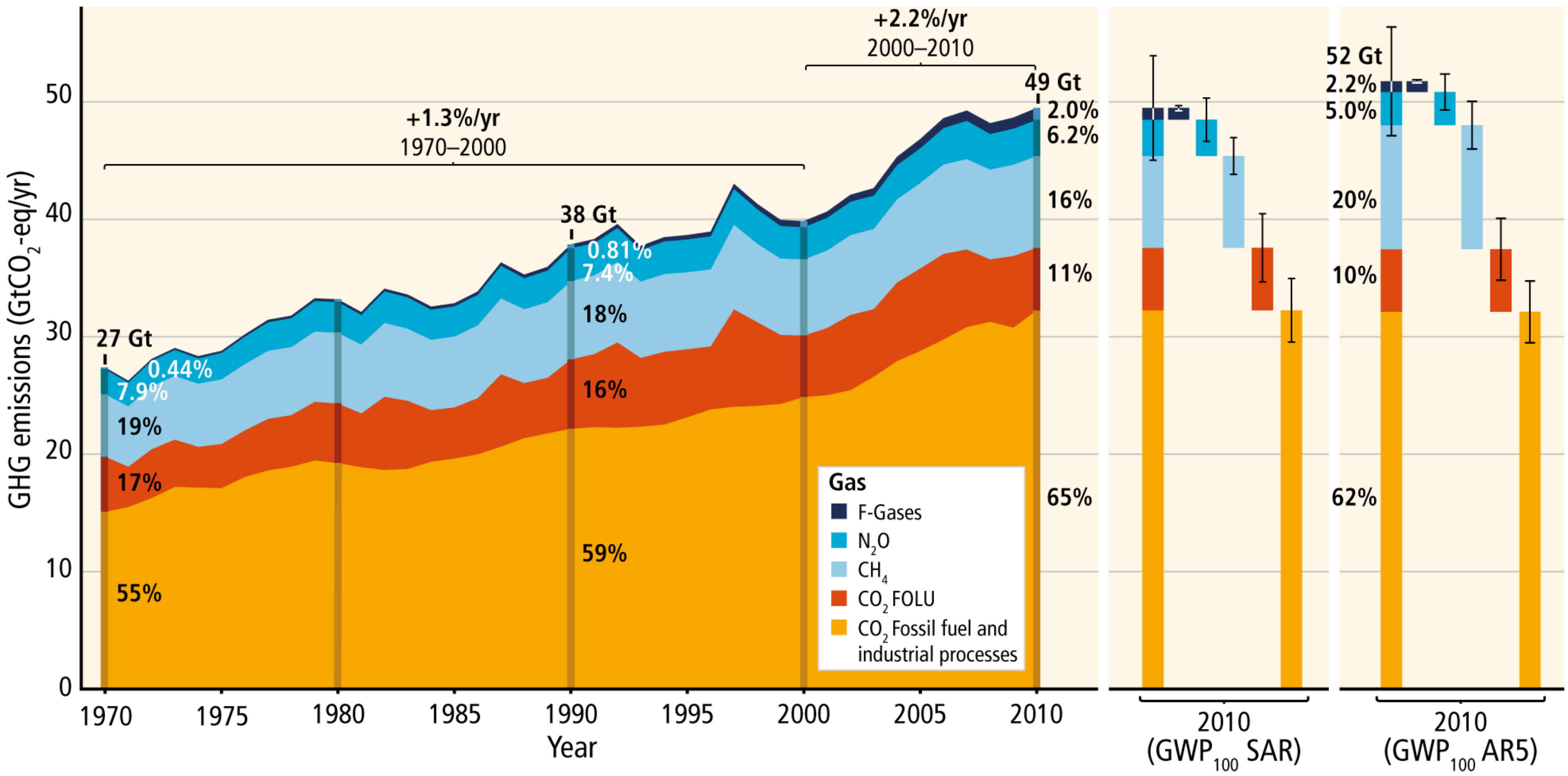
Carbon sequestration and its controlling factors in the temperate wetland communities along the Bohai Sea, China

Siyuan Ye [1,2], Edward Allen Laws [1,3], N. Yuknis[3], H. Brix[1,4]

[1] Key Laboratory of Coastal Wetlands Biogeosciences, Qingdao Institute of Marine Geology, China Geologic Survey, Qingdao, P. R. China
[2] Laboratory for Marine Geology, Qingdao National Laboratory for Marine Science and Technology, Qingdao, 266061, P. R. China
[3] School of the Coast & Environment, Department of Environmental Sciences, Louisiana State University, Baton Rouge, Louisiana, USA
[4] Aarhus University, Department of Bioscience, Plant Biology, Aarhus, Denmark

2018.4.25

Total annual anthropogenic GHG emissions by gases over 40 years (1970-2010)



@ IPCC, 2018: Climate change 2014 synthesis report fifth assessment report

Global Change

International Geosphere-Biosphere Programme

Issue 74 ▮ Winter 2009

Where sinking land meets rising water

Five hundred million people living on the world's deltas now face the twin threats of subsidence and rising sea levels.

and thread together into several distributaries that eventually lead to the San Francisco Bay. Deltas are the connection between river

Joaquin River Delta have been draining peat soils on the delta's islands to grow crops that prefer dry roots, such as corn. Expos-

Three river delta areas sinking, report claims

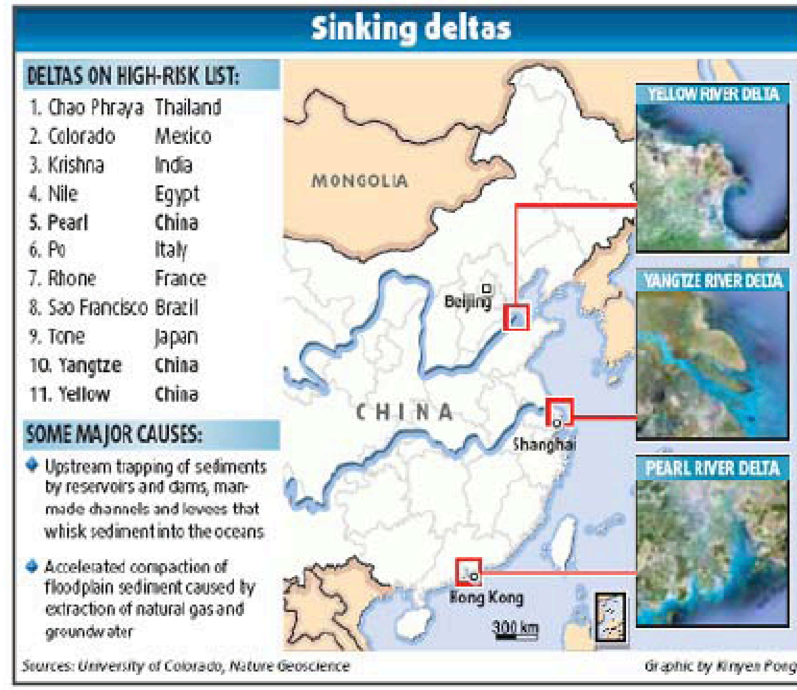
By Wang Qian (China Daily)
Updated: 2009-09-23 07:40

Comments(1) Print Mail

CHINA DAILY

Today's Paper|Subscribe

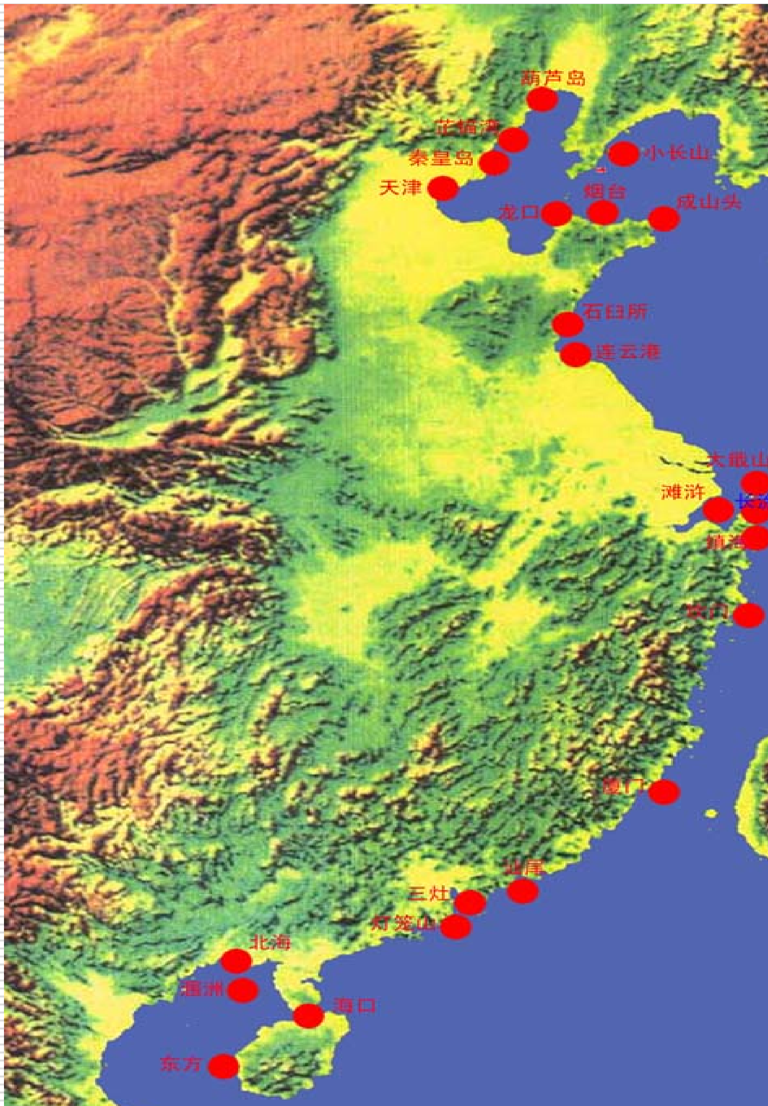
Three river deltas in China are sinking due to global warming and excessive extraction of underground water, leaving millions of people with an increasing risk of floods, a recent scientific report showed.

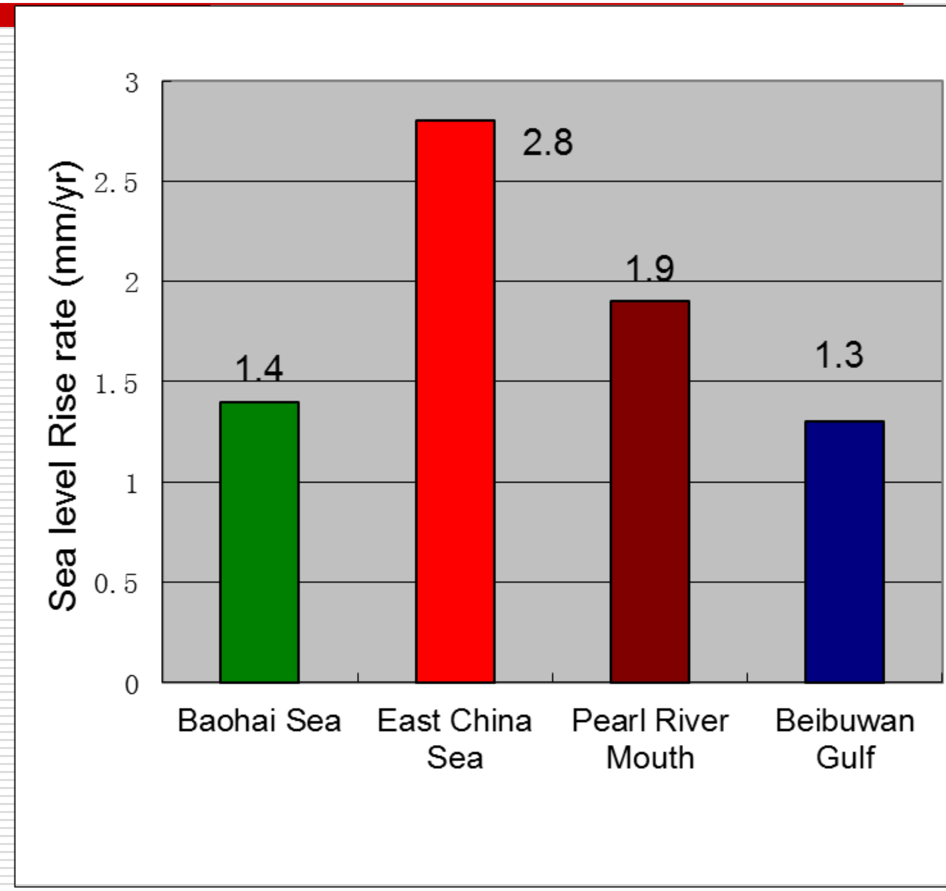


Deltaic wetlands become more vulnerable than ever!

- ➢ The rate of carbon sequestration
- ➢ Keep pace with Sea Level

The rate of sea level rise along China Coasts





Average sea level rise: 2.5 mm/yr

Tectonic movement

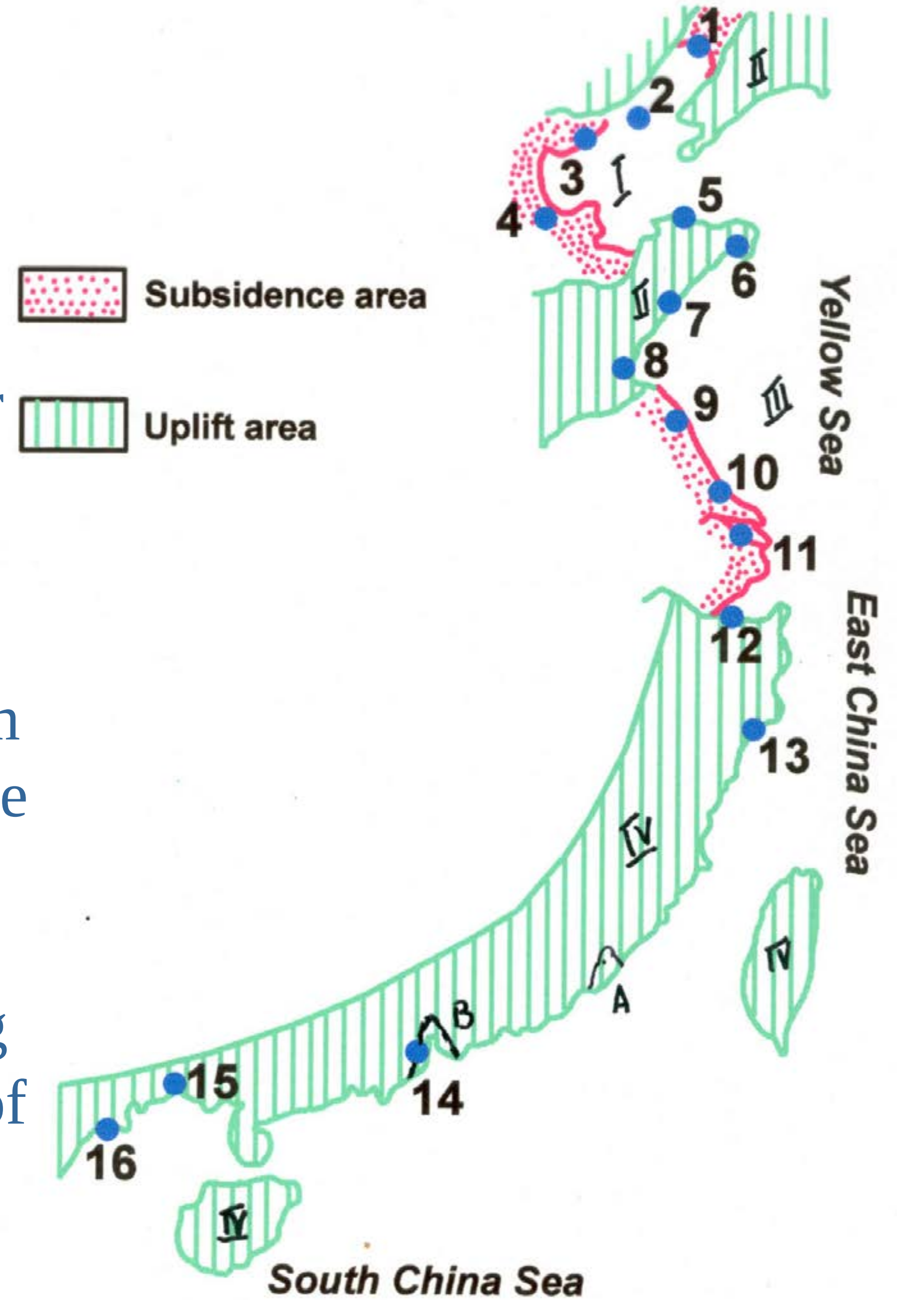
Tectonic uplift: 2-3 mm/yr
Tectonic subsidence:
Huanghe delta: 2-3 mm/yr
Changjiang delta: 1-2 mm/yr
Zhujiang delta: 1-2 mm/yr

Ground subsidence

Tianjin City center subsided 2.7 m during 1959-1993, with an average rate of 77 mm/yr

Shanghai subsided ~2.0 m during 1921-1998, with an average rate of 29 mm/yr

4-6mm/yr



Questions:

- The rate of carbon sequestration and its controlling factors?
- If the rate can balance sea level rise?

Study sites

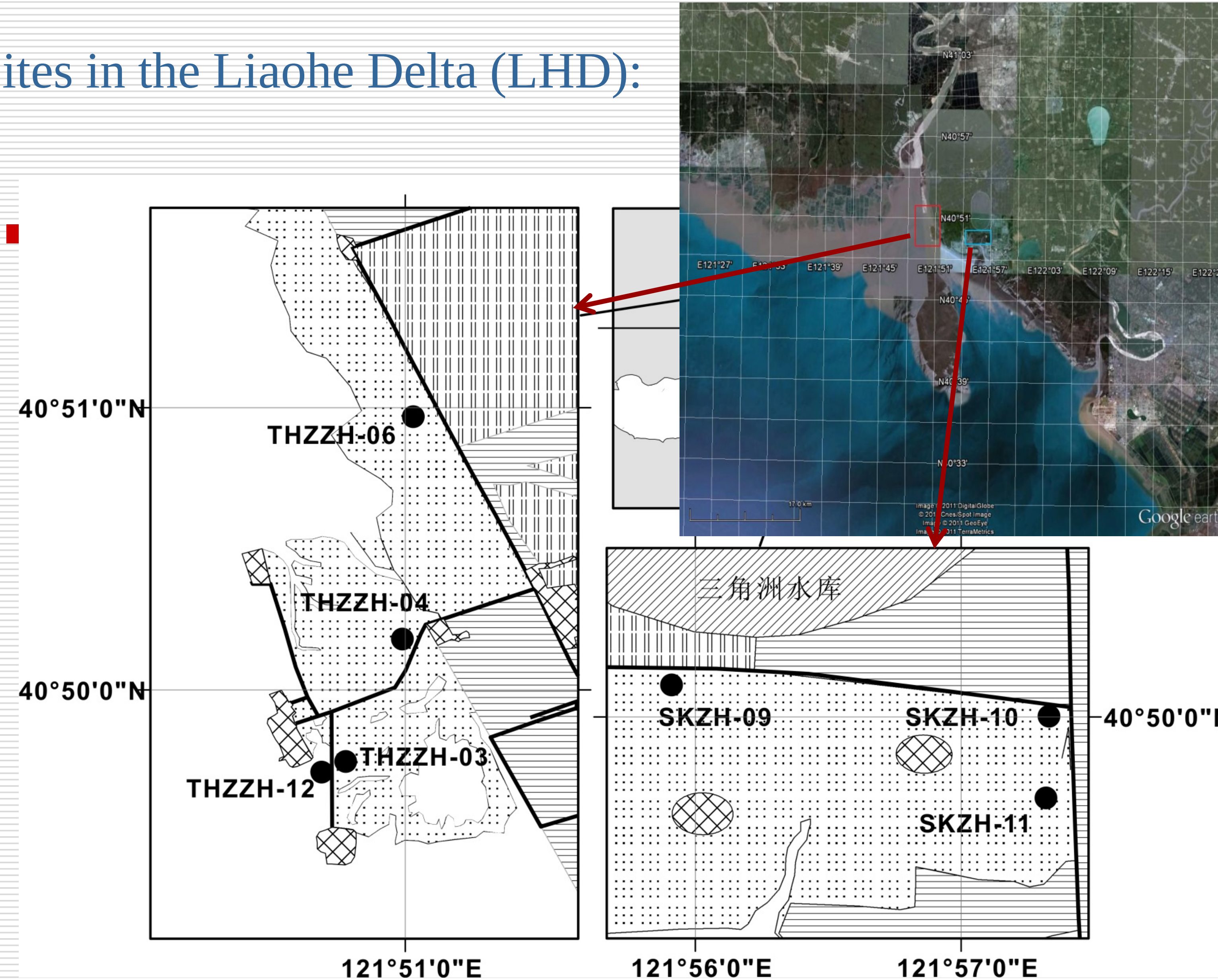
Yellow River Delta (YRD)

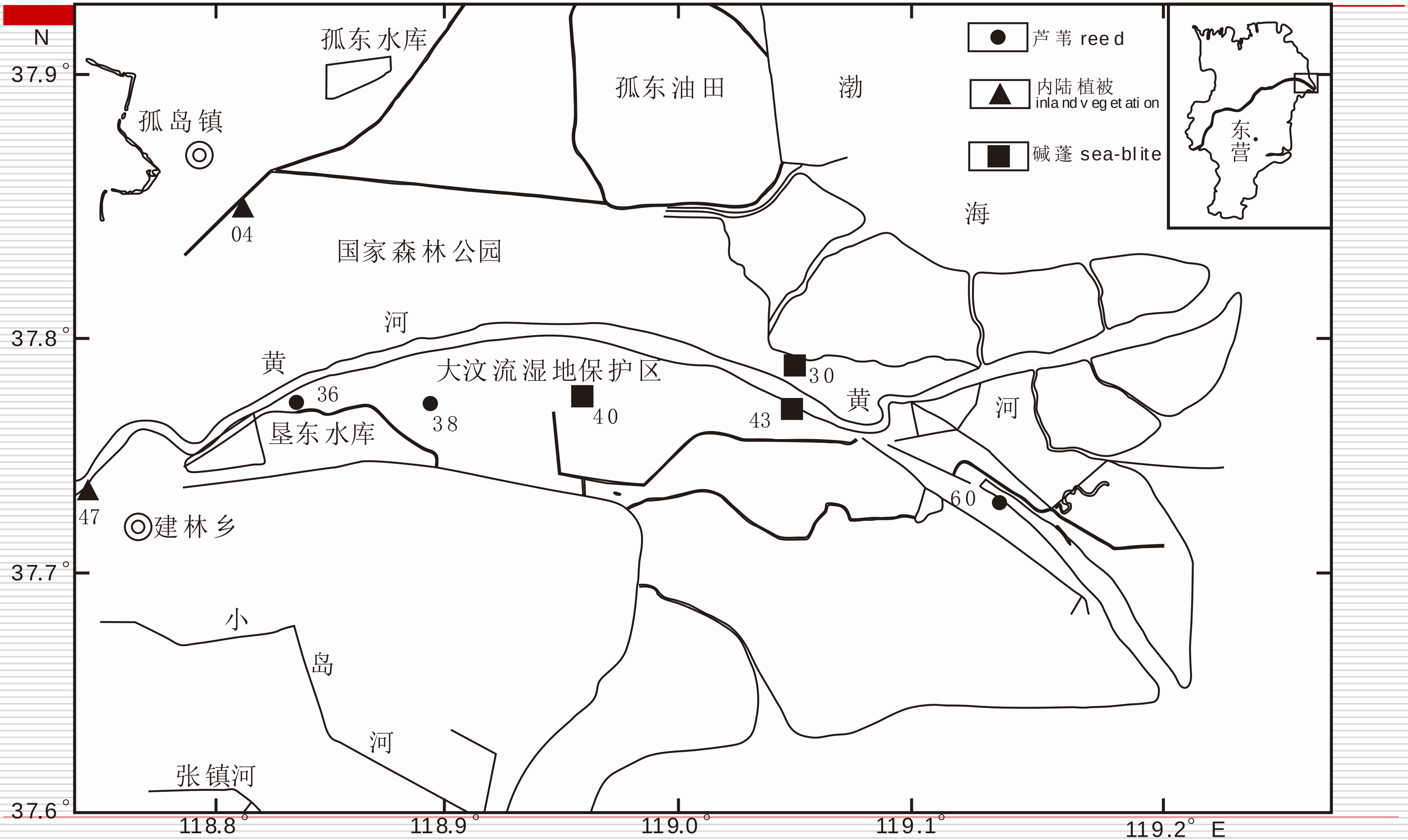
- ➢ Average tidal range: 0.73–1.77 m
- ➢ Climate: dry and warm
- • Air temperature: -23.3°C to 41.9°C and averages 12.3°C.
- • Precipitation: 537.3 mm
- • Evaporation: 1962 mm

Liaohe River Delta (LHD)

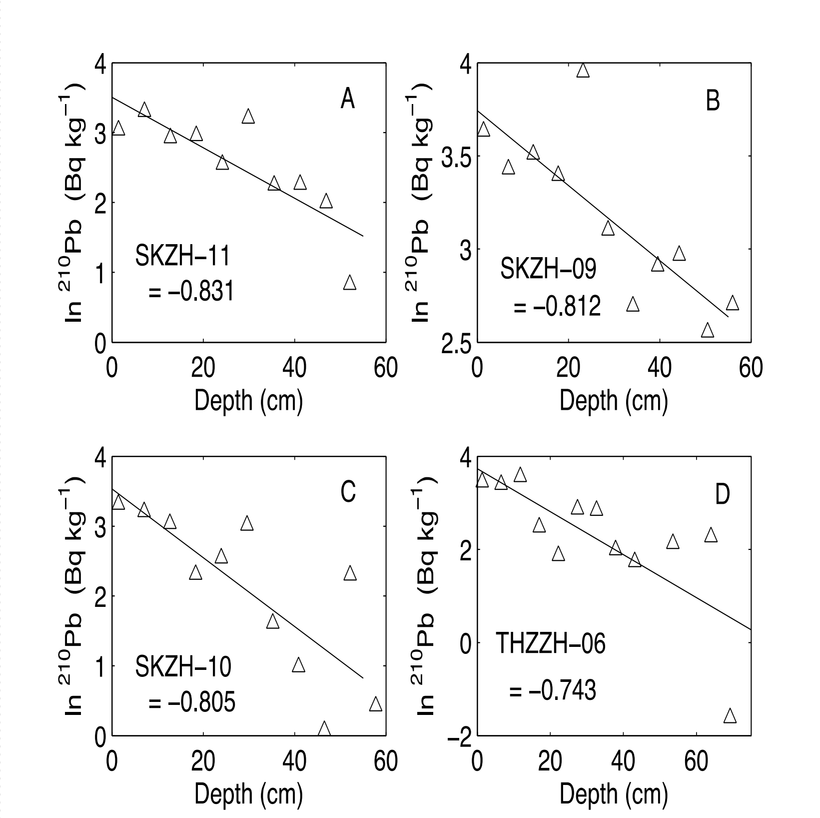
- ➢ Tidal range is 2.7 m
- ➢ Climate: moist and cool
- • Temperature ranges from –24.8 °C to 35.2°C, with an annual average of 8.4°C.
- • Precipitation: 623.2mm
- • Evaporation: 1669 mm,

Sites in the Liaohe Delta (LHD):




N
37.9°
37.8°
37.7°
37.6°
118.8°
118.9°
119.0°
119.1°
119.2° E
孤东水库
孤东油田
渤
海
孤岛镇
04
国家森林公园
河
黄
大汶流湿地保护区
36
38
40
30
43
黄
河
垦东水库
47
建林乡
60
小
岛
河
张镇河
芦苇 reed
内陆植被 inland vegetation
碱蓬 sea-blite
东营

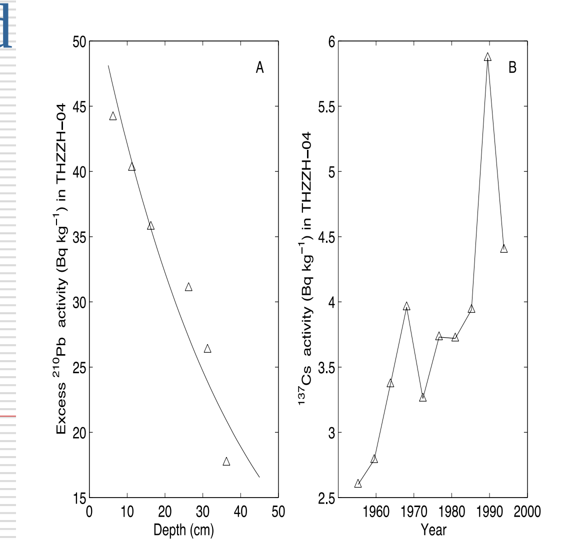
Sediment accretion rates



Natural logarithms of excess ^{210}Pb activity versus depth in soil cores collected from four sites in the LHD. Straight lines are linear regressions.

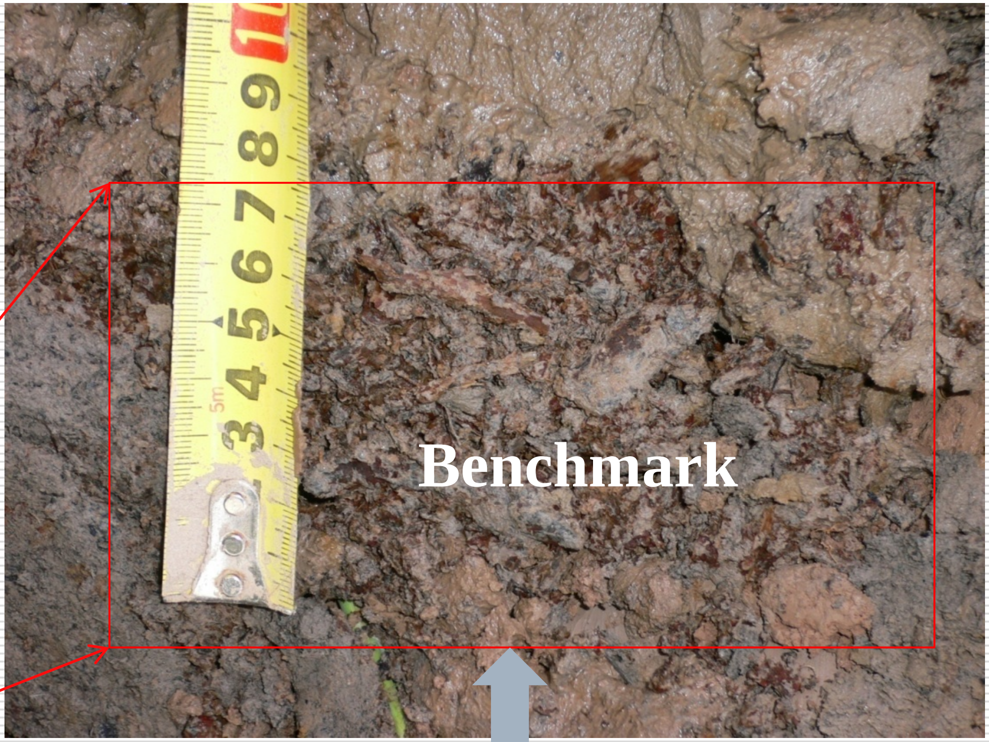
The slopes of the regression lines were in all cases significantly different from zero (p<0.047), and the calculated accretion rates ranged

y^{-1}



Based on the ^{210}Pb profiles, the years corresponding to the two peaks of ^{137}Cs activity in cores averaged 1964±4 and 1991±2

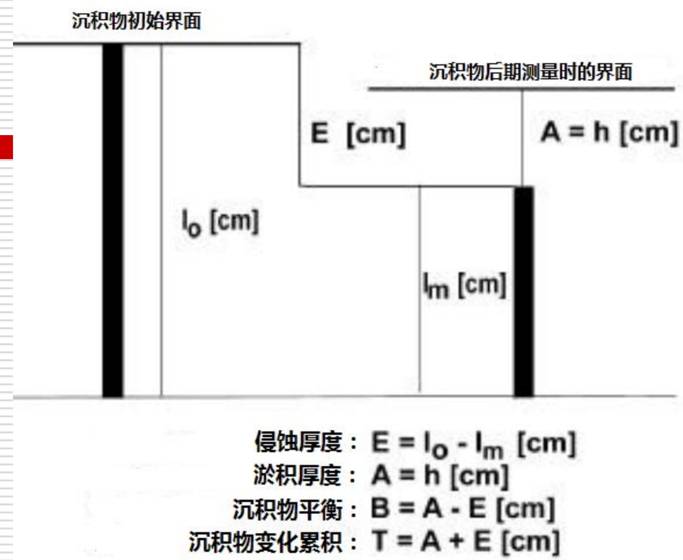
YRD: Sediment accretion rate (SAR)
=thickness of the soil layer above the benchmark/age

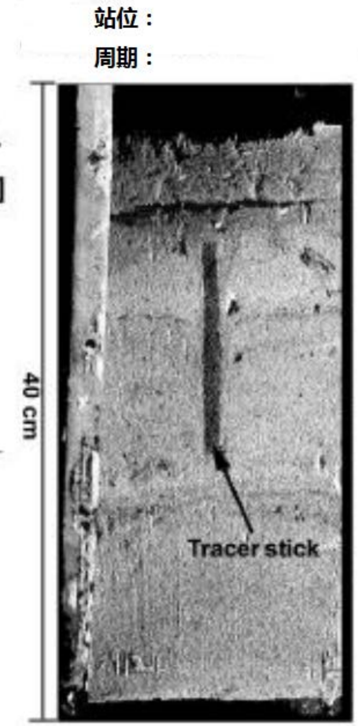


paleosol layers formed by sedimentary hiatuses during frequent distributary channel changes

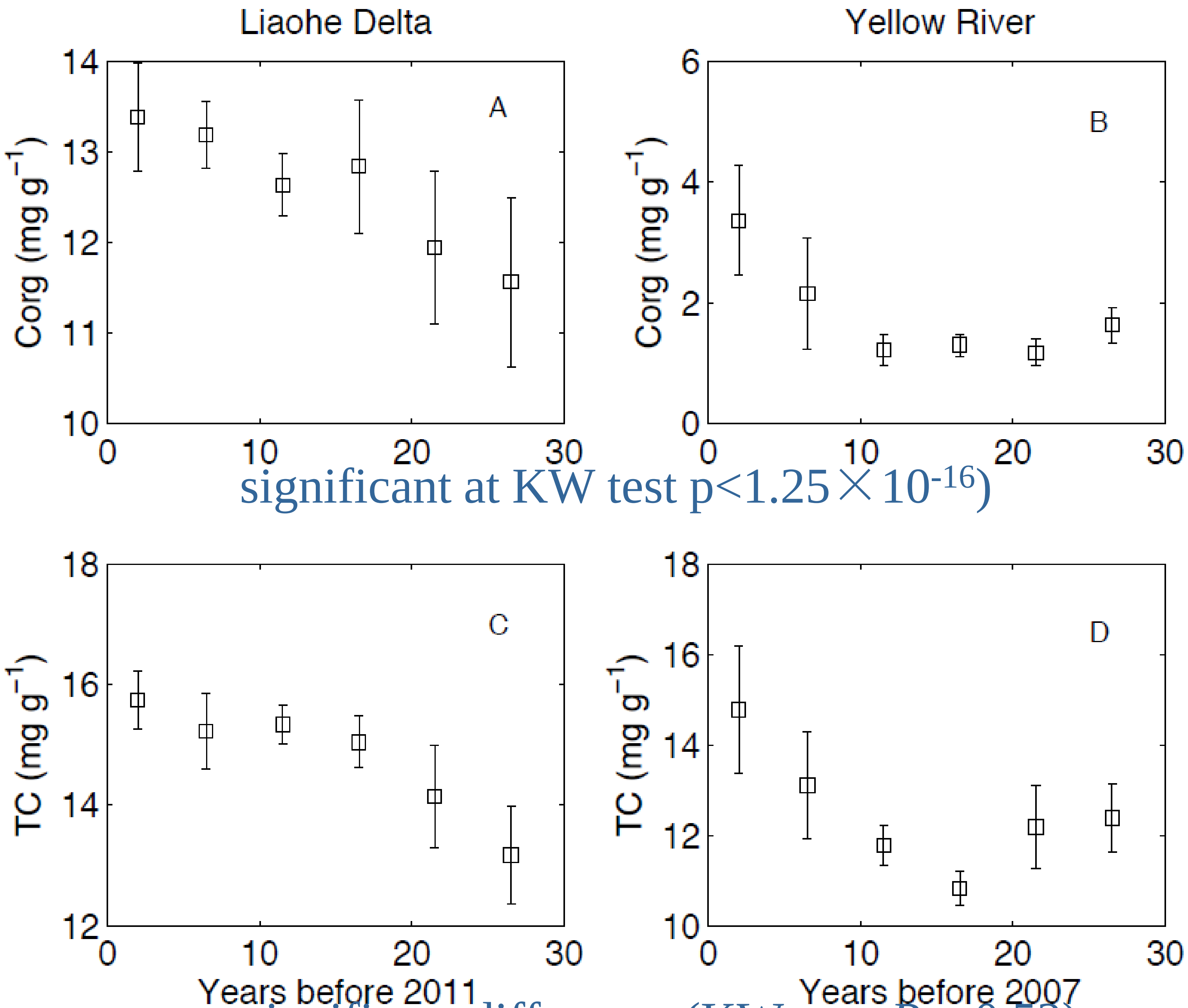
SAR=3.9 to 9.7 cm year^{-1}

Colour sand bar



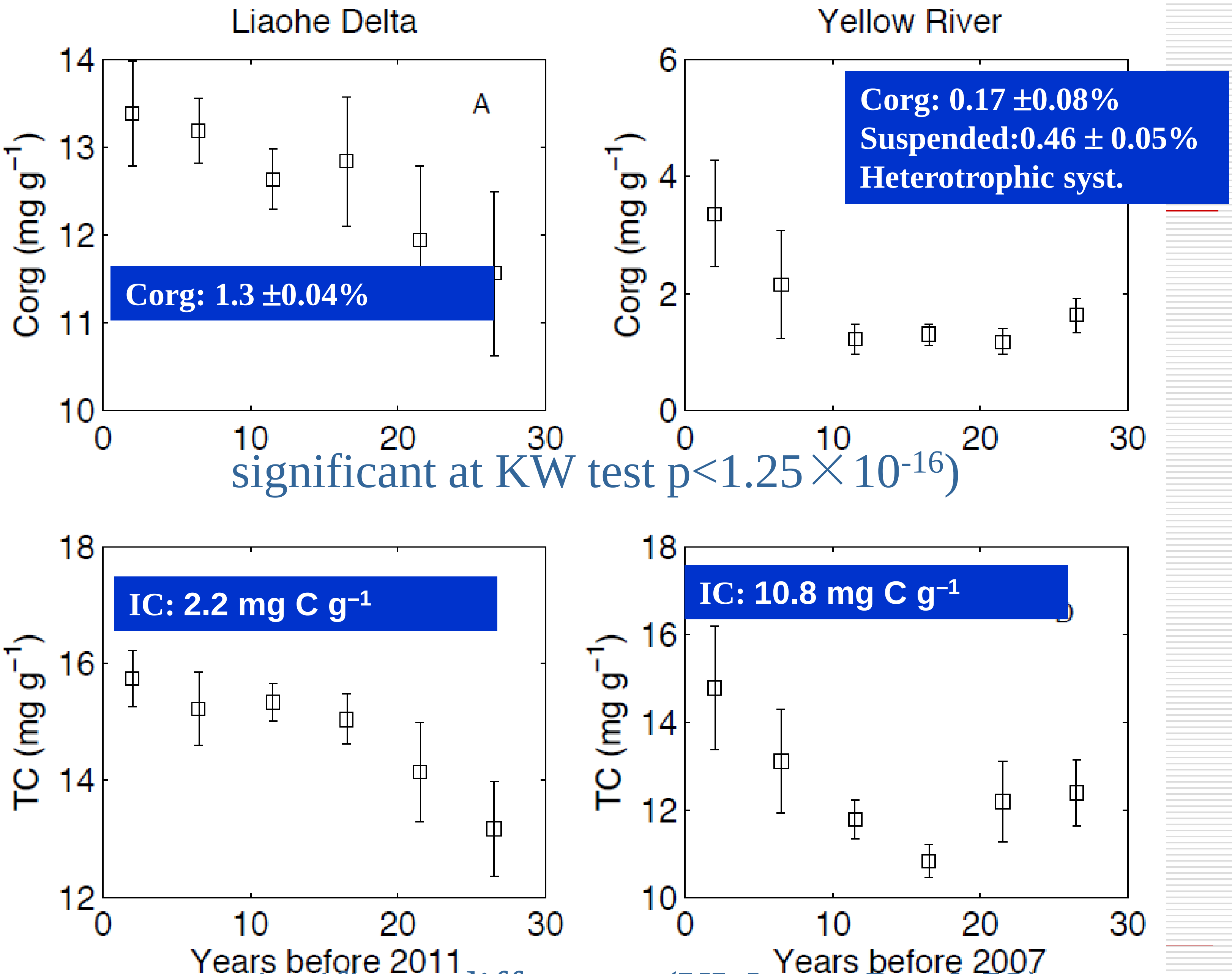


Schwarzer &Diesing (2001)



significant at KW test p<1.25 × 10^{-16})

no significant difference (KW test, $P = 0.53$)



Corg: 1.3 ±0.04%

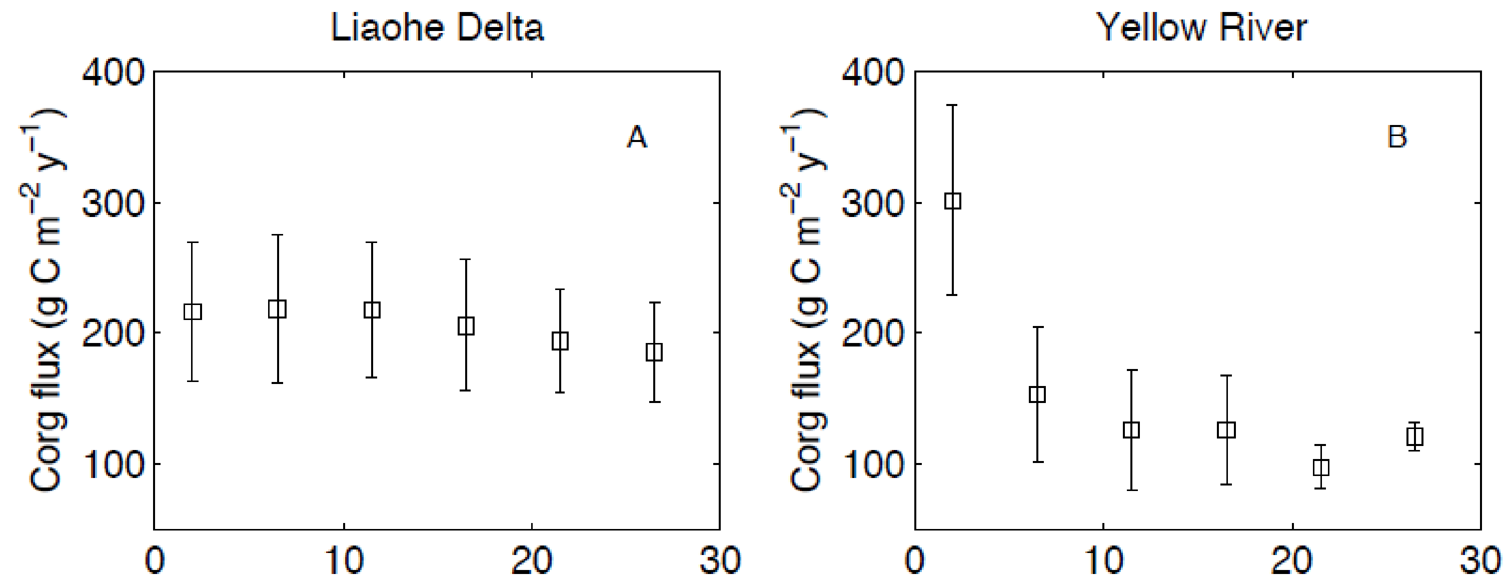
Corg: 0.17 ±0.08%
Suspended:0.46 ± 0.05%
Heterotrophic syst.

significant at KW test p<1.25×10^-16)

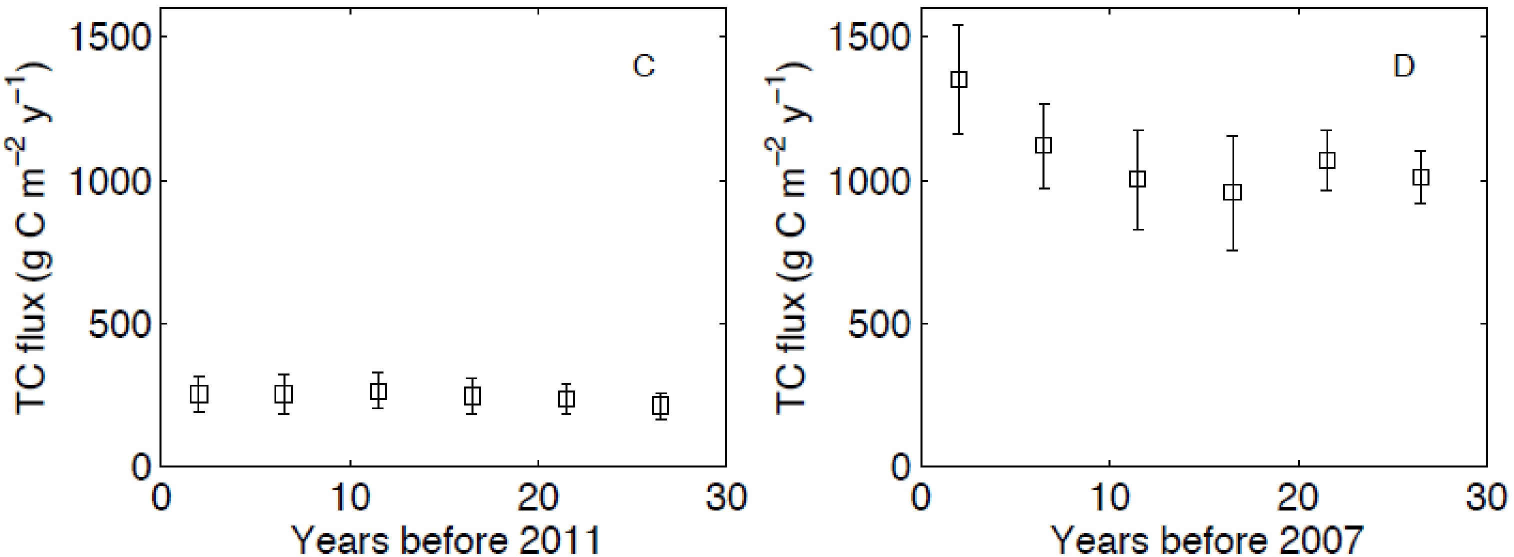
IC: 2.2 mg C g^{-1}

IC: 10.8 mg C g^{-1}

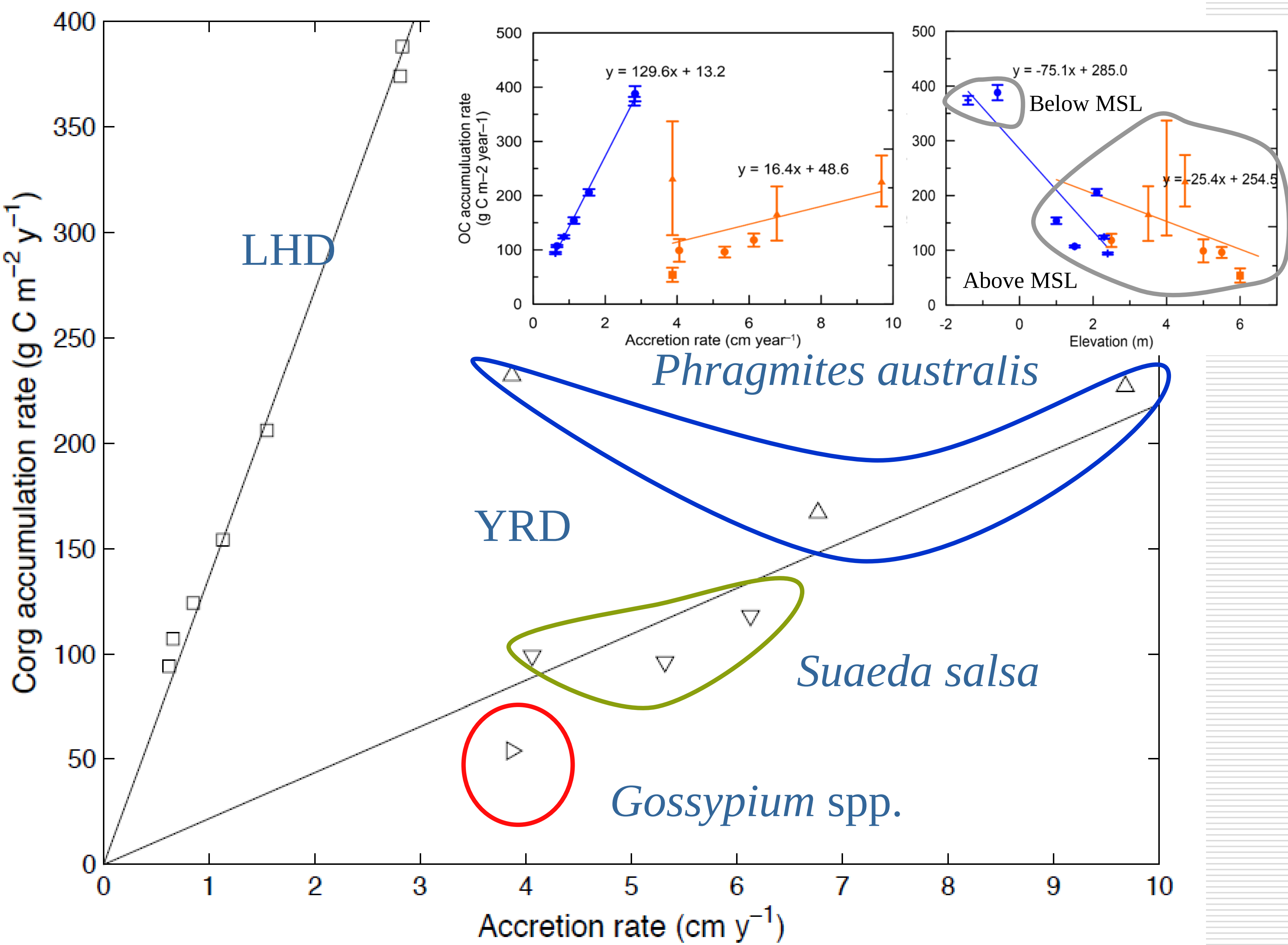
no significant difference (KW test, $P = 0.53$)



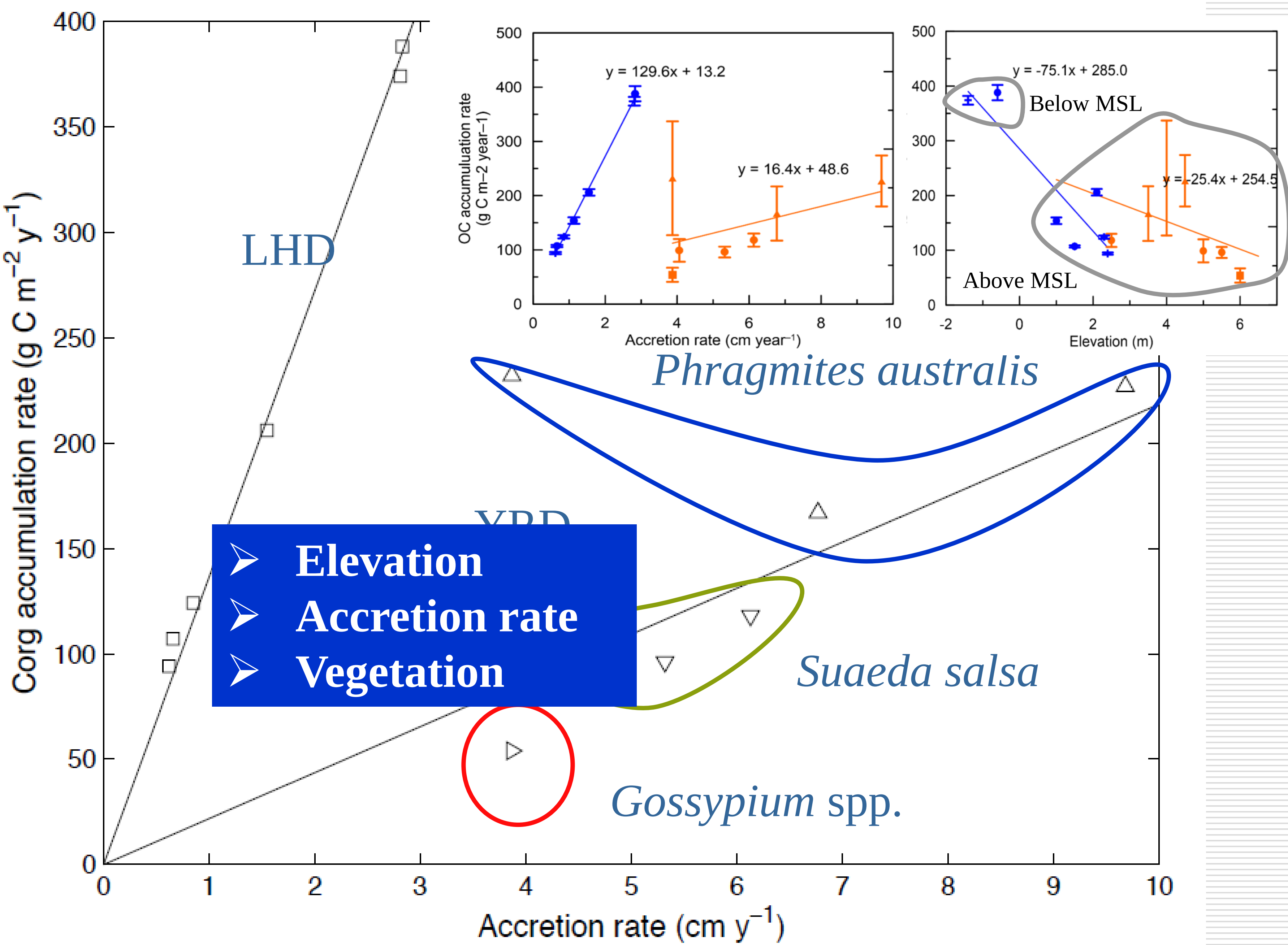
no significant difference (KW test, *P* = 0.41)



significant at *P* < 0.002

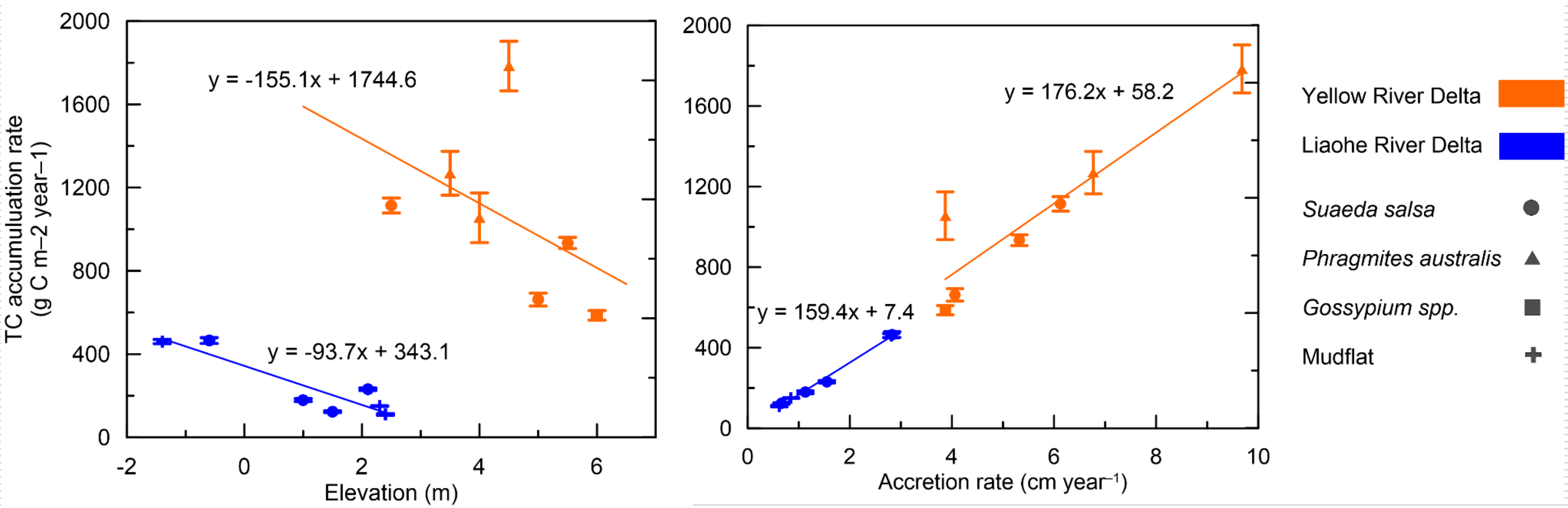


LHD
YRD
Phragmites australis
Suaeda salsa
Gossypium spp.
Corg accumulation rate (g C m−2 y−1)
Accretion rate (cm y−1)
y = 129.6x + 13.2
y = 16.4x + 48.6
OC accumulation rate (g C m−2 year−1)
Accretion rate (cm year−1)
y = -75.1x + 285.0
y = -25.4x + 254.5
Below MSL
Above MSL
Elevation (m)



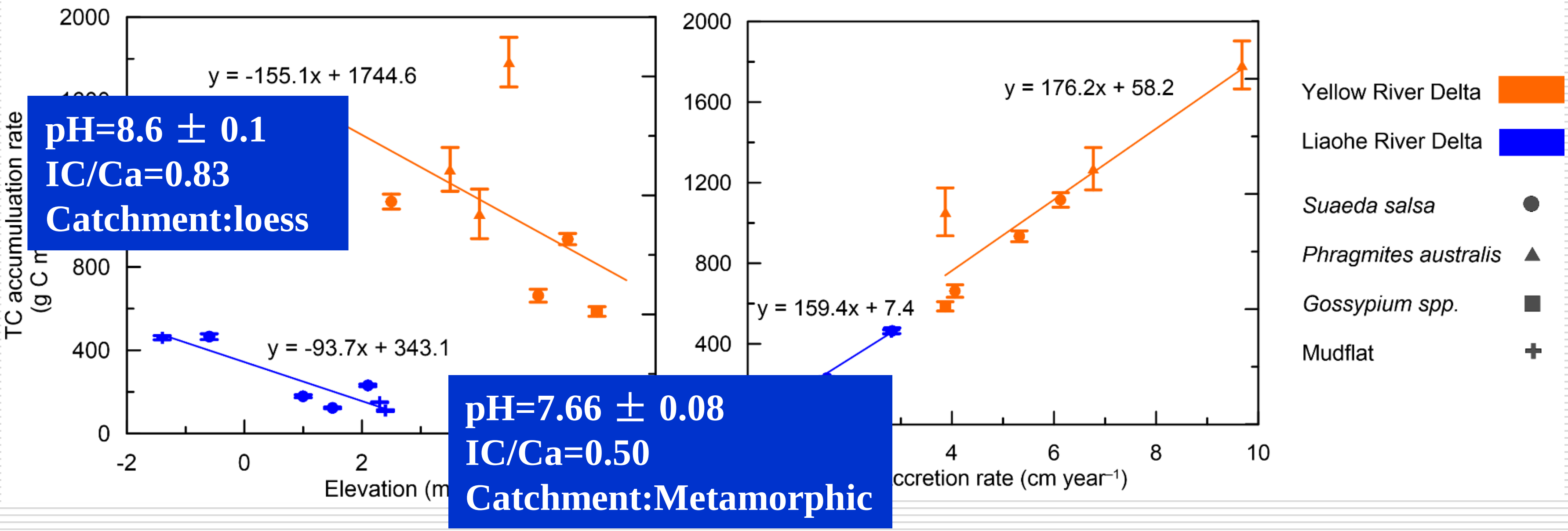
Corg accumulation rate (g C m−2 y−1)
Accretion rate (cm y−1)
LHD
YRD
Phragmites australis
Suaeda salsa
Gossypium spp.
Elevation
Accretion rate
Vegetation
OC accumulation rate (g C m−2 year−1)
Accretion rate (cm year−1)
y = 129.6x + 13.2
y = 16.4x + 48.6
Elevation (m)
y = -75.1x + 285.0
y = -25.4x + 254.5
Below MSL
Above MSL

Accumulation rate of TC vs Elevation and Sedi. Accretion rate(SAR)



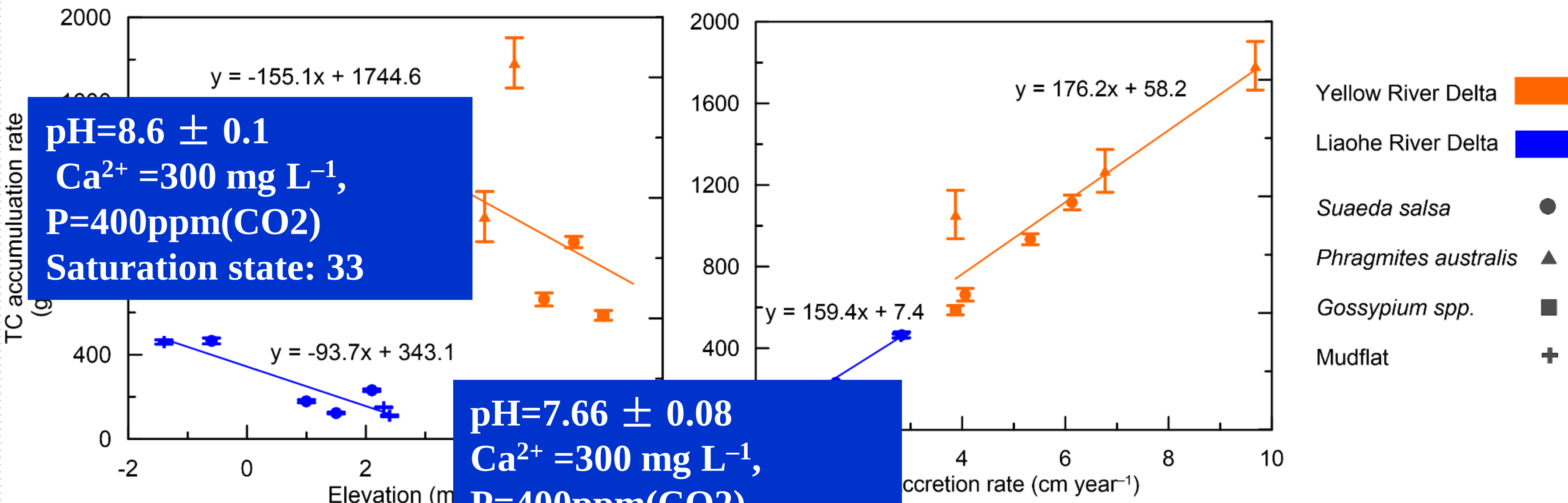
- TC rate: 4 times higher in the YRD than the LHD
- TC rate: negative related to elevation (interrupted by different vegetation coverage)
- TC rate: positive related to accretion rate (The slopes of both regression lines were significantly greater than 1.0 ($p<0.001$), but neither intercept was significantly different from zero ($p>0.06$).

Accumulation rate of TC vs Elevation and Sedi. Accretion rate(SAR)



- TC rate: 4 times higher in the YRD than the LHD
- TC rate: negative related to elevation (interrupted by different vegetation coverage)
- TC rate: positive related to accretion rate (The slopes of both regression lines were significantly greater than 1.0 (p<0.001), but neither intercept was significantly different from zero (p>0.06).

Accumulation rate of TC (ARC) vs Elevation and Sedi. Accretion rate(SAR)



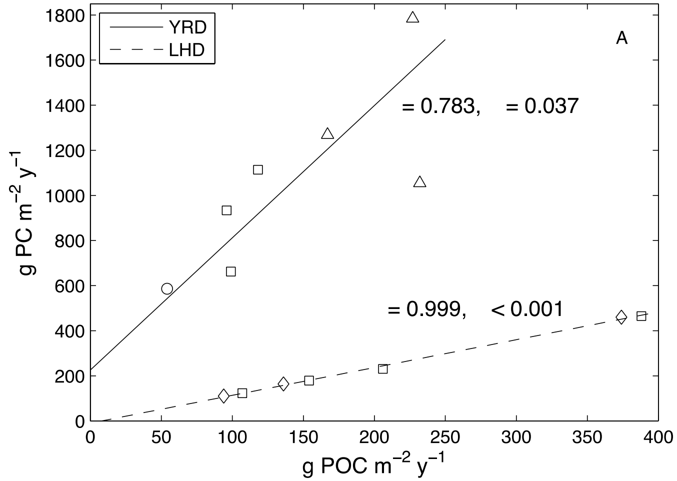
pH=8.6 ± 0.1
Ca^{2+} =300 mg L^{-1},
P=400ppm(CO2)
Saturation state: 33

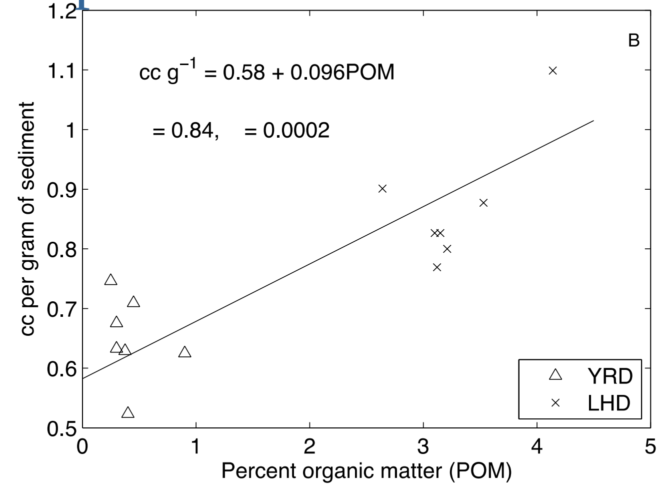
pH=7.66 ± 0.08
Ca^{2+} =300 mg L^{-1},
P=400ppm(CO2)
Saturation state: 0.5

- TC rate: 4 times higher in the YRD than the LHD
- TC rate: negative related to elevation (interrupted by different vegetation coverage)
- TC rate: positive related to accretion rate (The slopes of both regression lines were significantly greater than 1.0 (*p*<0.001), but neither intercept was significantly different from zero (*p*>0.06).

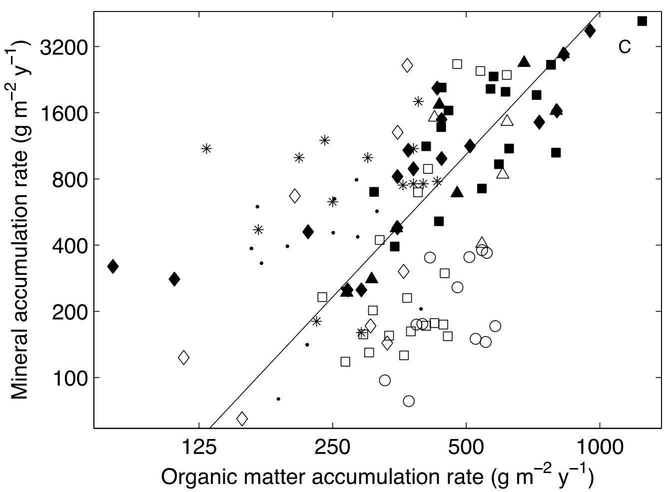
Relationships between sequestration rates of POC and PC in the YRD and LHD

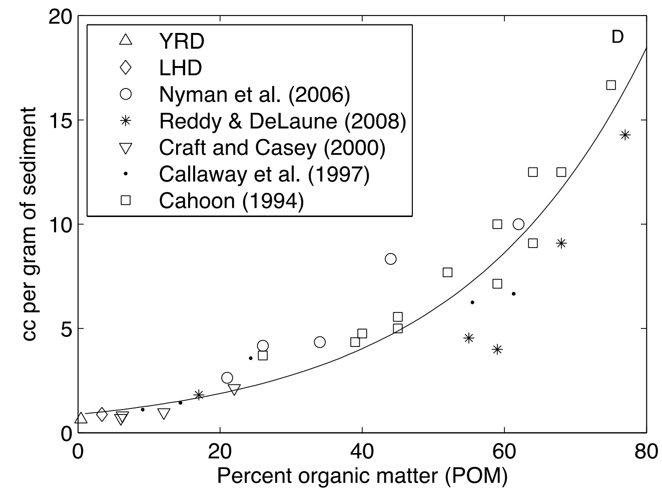
LHD&YRD pattern





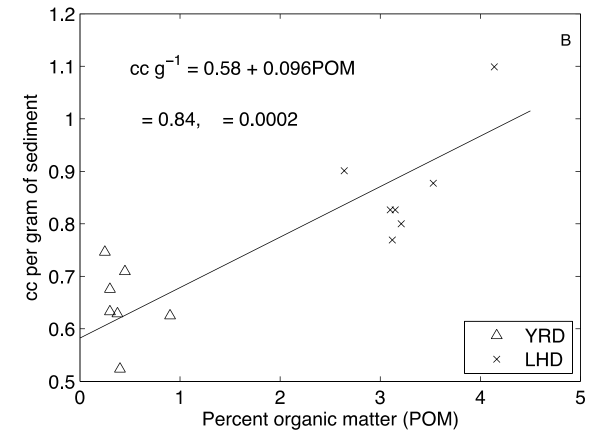
Global pattern



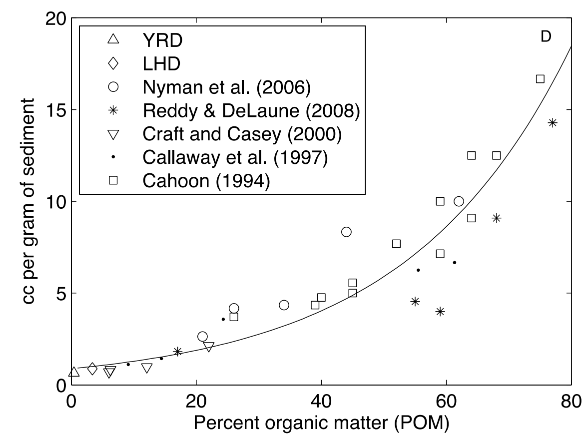


Relationships between sequestration rates of POM and BD^{-1} in the YRD and LHD

the regression line fit to the data indicates that sediment consisting of 100% POM would occupy (0.58 + 9.6)/0.58 = 18 times as much volume per gram as sediment consisting of 100% inorganic matter



OM is the dominate factor for keeping the elevation in the wetlands!




Thank you

参考文献

Brix, H., Sorrell, B.K., Lorenzen, B. 2001. Are Phragmites-dominated wetlands a net source or net sink of greenhouse gases? Aquatic Botany, 69 (2-4), 313-324.

Cahoon, D. R.Reed, D.j. & Day, J. W. Estimating shallow subsidence in microtidal salt marshes of the southeastern United States: Kaye and Barghoorn revisited Mar.Geol. 128, 1-9 (1995).

Cahoon, D. R. et al., A device for high precision measurement of wetland sediment elevation: I.Recent improvements to the sedimentation-erosion table. J. Sediment. Res. 72, 730-733 (2002).

Chmura, G. L. et al, 2003, Global carbon sequestration in tidal, saline wetland soils. Global Biogeochemical Cycles.

Bernal, B. and Mitsch, W. J. 2012, Comparing carbon sequestration in temperate freshwater wetland communities. Global change biology, 18(5), 1636-1647.

Delaune, R. D., W.H. Patrick Jr., R.J.Buresch. 1978. Sedimentation rates determined by 137 Cs dating in a rapidly accreting salt marsh. Nature. 275: 532-533.

Eakins, J.D. 1982. The 210Pb technique for dating sediments, and some applications. AAEC Research Establishment, Lucas Heights Reseach Laboratories, PMB Sutherland, 3322, N.S.W., Australia. 30-47.

IPCC, 2007, Climate Change 2007: The Physical Science Basis. Contribution of Working Group 1 to the fourth assessment report of the intergovernmental panel on climate change.[Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller(eds.)]. Cambridge University press, Cambridge, United Kingdom and New York, NY, USA.

Krauss, K. W. et al. Surface elevation change and susceptibility of different mangrove zones to sea-level rise on Pacific islands of Micronesia. Ecosystems 13, 129-143 (2010).

Schwarzer, K., Diesing M, 2001, Sediment redeposition in nearshore areas-examples from the Baltaic Sea, American society of civil engineers proceedings of the conference, Lund, Sweden.

Chemical and physical data comparison between YRD and LHD

Element	YRD	LHD	LHD
Zn ($mg\ g^{-1}$)	0.050 ± 0.003	0.117 ± 0.005	0.018 ± 0.002
Cu ($mg\ g^{-1}$)	0.017 ± 0.001	0.028 ± 0.002	0.0039 ± 0.000 1
Mn ($mg\ g^{-1}$)	0.50 ± 0.03	1.15 ± 0.09	0.29 ± 0.01
Fe ($mg\ g^{-1}$)	25.3 ± 1.0	43.0 ± 2.1	0.17 ± 0.01
Mg ($mg\ g^{-1}$)	11.46 ± 0.30	14.5 ± 0.5	1.18 ± 0.02
Ca ($mg\ g^{-1}$)	43.4 ± 1.2	14.6 ± 0.5	4.13 ± 0.10
K ($mg\ g^{-1}$)	17.3 ± 0.3	24.8 ± 0.1	0.73 ± 0.01
Al ($mg\ g^{-1}$)	56.5 ± 1.2	80.2 ± 1.2	
N ($mg\ g^{-1}$)	0.27 ± 0.03	0.88 ± 0.08	
P ($mg\ g^{-1}$)	0.60 ± 0.01	0.68 ± 0.01	0.03 ± 0.00
S ($mg\ g^{-1}$)	0.17 ± 0.01	0.49 ± 0.05	
TC ($mg\ g^{-1}$)	12.6 ± 0.7	14.7 ± 0.3	
OC ($mg\ g^{-1}$)	1.82 ± 0.32	12.5 ± 0.4	
BD ($g\ cm^{-3}$)	1.51 ± 0.04	1.16 ± 0.05	
MC (%)	22.7 ± 1.0	31.2 ± 1.0	
OC : N (mol : mol)	7.1 ± 0.3	17.4 ± 1.4	
N : P (mol : mol)	1.0 ± 0.1	2.87 ± 0.23	
pH	8.6 ± 0.1	7.66 ± 0.08	