



From micro to macro scale – the impact on the sediment discharge after construction of the Three Gorges Dam on Yangtze River (Changjiang)

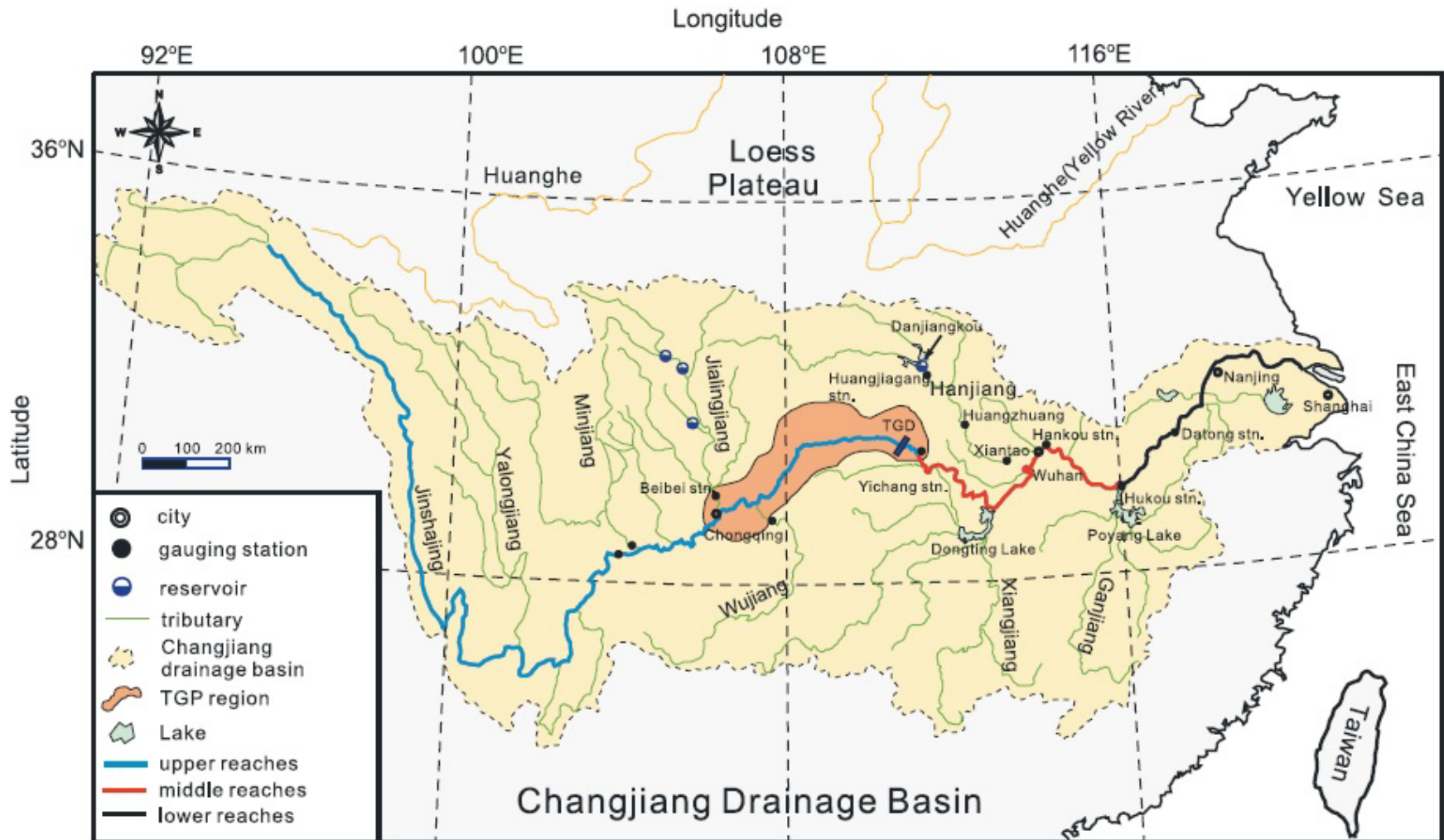
Aleksandra Dewiszek

*9th International SedNet conference
Solving societal challenges; working with sediments
23–26 September 2015, Krakow, Poland*

Plan of presentation

1. Study area
2. Yangtze (Changjiang) River
3. The Three Gorges Dam
4. Main goals of the Three Gorges Dam (TGD) project
5. Impacts of the Three Gorges Dam
6. Conclusions

Study area



Yangtze (Changjiang) River



Yangtze (Changjiang) River

- World's 3rd largest river in terms of length – 6300 km
- Catchment covers an area of 1 810 000 km²
- Largest river in terms of catchment population – over 450 million people
- 5th globally in terms of water discharge – 900 km³/yr
- 4th largest in terms of sediment load – 470 Mt/yr
- Nearly 50 000 dams have been constructed within the Yangtze River basin

The Three Gorges Dam



The Three Gorges Dam

Power generation:

- Nominal capacity: 22 500 MW
- Annual generation: 98,8 TWh (2014)
power plant (10 billion)
- Normal elevation: 175 m
in the world!

Main goals of the Three Gorges Dam project



Flood Control



Power Generation

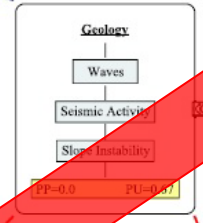
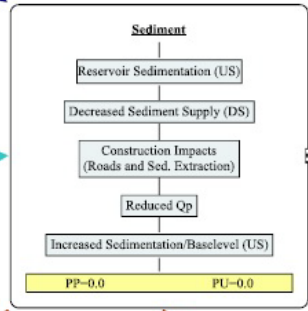
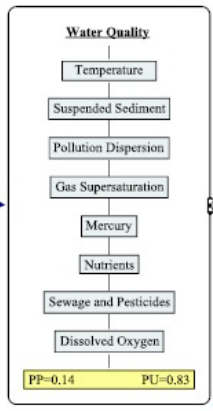
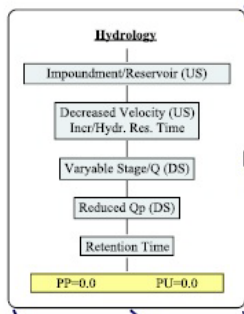


Navigation

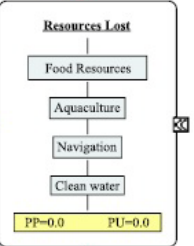
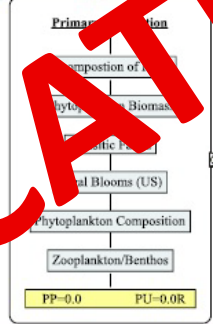
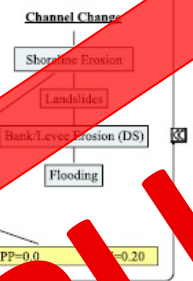
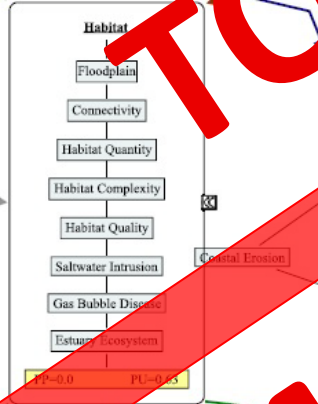
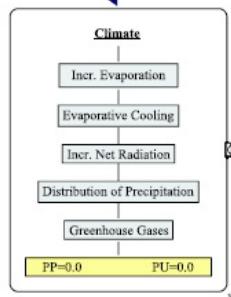


Tourism

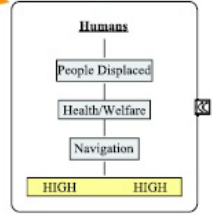
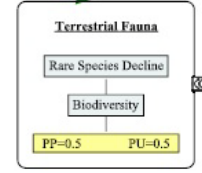
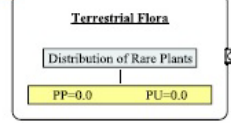
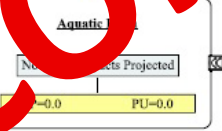
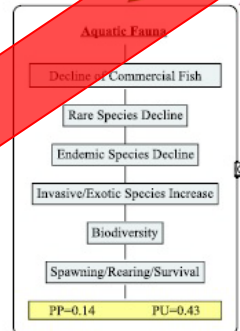
1st Order



2nd Order



3rd Order



TOO COMPLICATED

Impacts of the TGD

1. Hydrology
2. Geology
3. Water quality
4. Sediment
5. Human and the environment
 - ✿ People resettlement
 - ✿ Reducing emission of the millions tonnes of greenhouse gases and tonnes of dust due to reduction of coal consumption
 - ✿ Mining sand and gravel from the reservoirs and the lakes
6. Flora and fauna

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Hydrology

- Inundation of upstream tributaries
 - Decrease of water discharge and flow velocity
 - Widely varying water level
 - Influence on two largest freshwater lakes in China – Poyang and Dongting
 - Local and regional climate changes
 - Methane generation
- 



1987

2000

2004

2006



1987

2000

2004

2006

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2. **Geology**

3. Water quality


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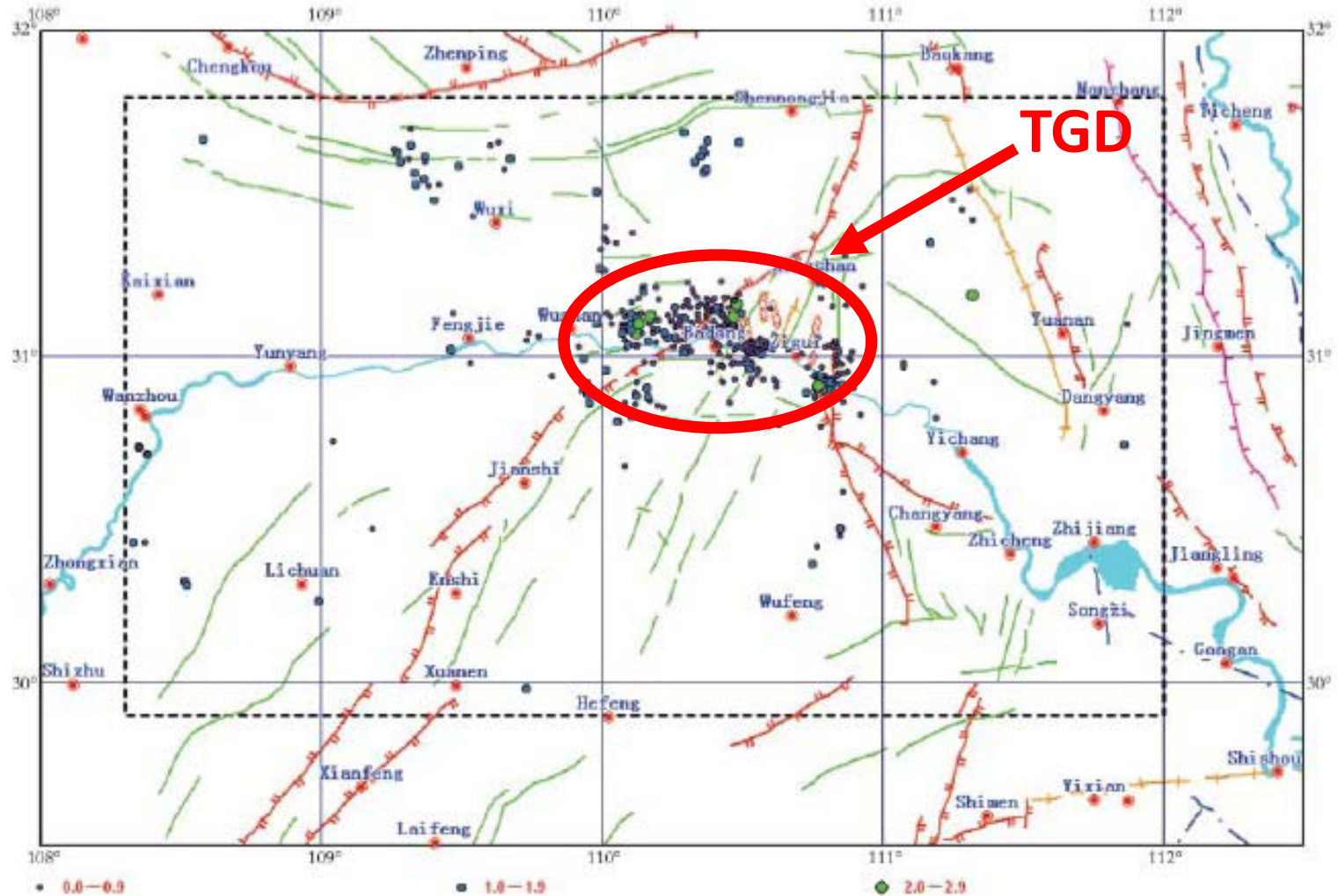
Geology

- Erosion of reservoir shorelines
 - Slopes instability
 - Landslides
 - Reservoir-induced seismicity (RIS)
 - Vertical surface displacements and plane level changes in the front reservoir area
- 

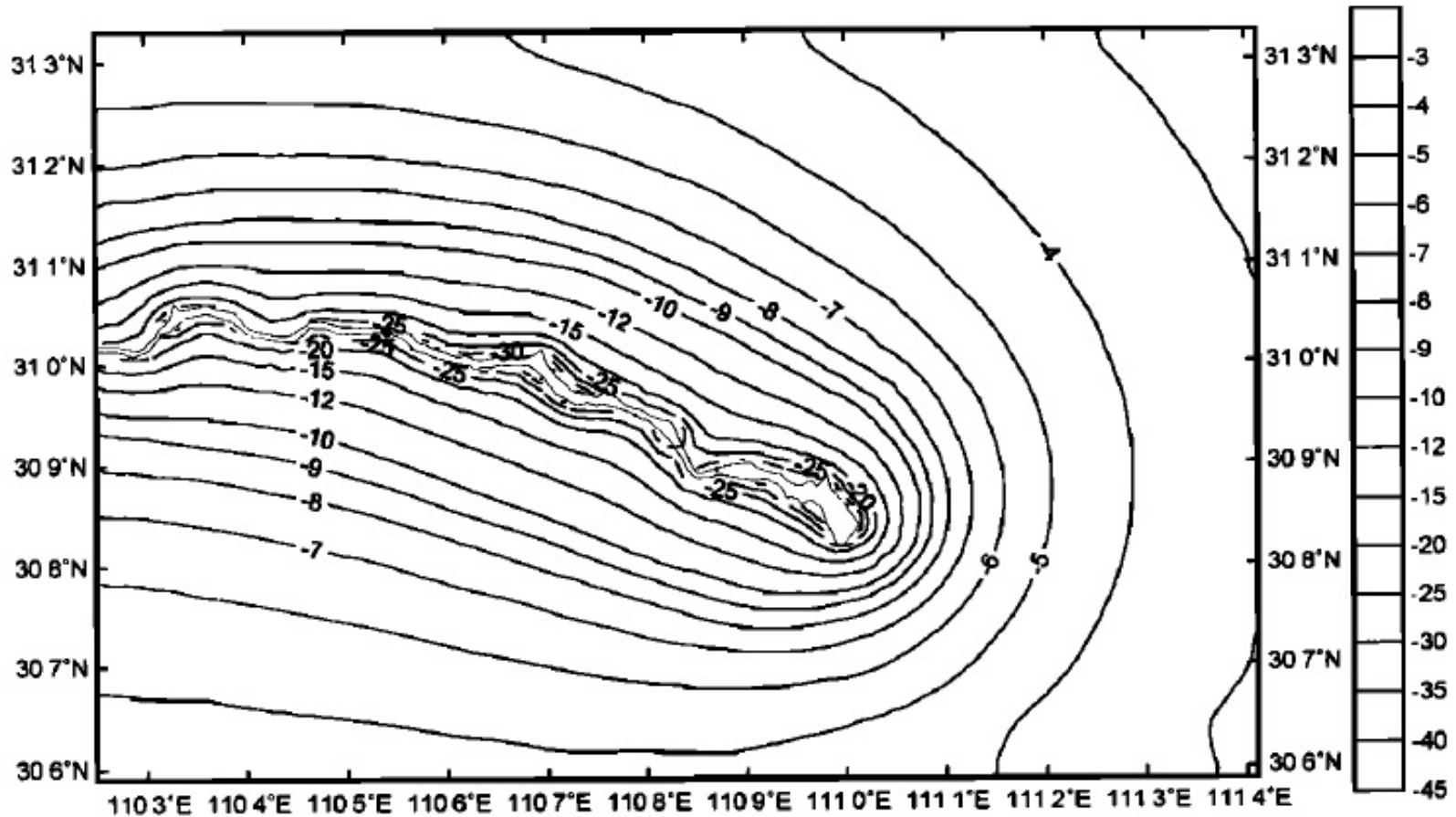
Landslides



Reservoir-induced seismicity (RIS)




Vertical surface displacements and plane level changes in the front reservoir area



Impacts of the TGD

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Water quality

- Significant increase of saltwater intrusion
 - Algae blooms
 - Pollution caused by nitrogen, phosphorus, pesticides and mercury
 - Decrease in Si:N ratio at Datong downstream of TGP
- 

Red algae bloom on Yangtze River




Water pollution



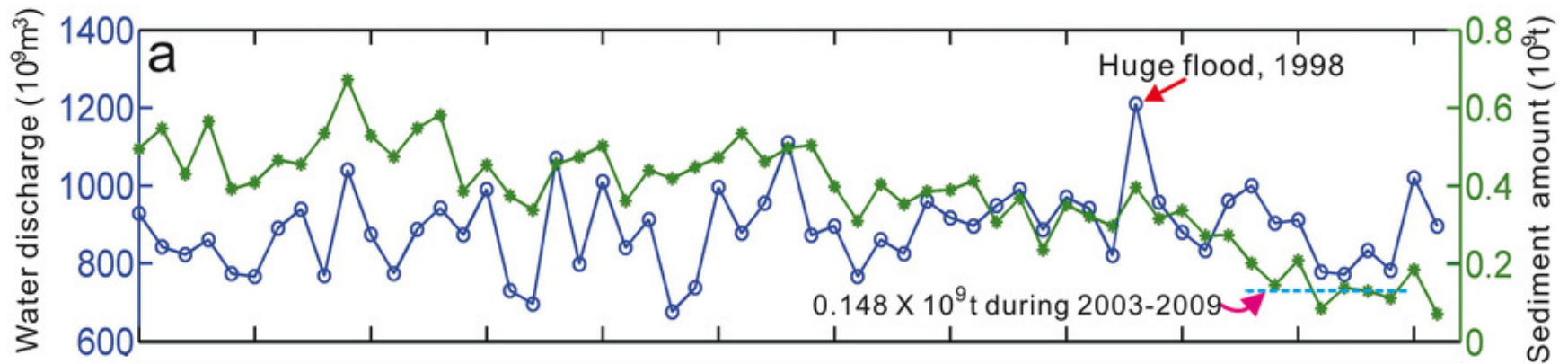
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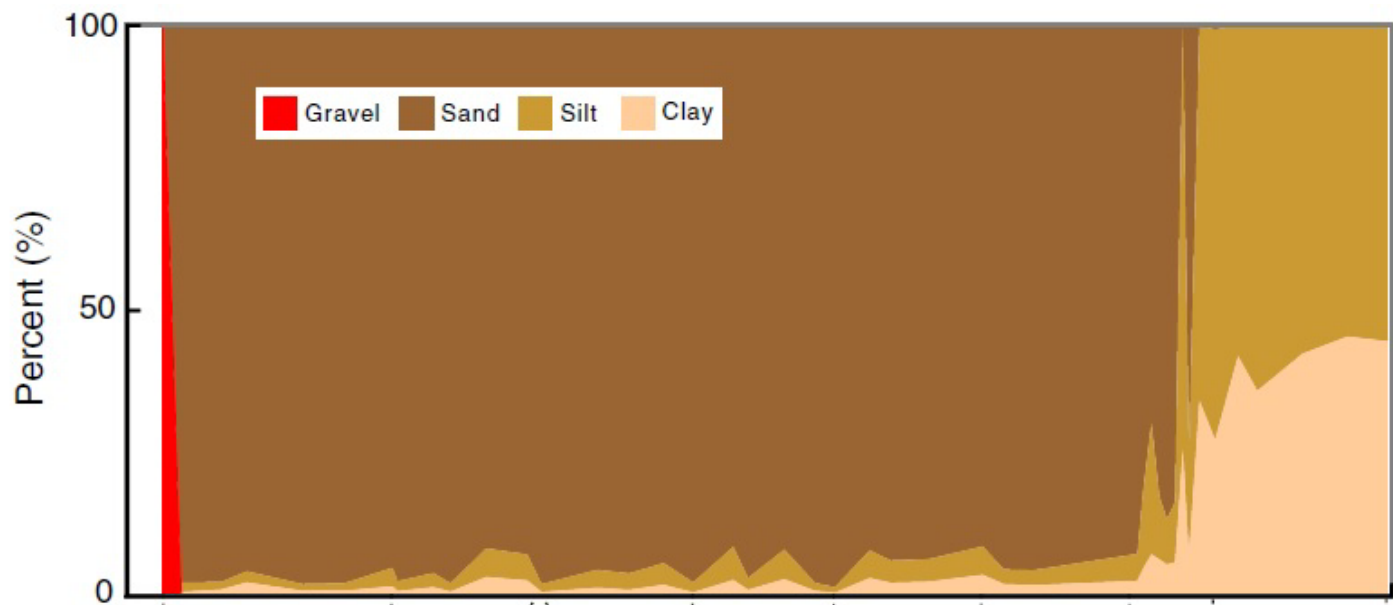
Sediment

1. Significant reduction of suspended sediment concentration
 2. Decrease of grain size diameter downstream of TGD
 3. Filling the reservoir by sedimentation in the TGD
 4. Erosion of the downstream reaches
 5. Reduction of sand bars in the estuary
 6. Influence on the Changjiang Submerged Delta
 7. Migration of the depocentre in the East China Sea
 8. Sand and gravel mines on the main lakes and reservoir
 9. Changes of the Earth rotation
- 

Yearly changes of water and sediment discharges at Datong and the maximum tidal level at Wusong



Dai, Liu, Wei, & Chen, 2014



Avg water discharge (km³/yr)

432

707

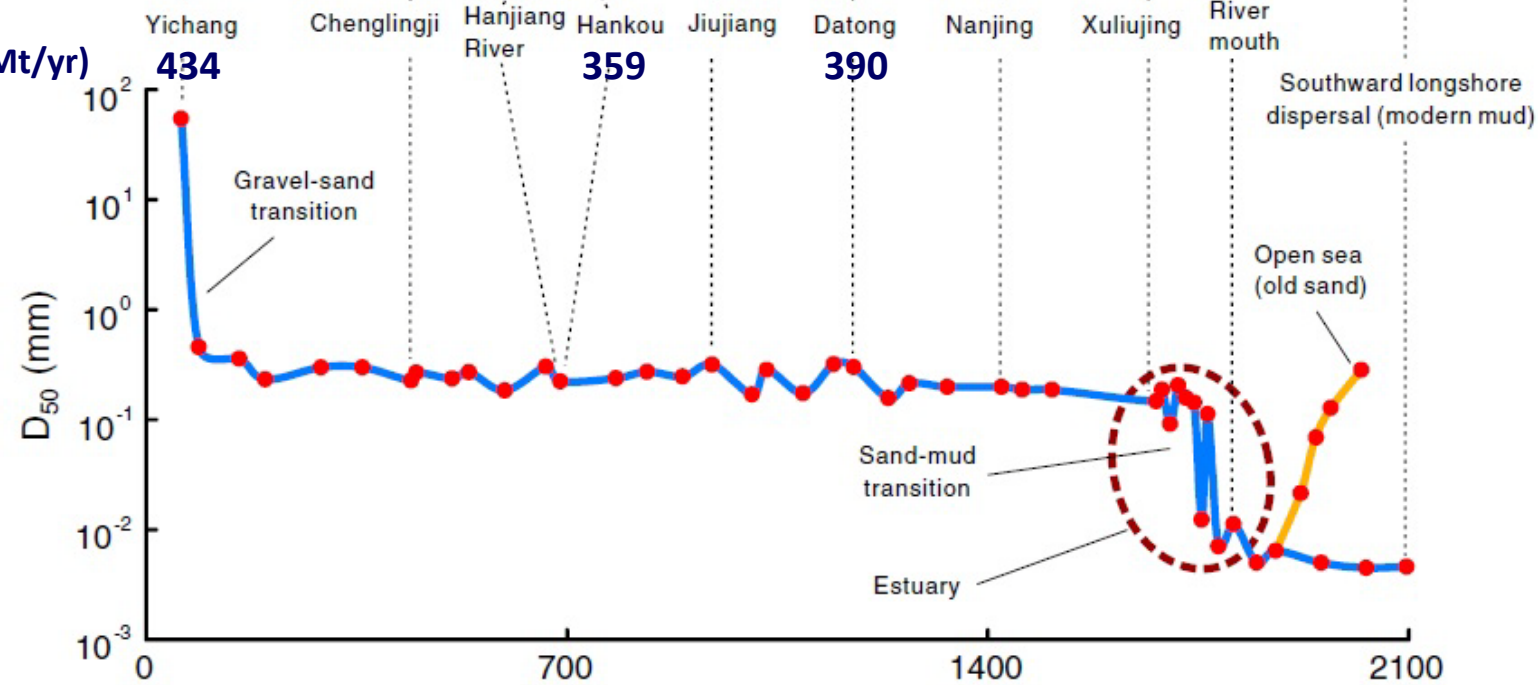
896

Avg sediment loads (Mt/yr)

434

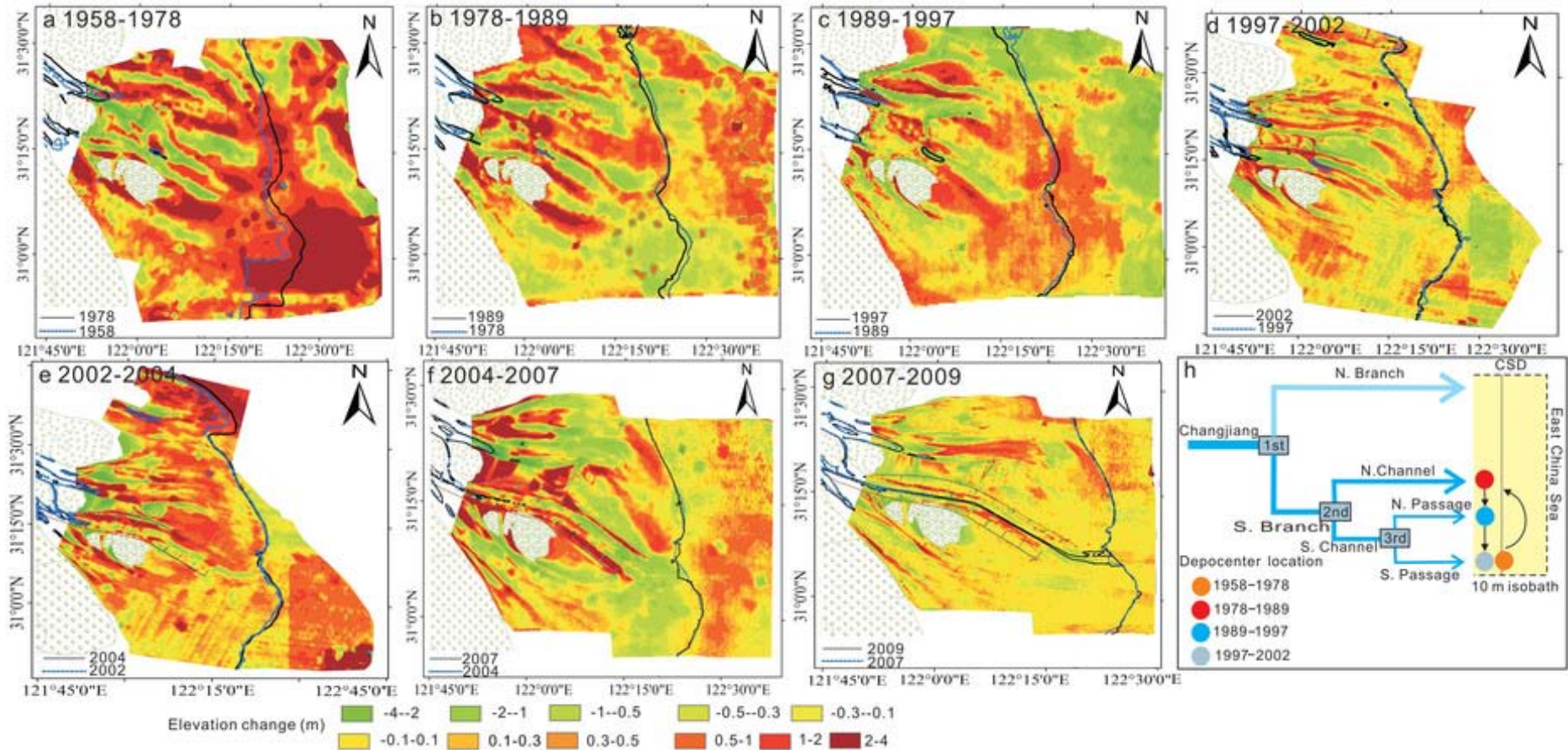
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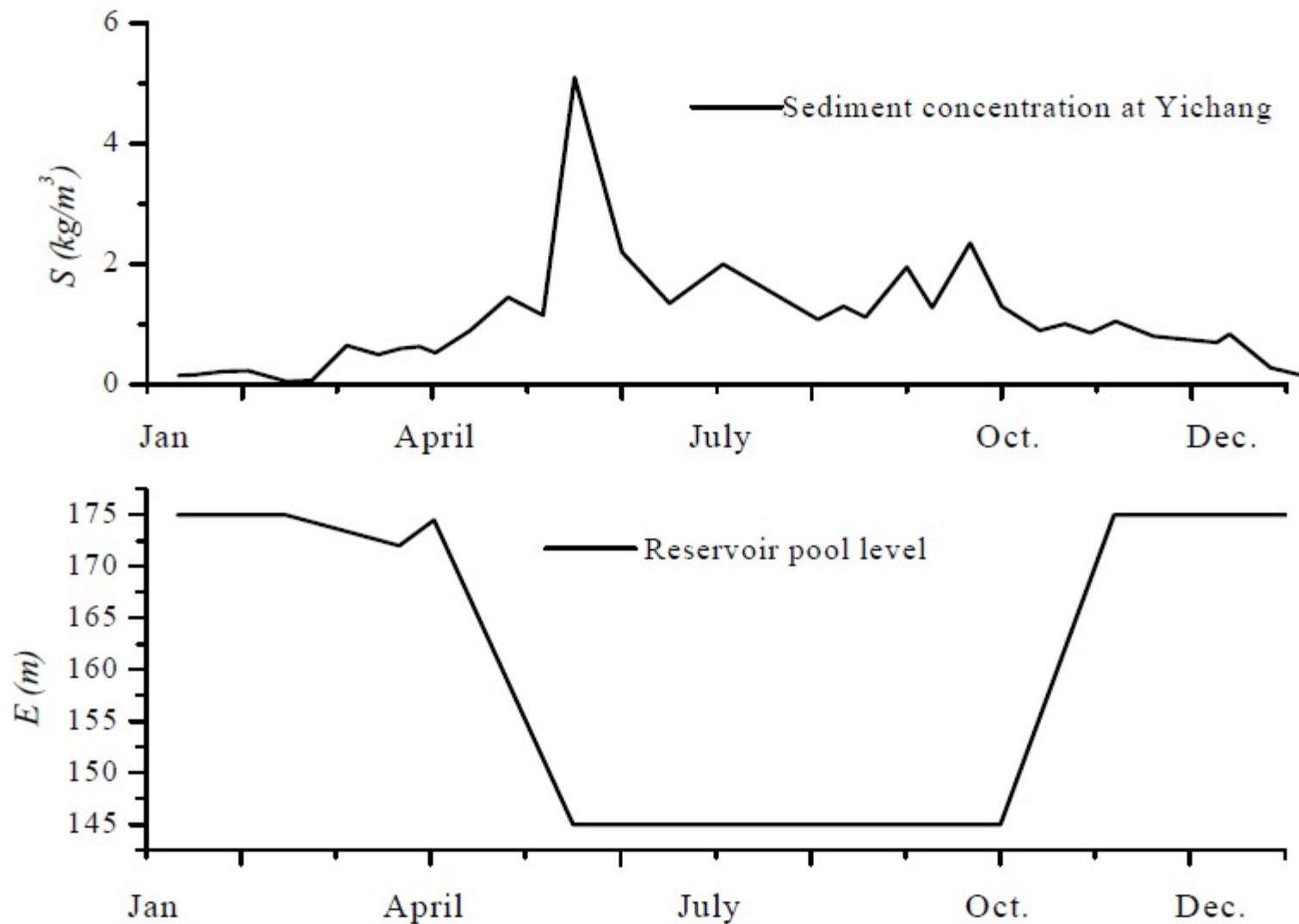
390



Downstream distance from the TGD (km) Luo, Yang, Zhang, 2012

Influence on the Changjiang Submerged Delta





Storing the clear and releasing the turbid – during the flood season, when the river carries 90% of the annual sediment load and 61% of the annual runoff, the pool level is drawn down to 145 m to create a condition in favor of sediment flushing.

Sand mine on the Poyang Lake



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Human and the environment

- A total of 19 counties and cities, 13 county towns, 140 towns and 4 500 villages are inundated
- Population resettled: around 1,2 million (55% urban population and 45% villagers)
- Farmland inundated: 23 793 ha
- Highways inundated: 956 km
- Factories and mines submerged: 657 km

Conclusions

1. The **decrease of grain size diameter** downstream of TGD is being observed
2. The **riverbed has turned** from accretionary before the TGD **to erosional afterwards**
3. The **impact of TDG on the Yangtze is not only limited to the river hydrology and sedimentology**, but also affects the estuarine and deltaic regions near the river mouth
4. The **sediment input into the delta** area of the Changjiang **declined about 70%** since building of the TGD in 2003
5. A **change in the location of the depocenter** in the upper Chanjiang Submerged Delta was observed
6. The **sediment management strategy “store the clear and release the turbid” effectively reduces the reservoir sedimentation**
7. **Changes the rotation of the Earth**



Questions?