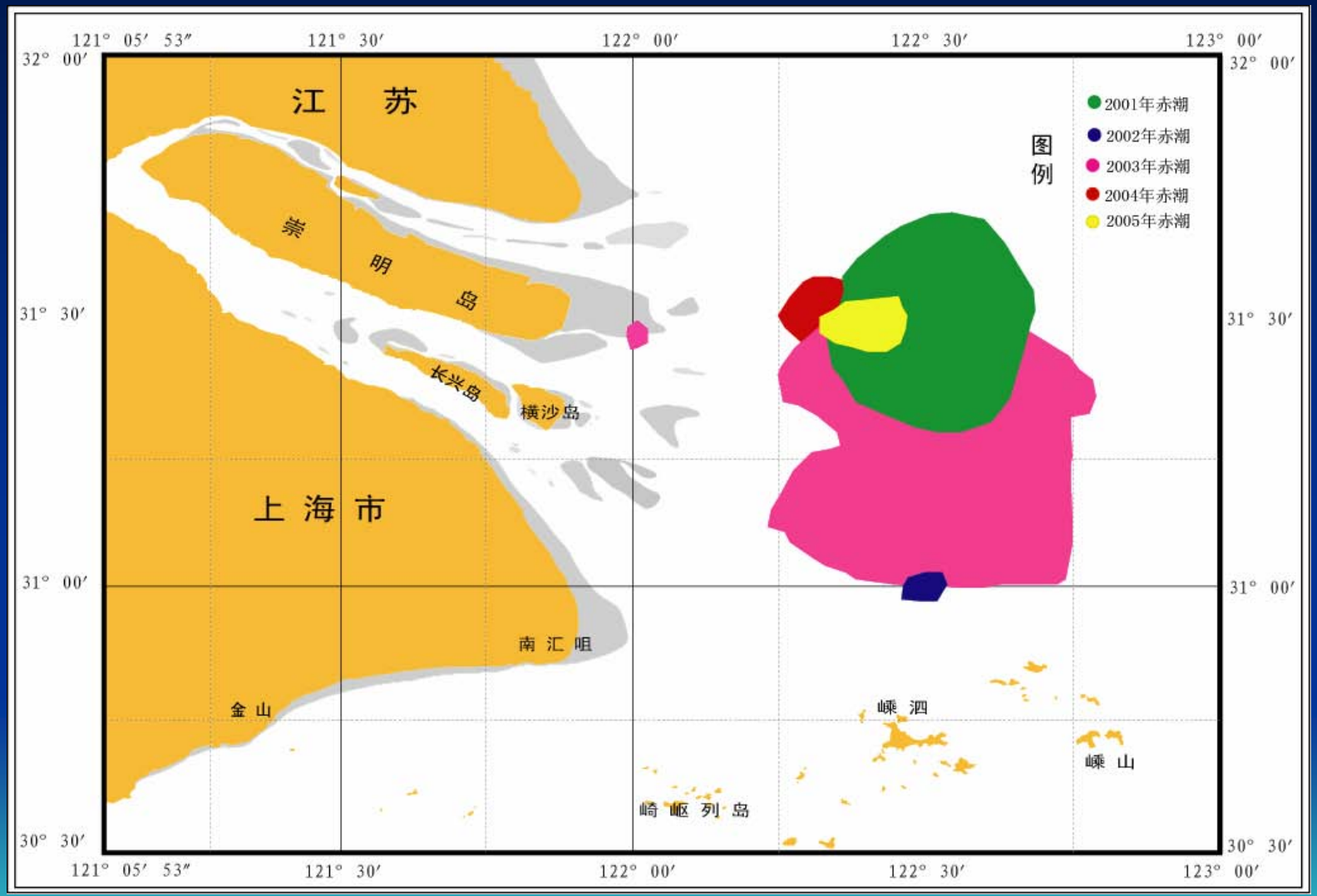
Maximum turbidity zone Shrink



Biomass of benthos respond rapidly

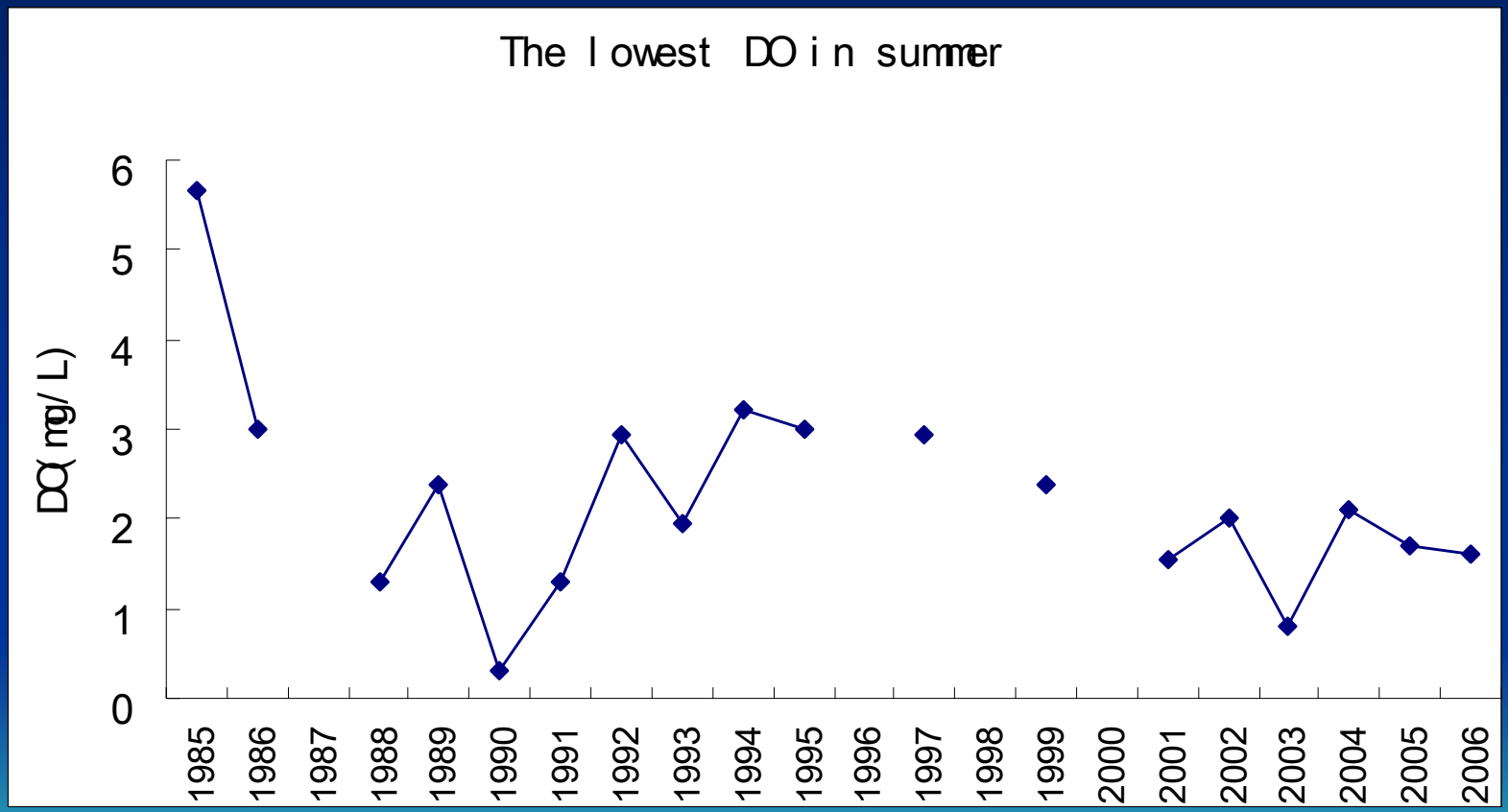


Bloom zone move close to the coast

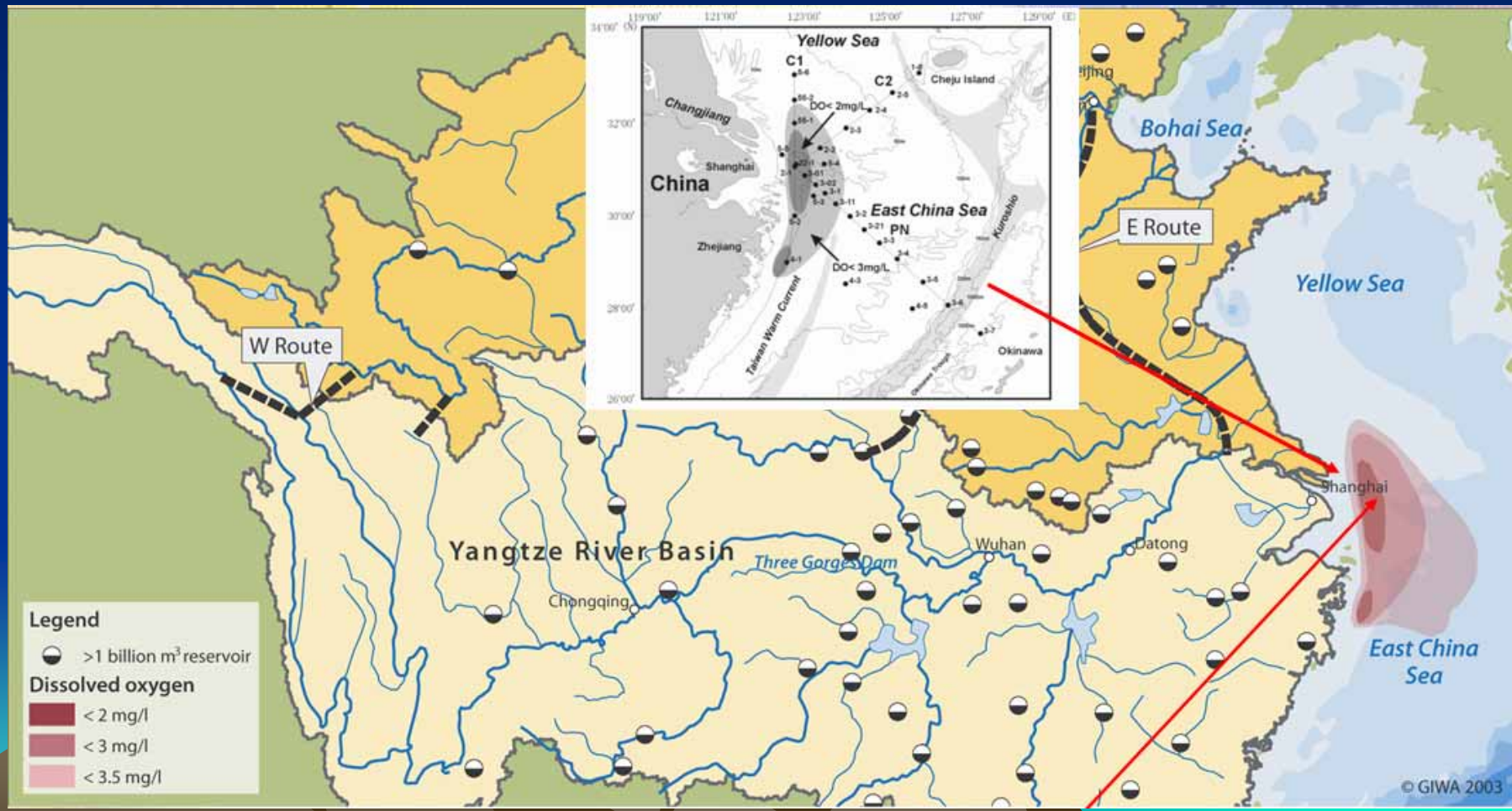


More dinoflagellates bloom

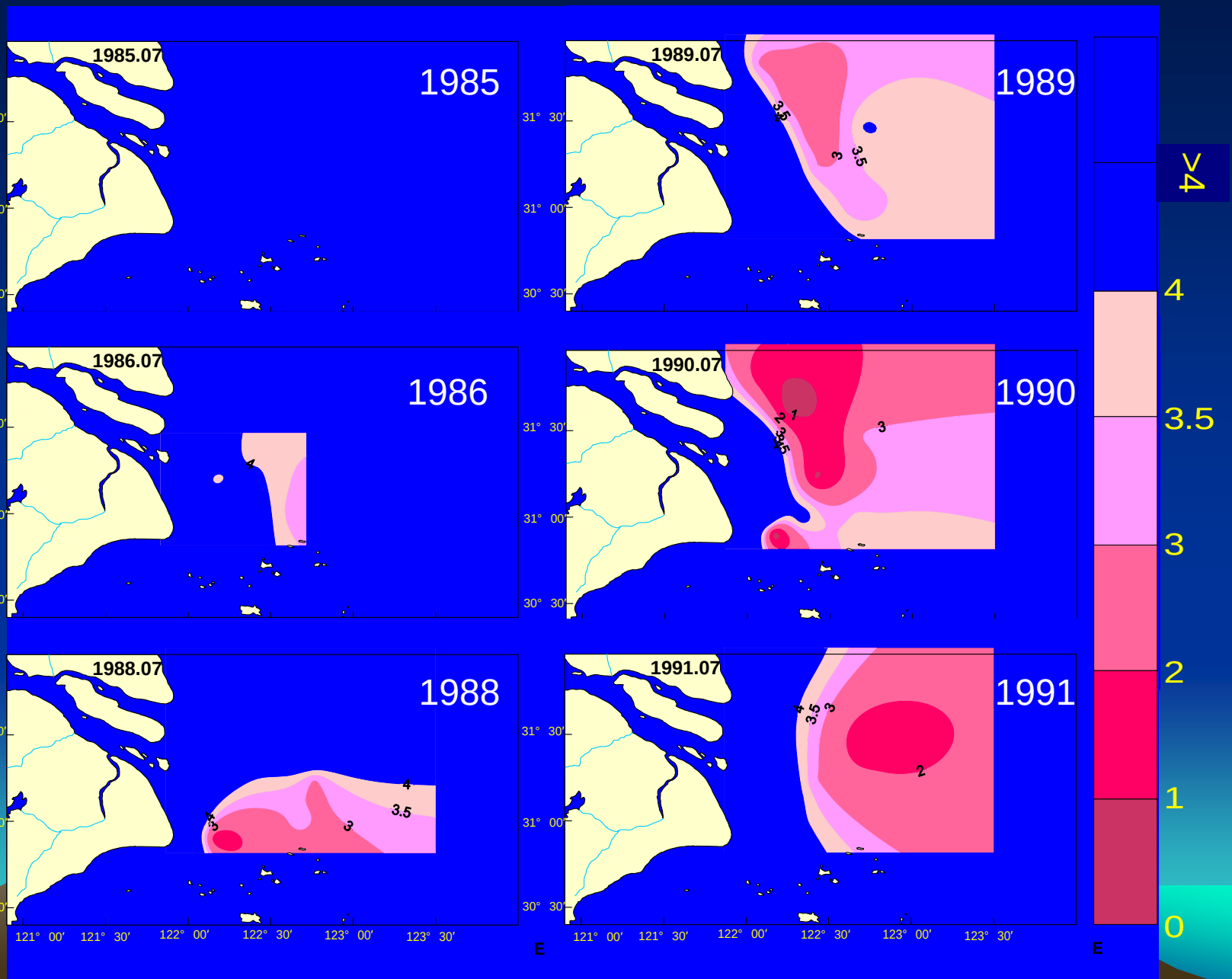
Lowest DO of bottom layer in Summer decreased



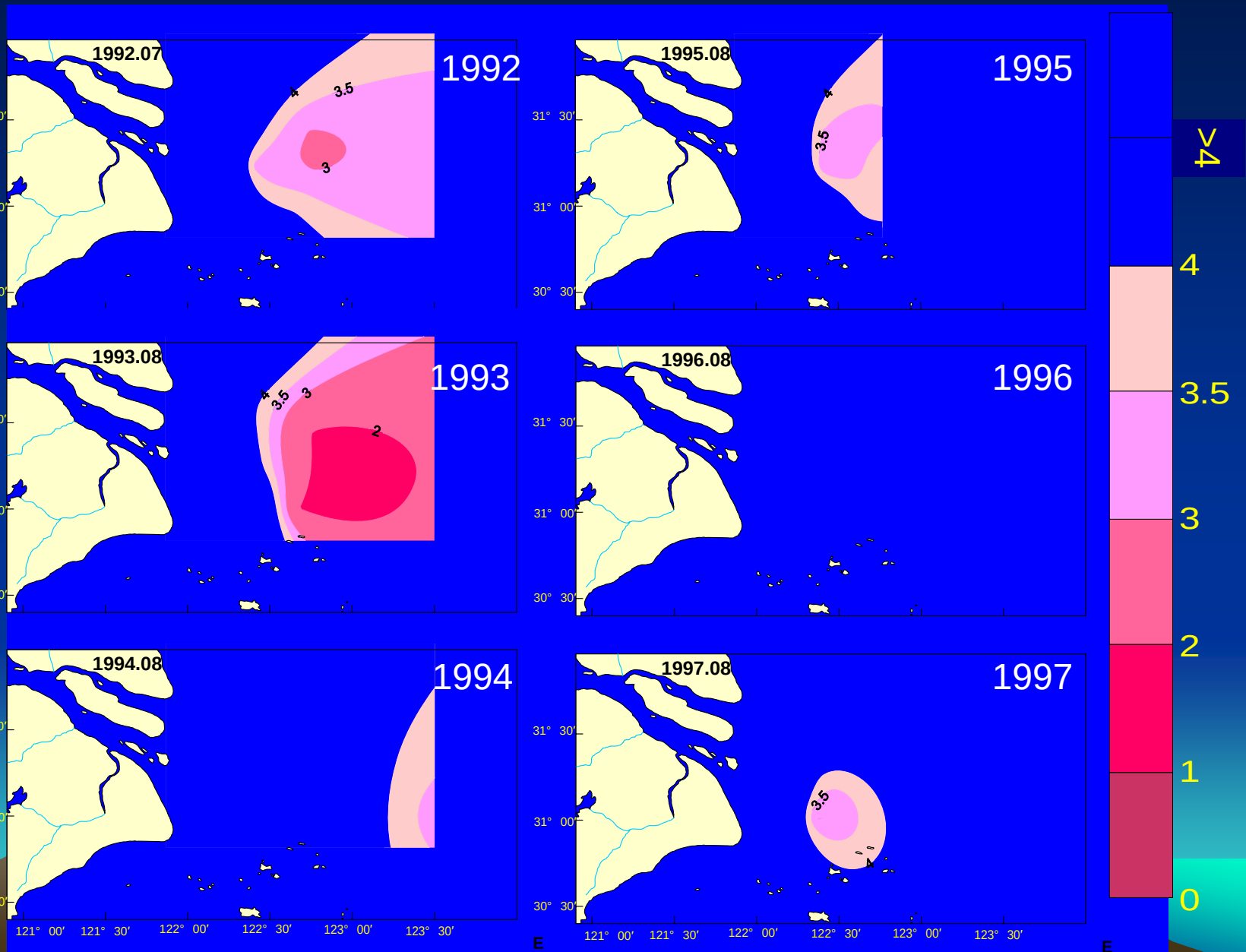
hypoxic zone is closer to coast



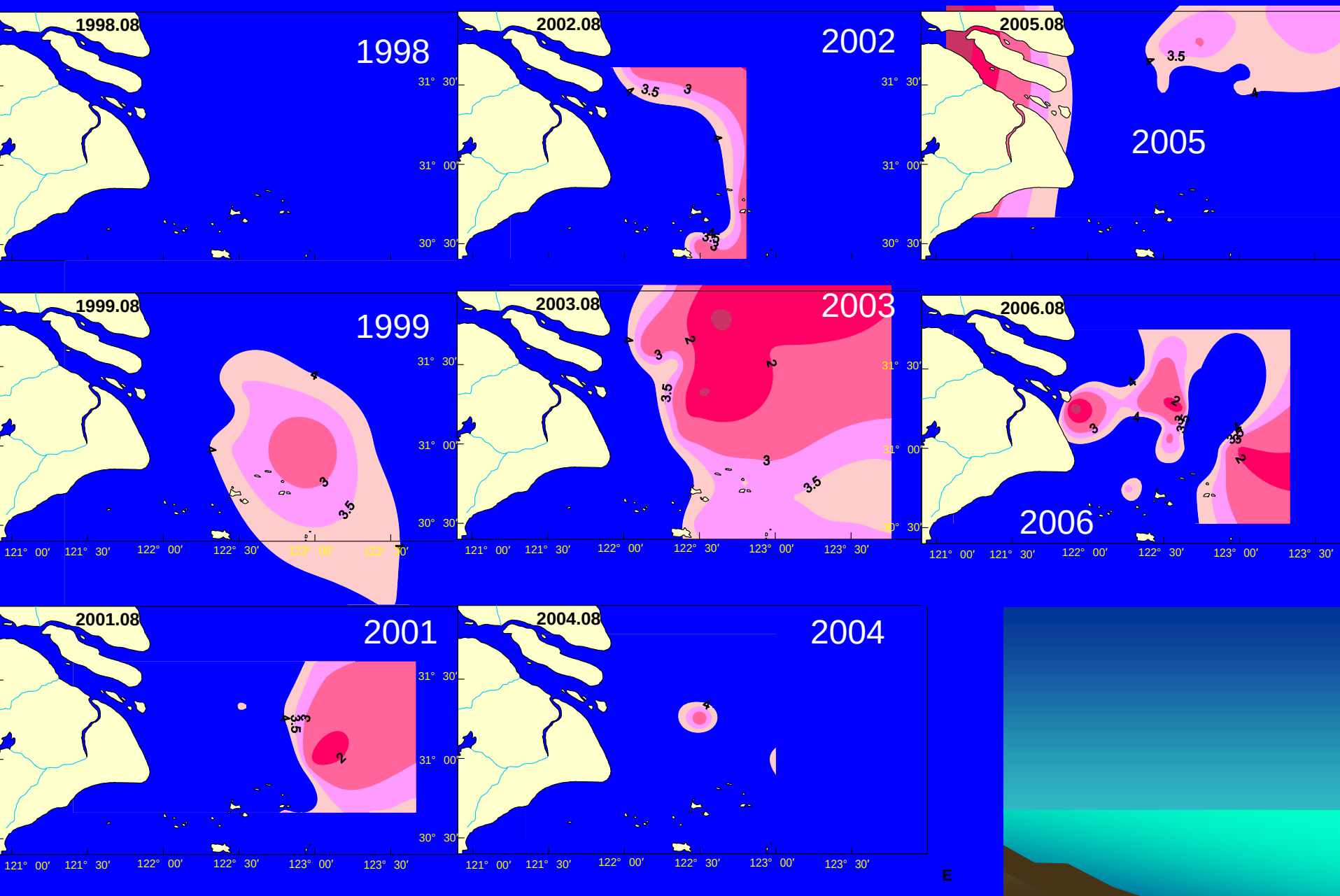
hypoxic zone of bottom layer in Summer



hypoxic zone of bottom layer in Summer



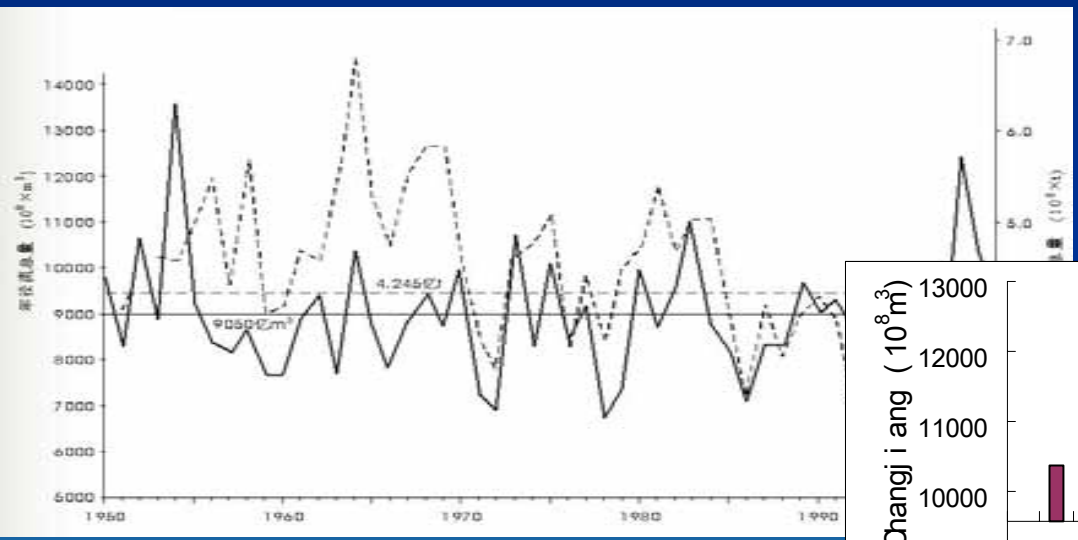
hypoxic zone of bottom layer in Summer

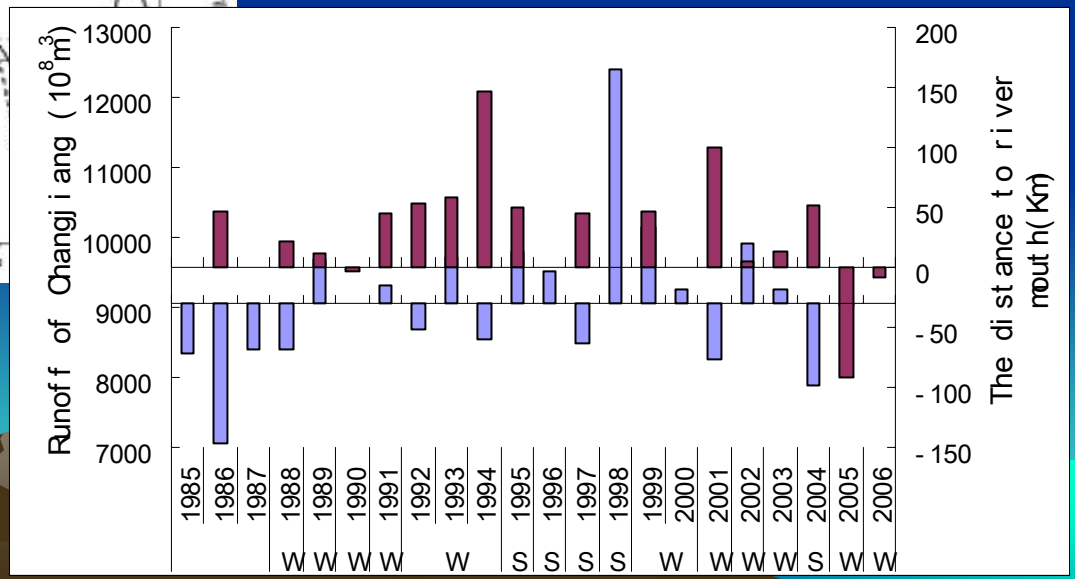


hypoxic zone is related with runoff

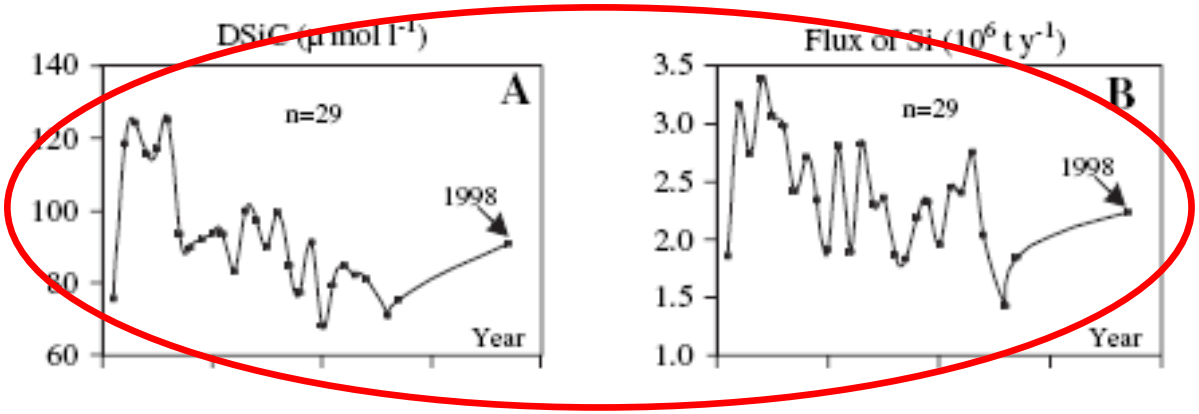
1.the distance of the low oxygen zone and the river mouth , the coverage of low oxygen zone are all contrast with the anomality of average runoff of Changjiang

2. When the runoff is close to the average, no matter higher or lower, there exist a large scale low oxygen zone

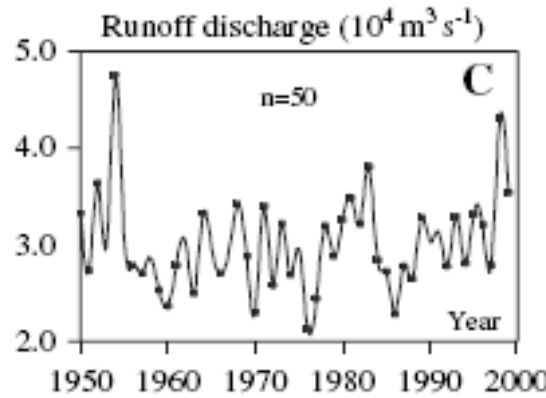


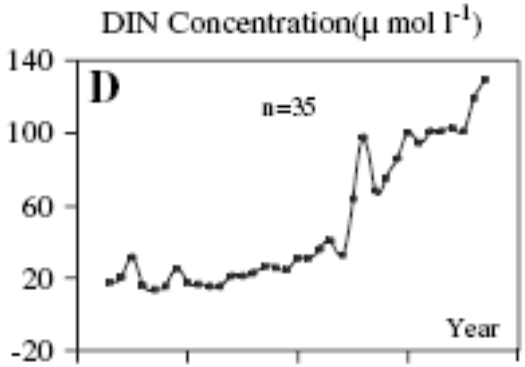


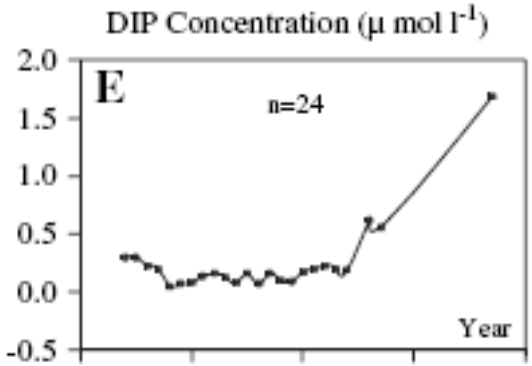
Long term trend of other chemical and biological factors

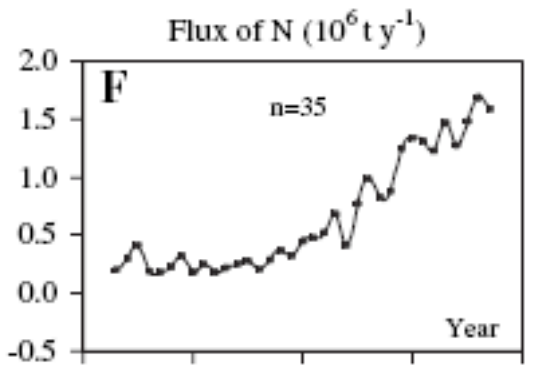

DSiC (μ mol l-1)
A
n=29
1998
Year
140
120
100
80
60

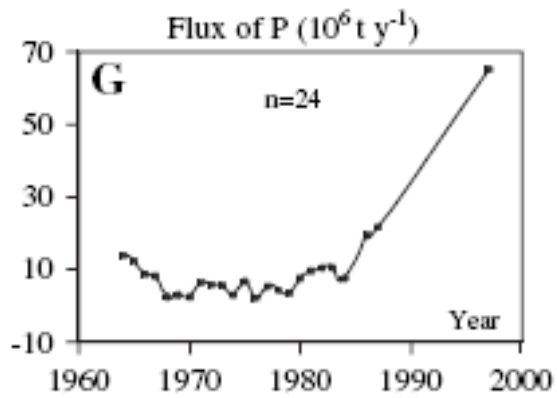
Flux of Si (10^6 t y-1)
B
n=29
1998
Year
3.5
3.0
2.5
2.0
1.5
1.0

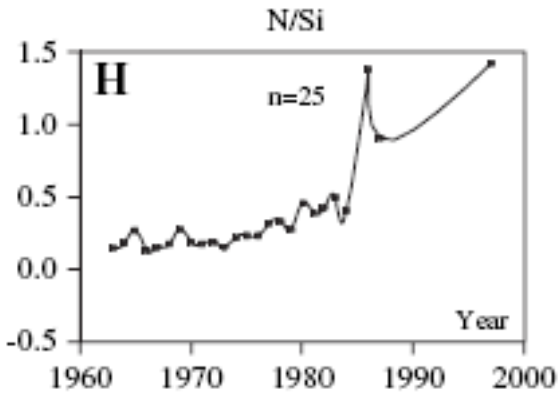

Runoff discharge (10^4 m^3 s-1)
C
n=50
Year
5.0
4.0
3.0
2.0
1950 1960 1970 1980 1990 2000

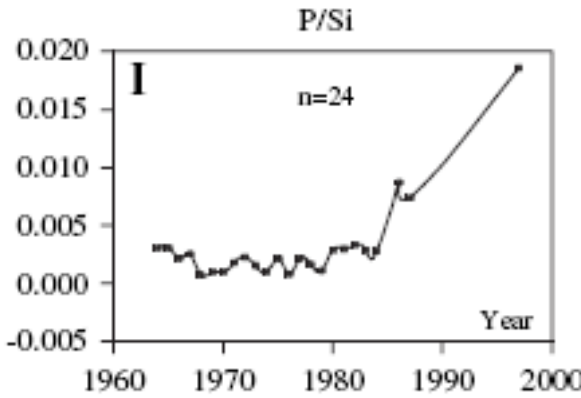

DIN Concentration(μ mol l-1)
D
n=35
Year
140
100
60
20
-20


DIP Concentration (μ mol l-1)
E
n=24
Year
2.0
1.5
1.0
0.5
0.0
-0.5

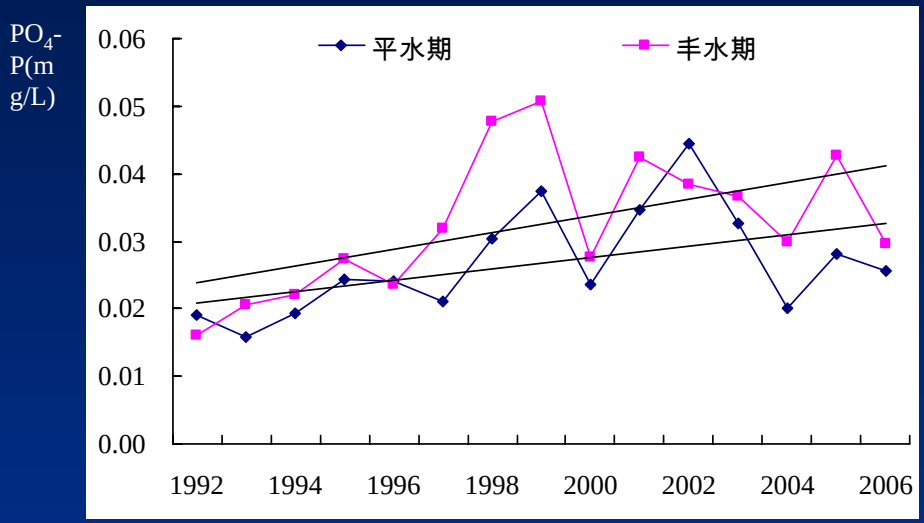

Flux of N (10^6 t y-1)
F
n=35
Year
2.0
1.5
1.0
0.5
0.0
-0.5

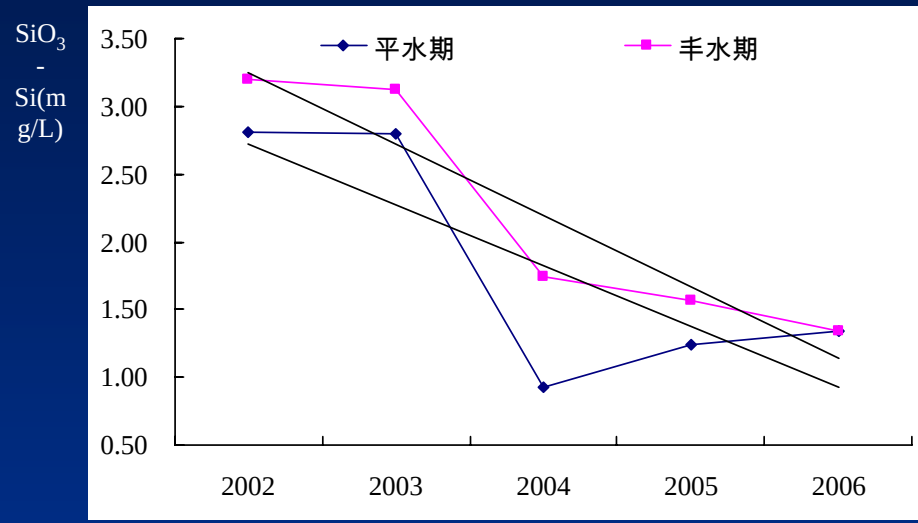

Flux of P (10^6 t y-1)
G
n=24
Year
70
50
30
10
-10
1960 1970 1980 1990 2000

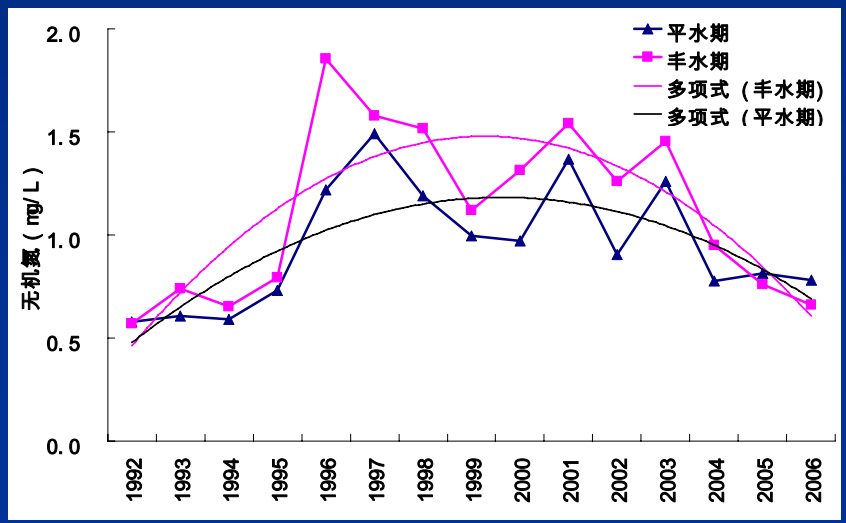

N/Si
H
n=25
Year
1.5
1.0
0.5
0.0
-0.5
1960 1970 1980 1990 2000


P/Si
I
n=24
Year
0.020
0.015
0.010
0.005
0.000
-0.005
1960 1970 1980 1990 2000

Decline of Si flux and change of nutrient structure

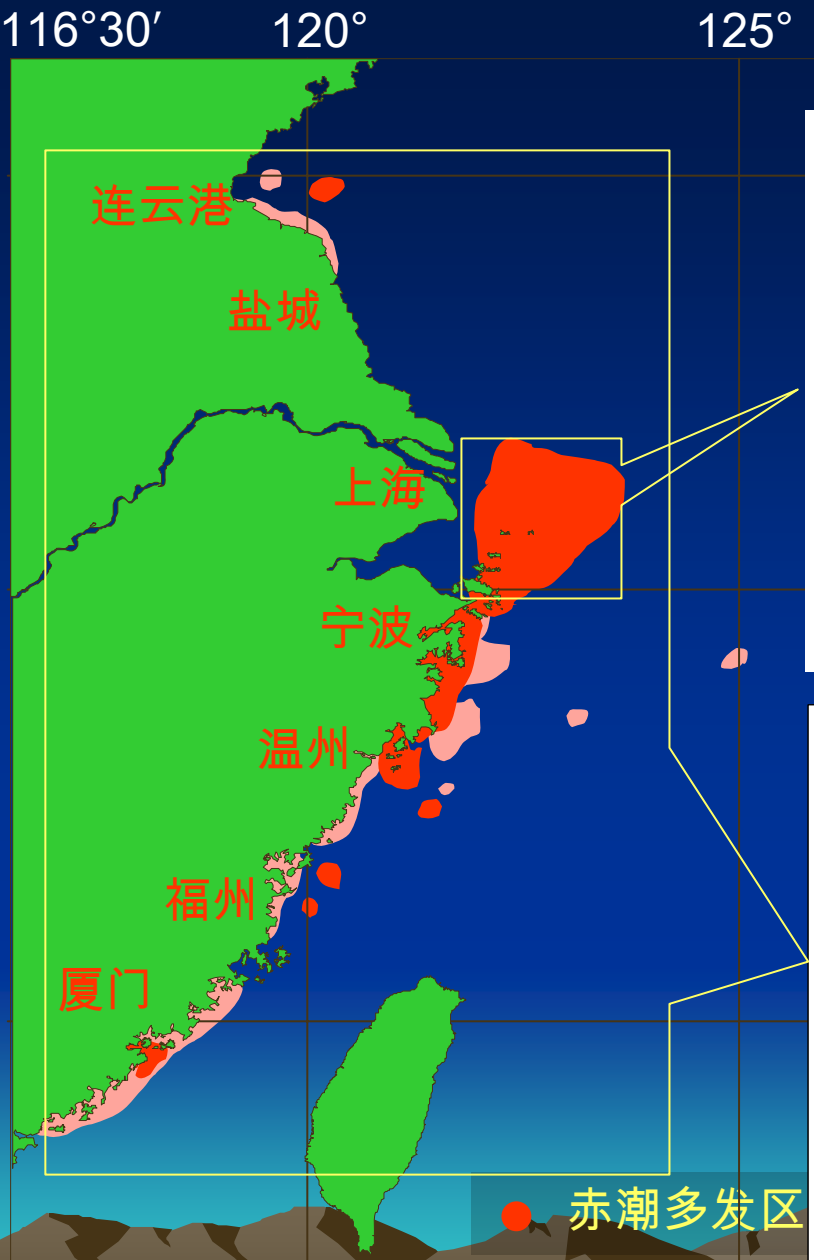


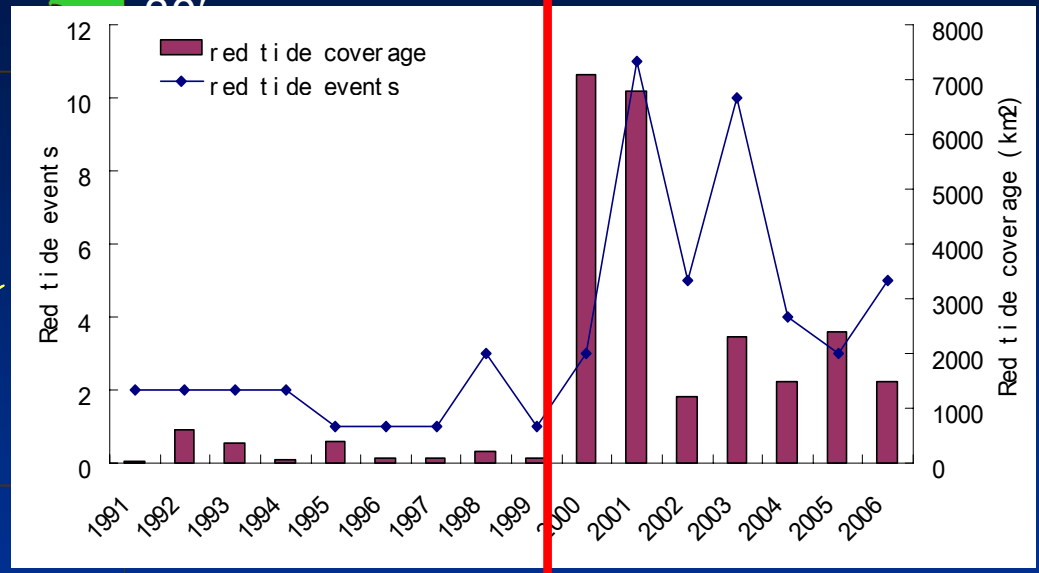


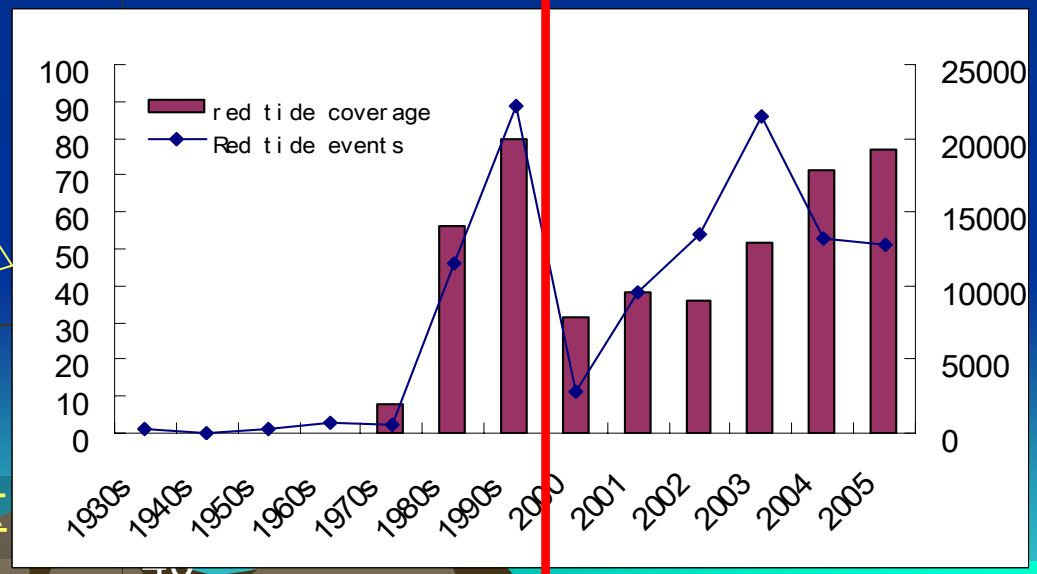


The increasing N:Si ratio could exacerbate eutrophication by reducing the potential for diatom growth in favor of noxious flagellates. Decreasing DSi and increasing DIN and DIP flux into the East China Sea have impacted the predominant algae species, the frequency of red tides and the composition of red tide phytoplankton.

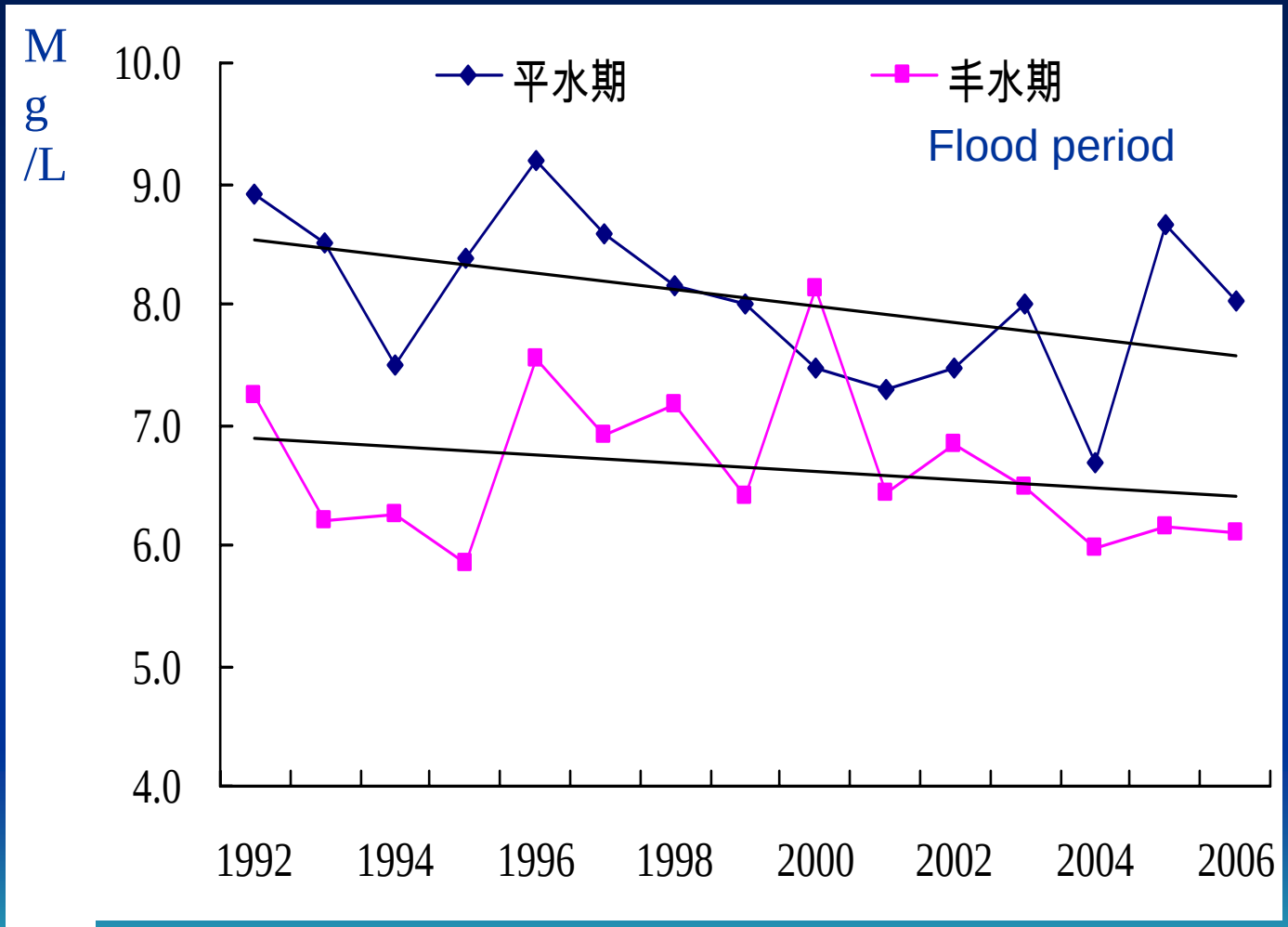
Red tides


116°30′
120°
125°
36°
连云港
盐城
上海
宁波
温州
福州
厦门
赤潮多发区

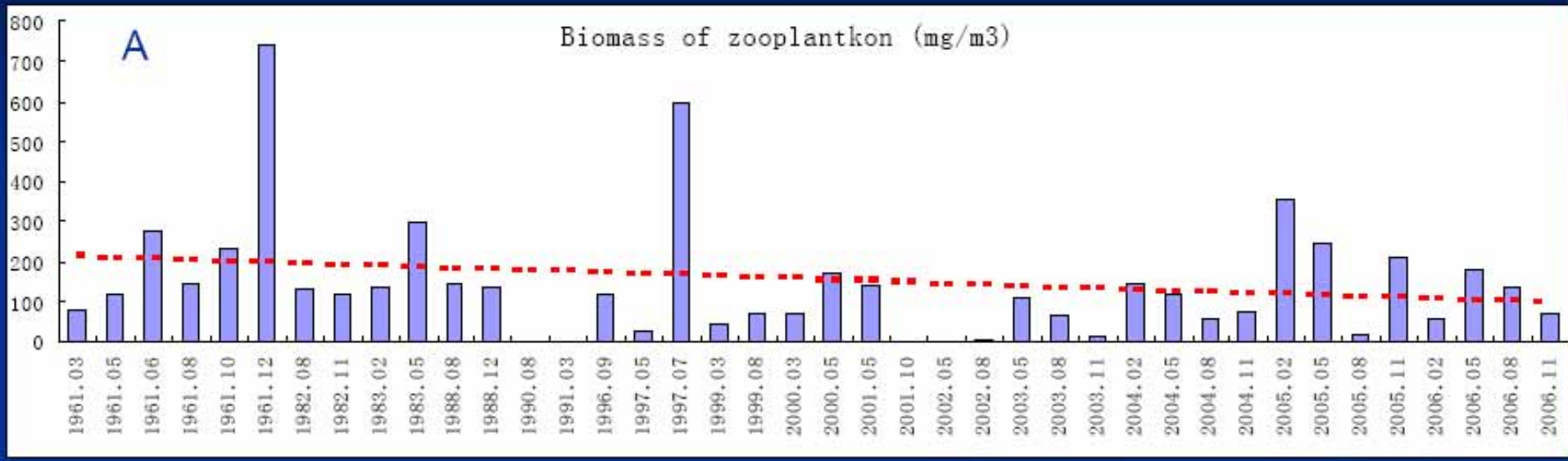

red tide coverage
red tide events
Red tide events
Red tide coverage (km2)
0
2
4
6
8
10
12
0
1000
2000
3000
4000
5000
6000
7000
8000
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006

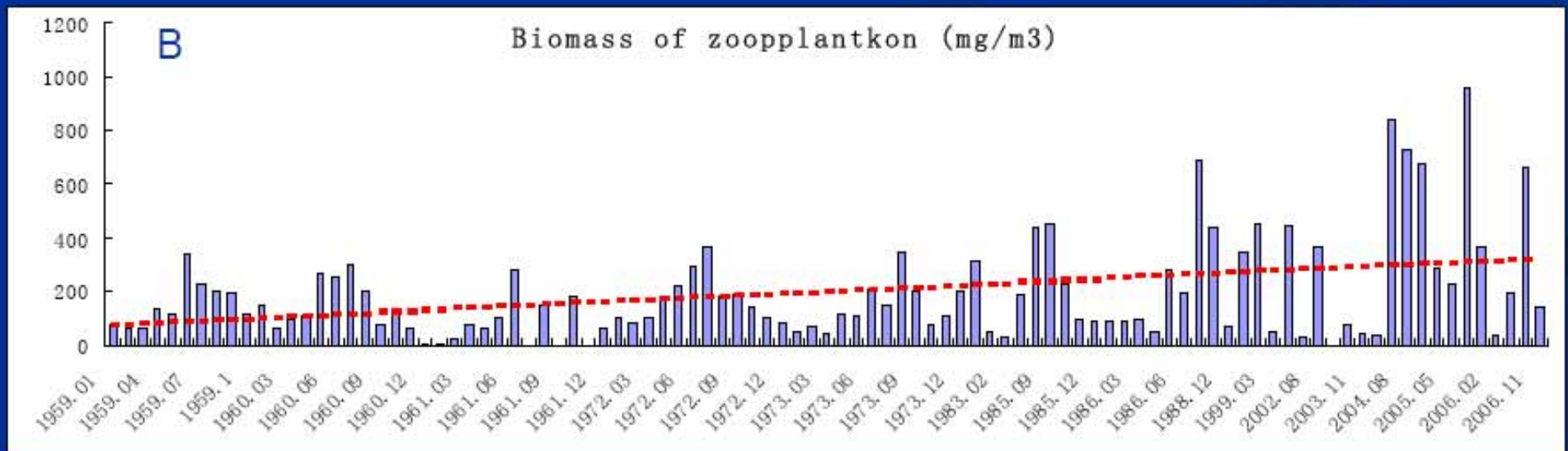

red tide coverage
Red tide events
0
10
20
30
40
50
60
70
80
90
100
0
5000
10000
15000
20000
25000
1930s
1940s
1950s
1960s
1970s
1980s
1990s
2000
2001
2002
2003
2004
2005

DO in surface layer decreased

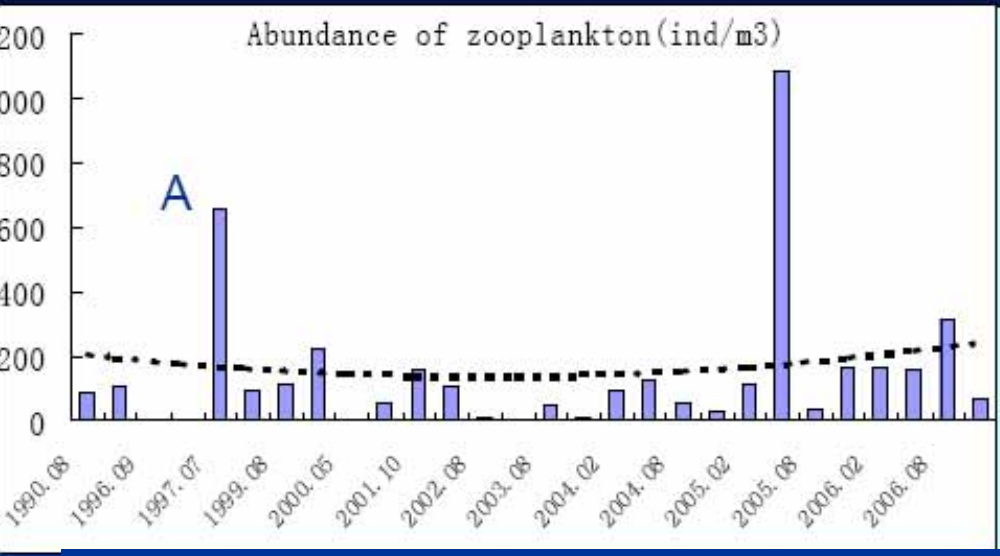


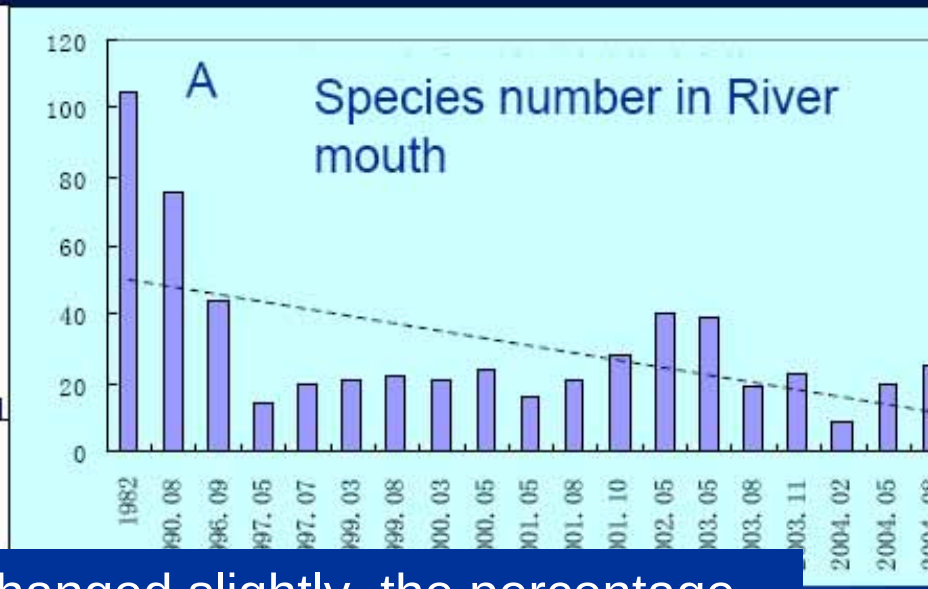
Biomass of Zooplankton



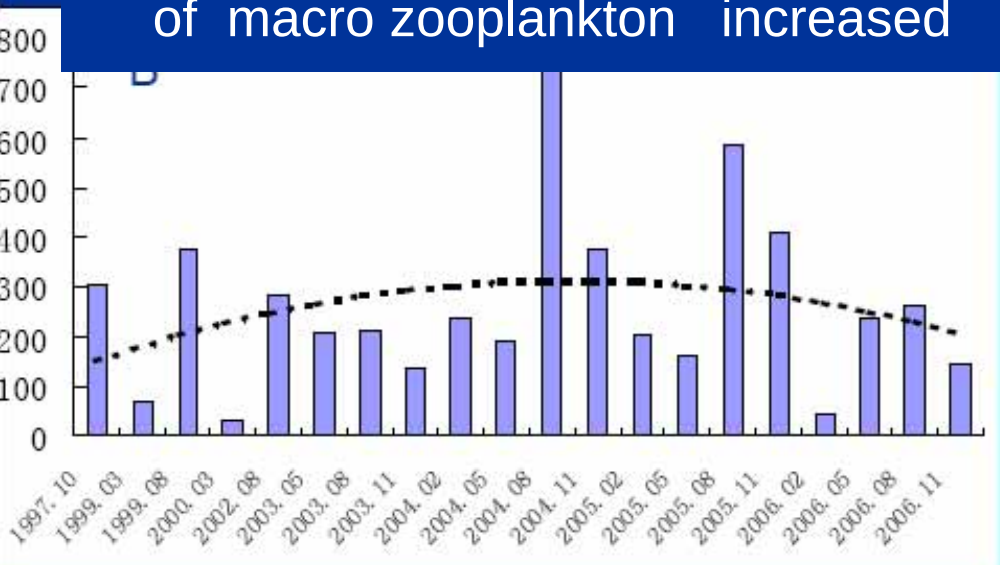


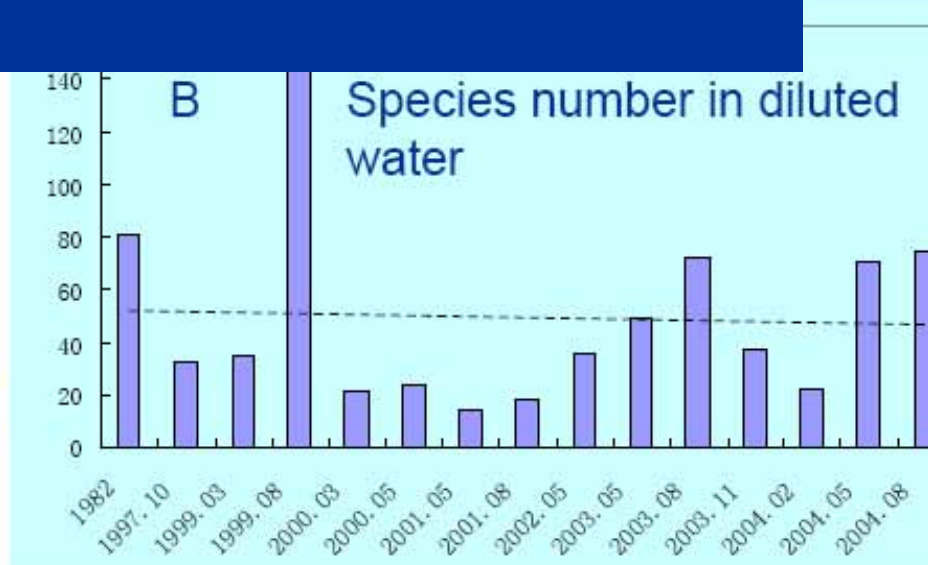
The zooplankton species number and abundance



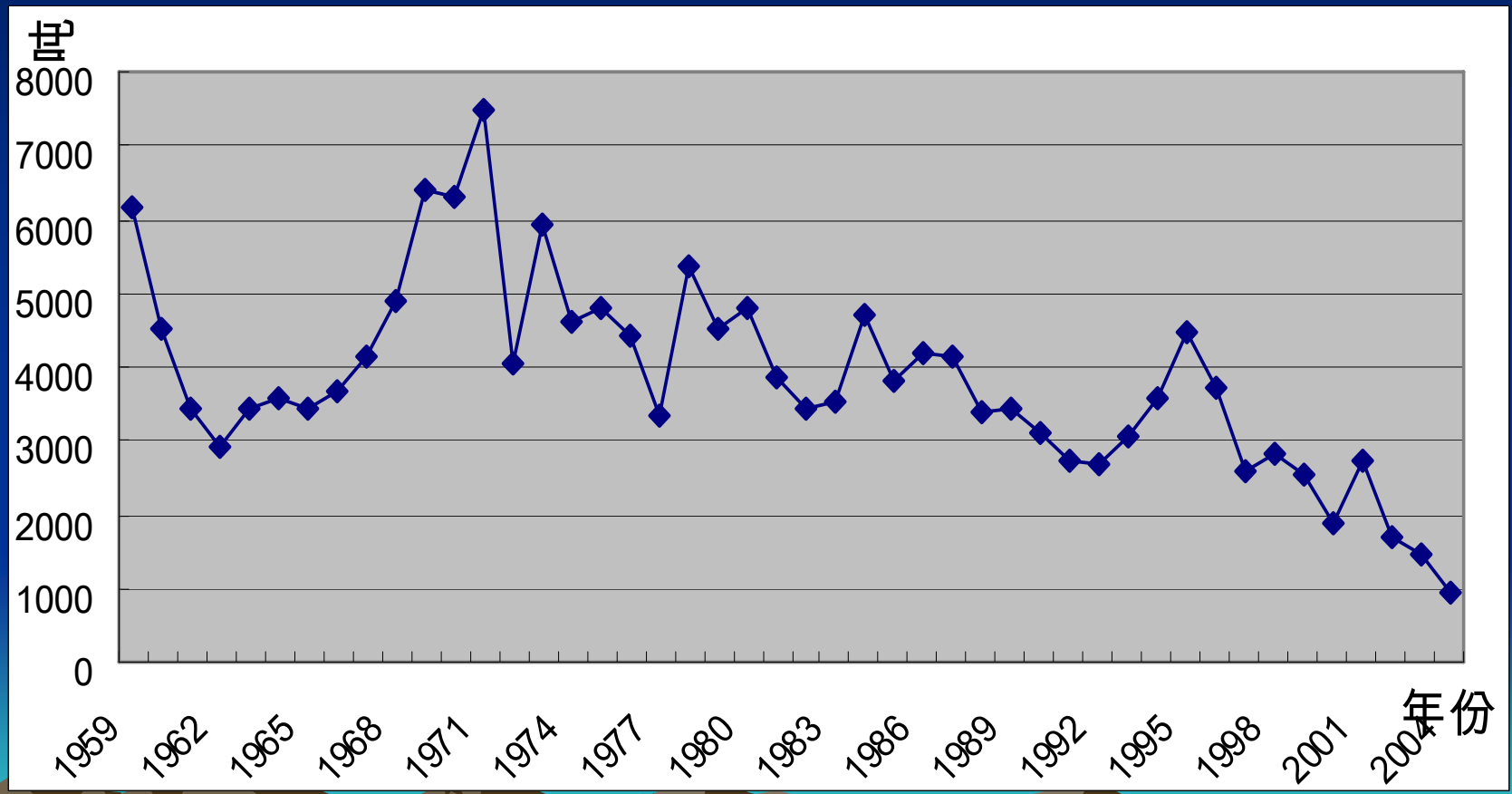


- Zooplankton community structure changed slightly, the percentage of macro zooplankton increased

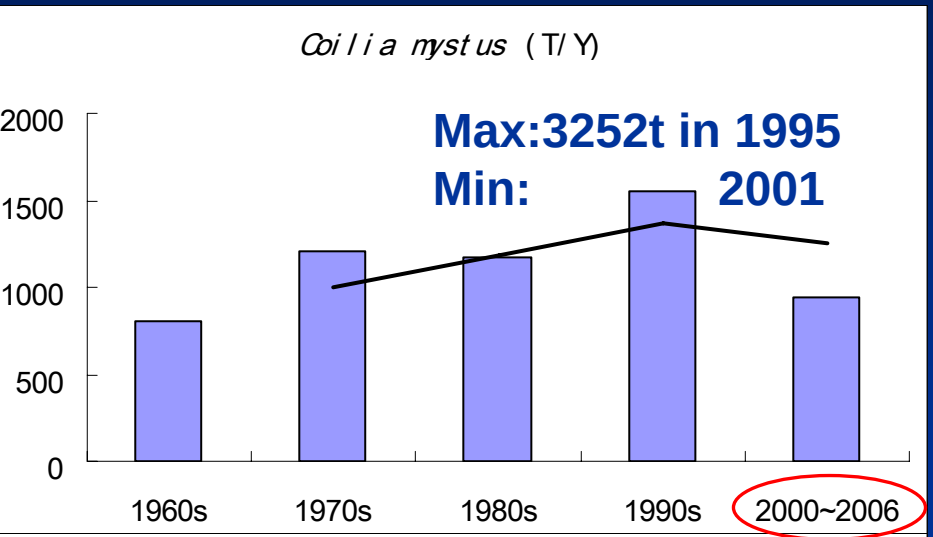


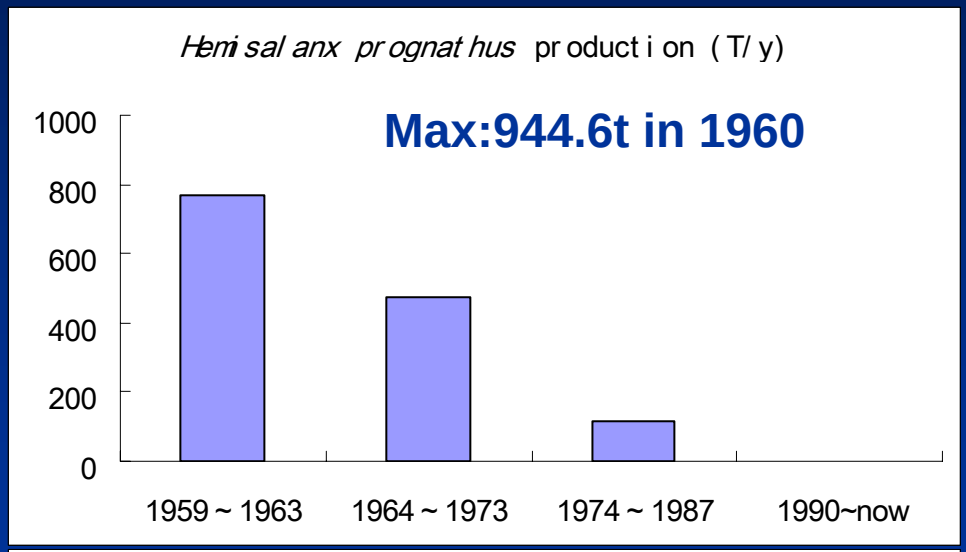


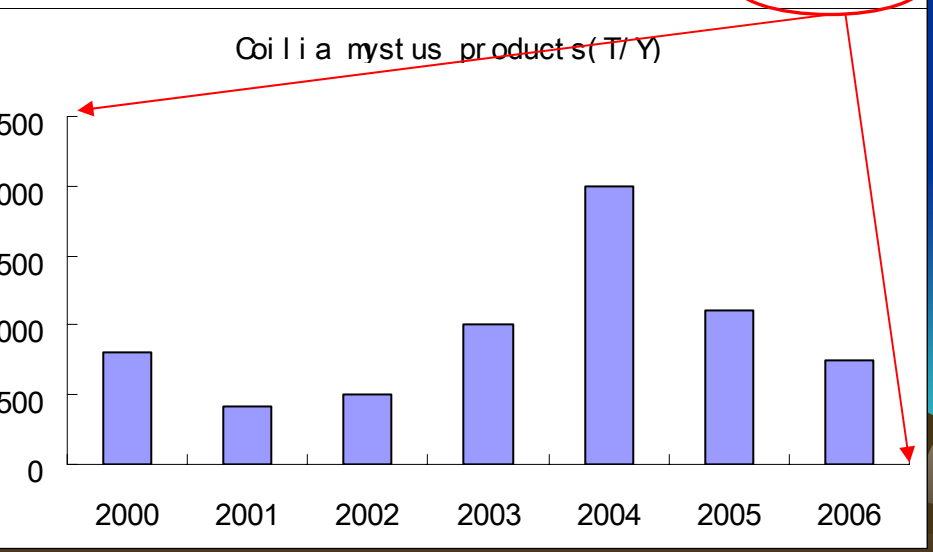
The fishery production (ton) in Changjiang Esturay

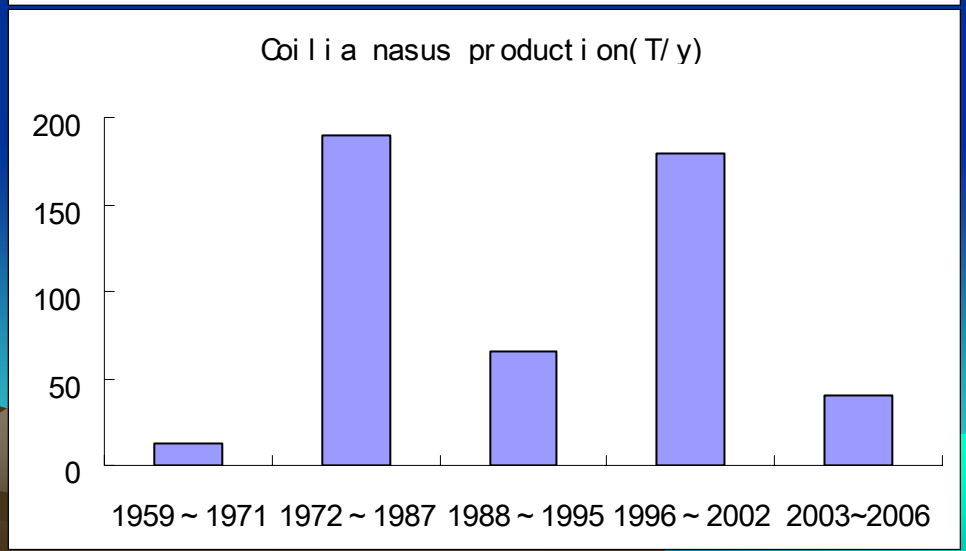


Important fishery composition changed

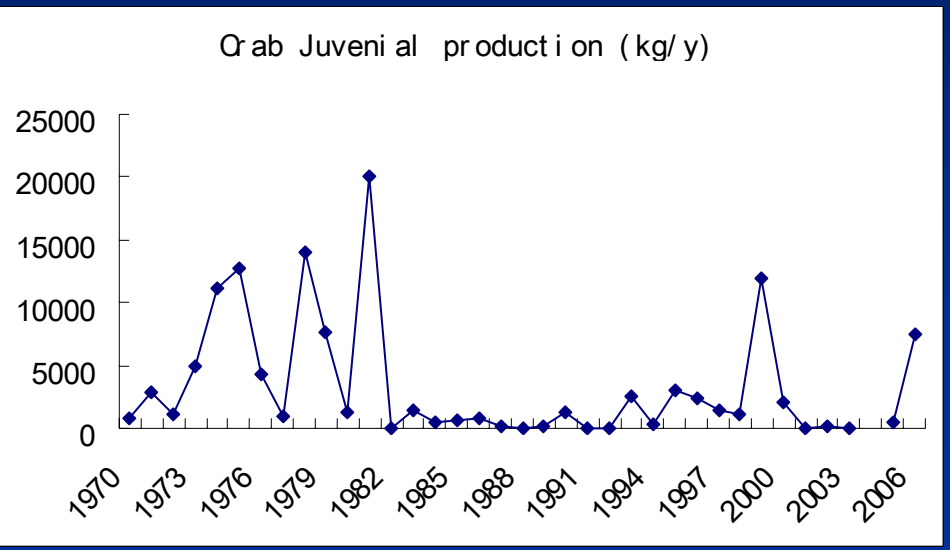


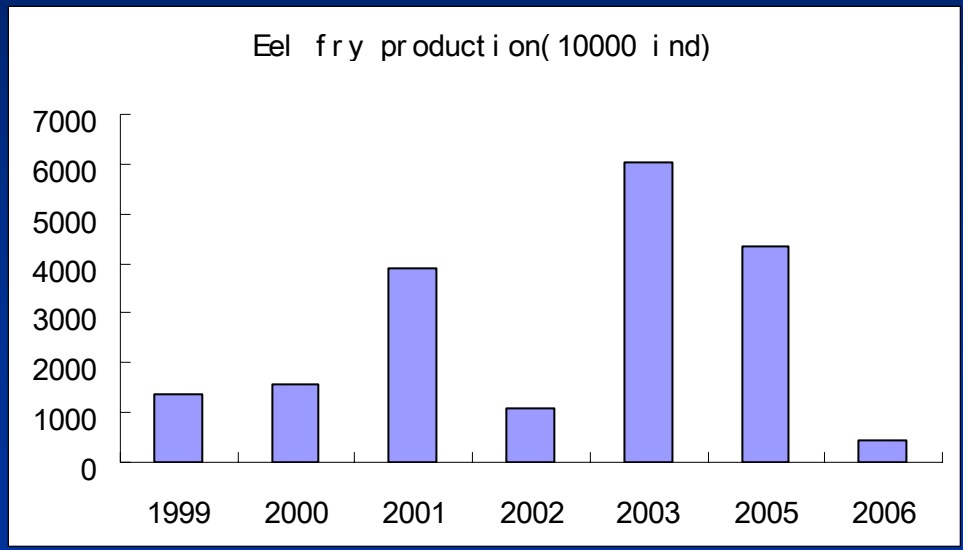






Fish fry production

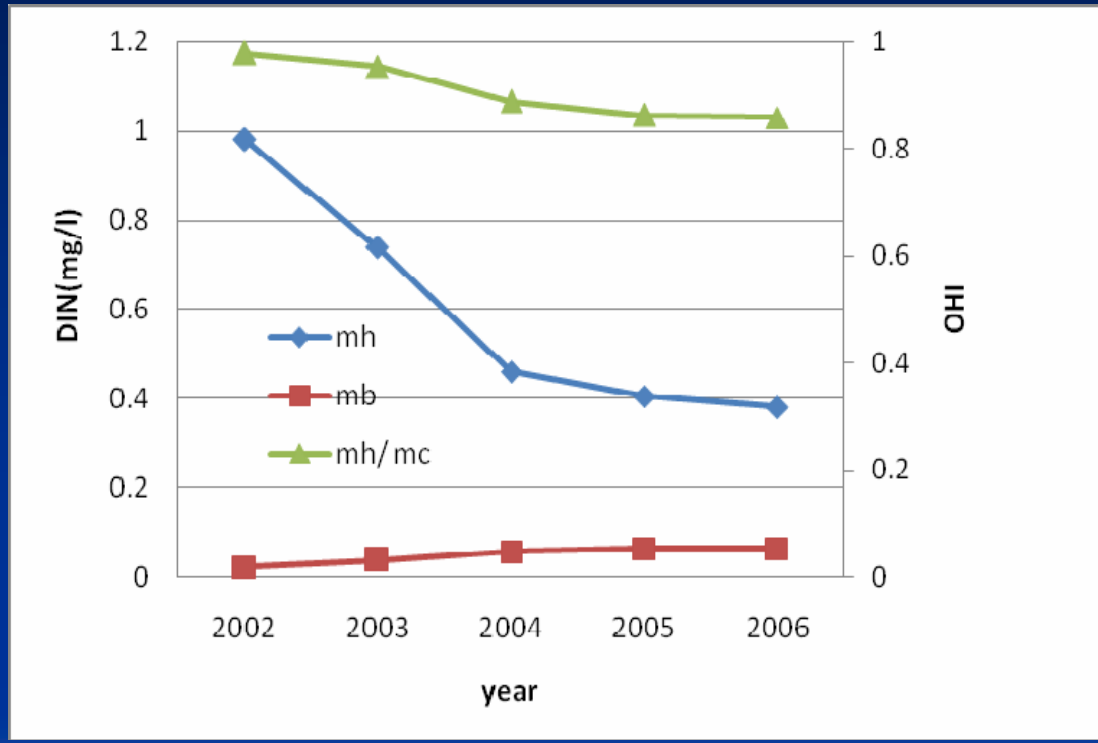




Anthropological influence

◆The value of overall human influence of five years are higher than 0.8. It explains that the Changjiang River estuary is highly affected by human activity.

◆However the value from 2002 to 2006 declined gradually, especially after 2003. The human-derived nitrogen concentration also declined gradually



The ASSESTS assessment system contains three factors: pressure, status and response.

results

1. Soil protection projects combined with silting in reservoirs greatly lowered DSiC and sand transport flux. Changes in the proportions of dissolved Si, N, and P in riverine nutrient loads will cause shifts of phytoplankton populations in water bodies, and will accelerate algal growth through Eutrophication, and consequently degrade water quality through oxygen depletion.
2. The changing of Runoff and sand transport flux also elevate the variability and uncertainty of the Ecosystem in East China Sea.

Acknowledgement

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