Decadal changes in river discharge from the continental United States to the Gulf of Mexico

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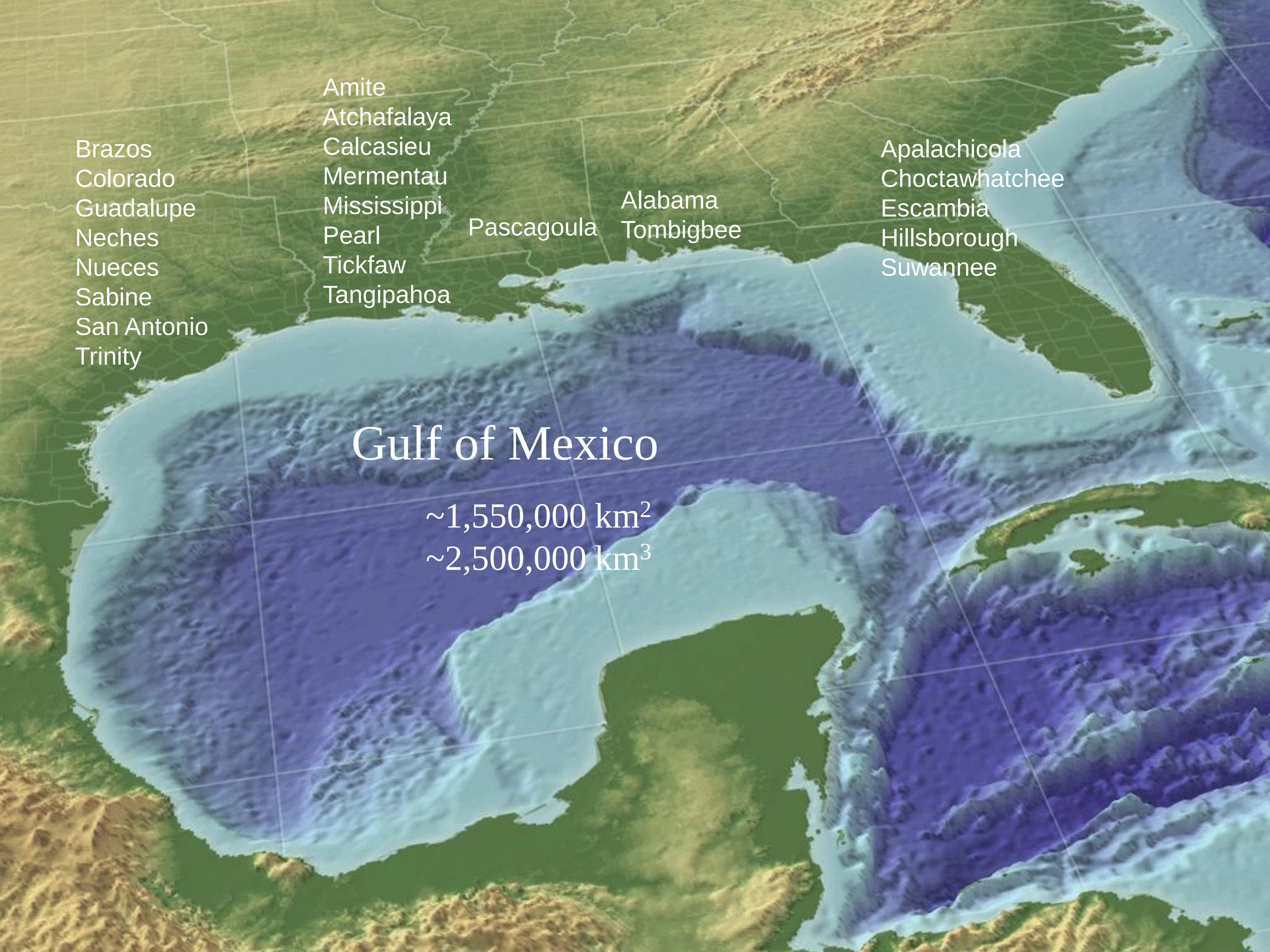
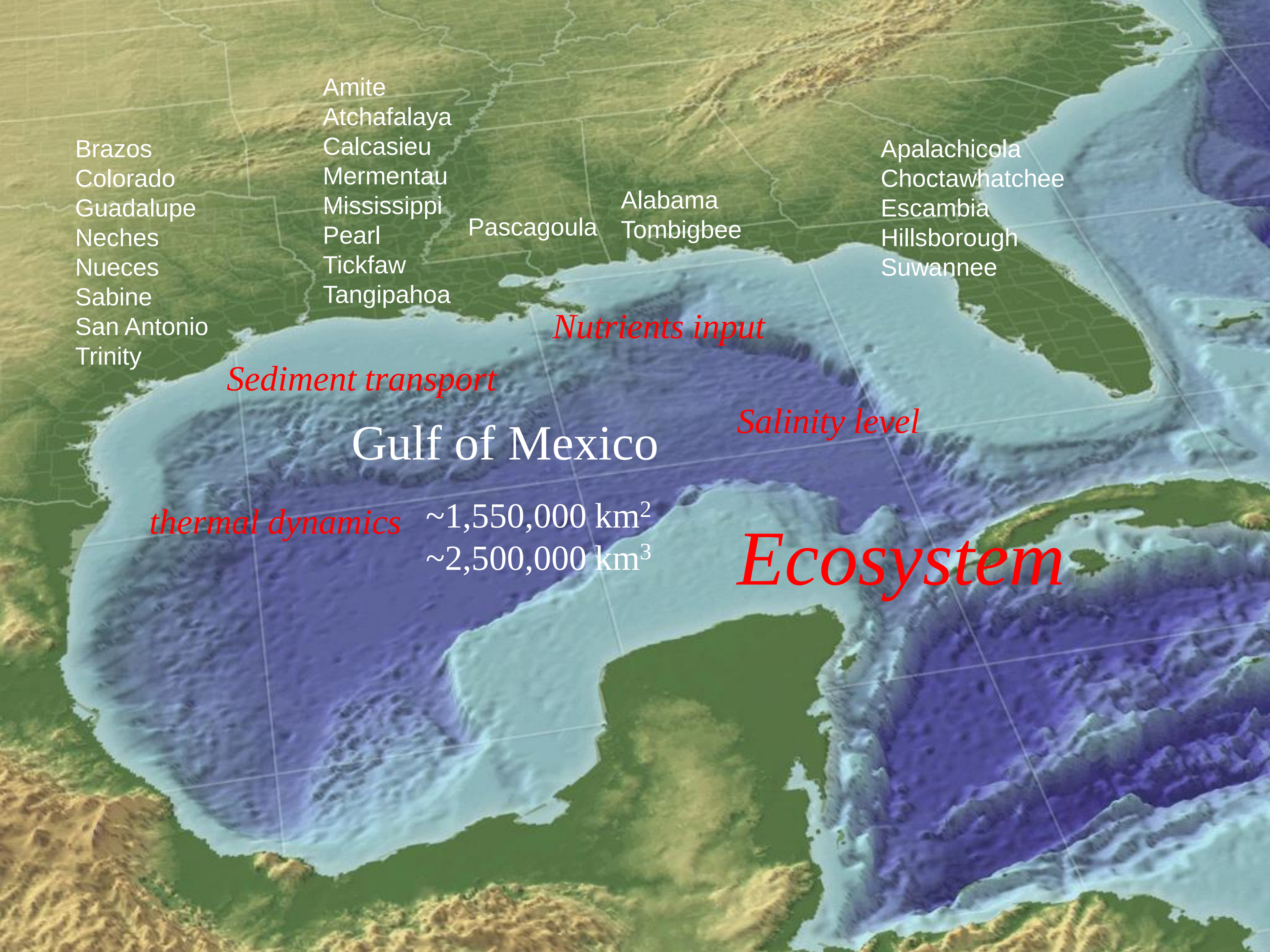

Gulf of Mexico
~1,550,000 km²
~2,500,000 km³
Brazos
Colorado
Guadalupe
Neches
Nueces
Sabine
San Antonio
Trinity
Amite
Atchafalaya
Calcasieu
Mermentau
Mississippi
Pearl
Tickfaw
Tangipahoa
Pascagoula
Alabama
Tombigbee
Apalachicola
Choctawhatchee
Escambia
Hillsborough
Suwannee


Amite
Atchafalaya
Calcasieu
Mermentau
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Pearl
Tickfaw
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Choctawhatchee
Escambia
Hillsborough
Suwannee
Nutrients input
Sediment transport
Salinity level
Gulf of Mexico
thermal dynamics
~1,550,000 km²
~2,500,000 km³
Ecosystem


Amite
Atchafalaya
Calcasieu
Mermentau
Mississippi
Pearl
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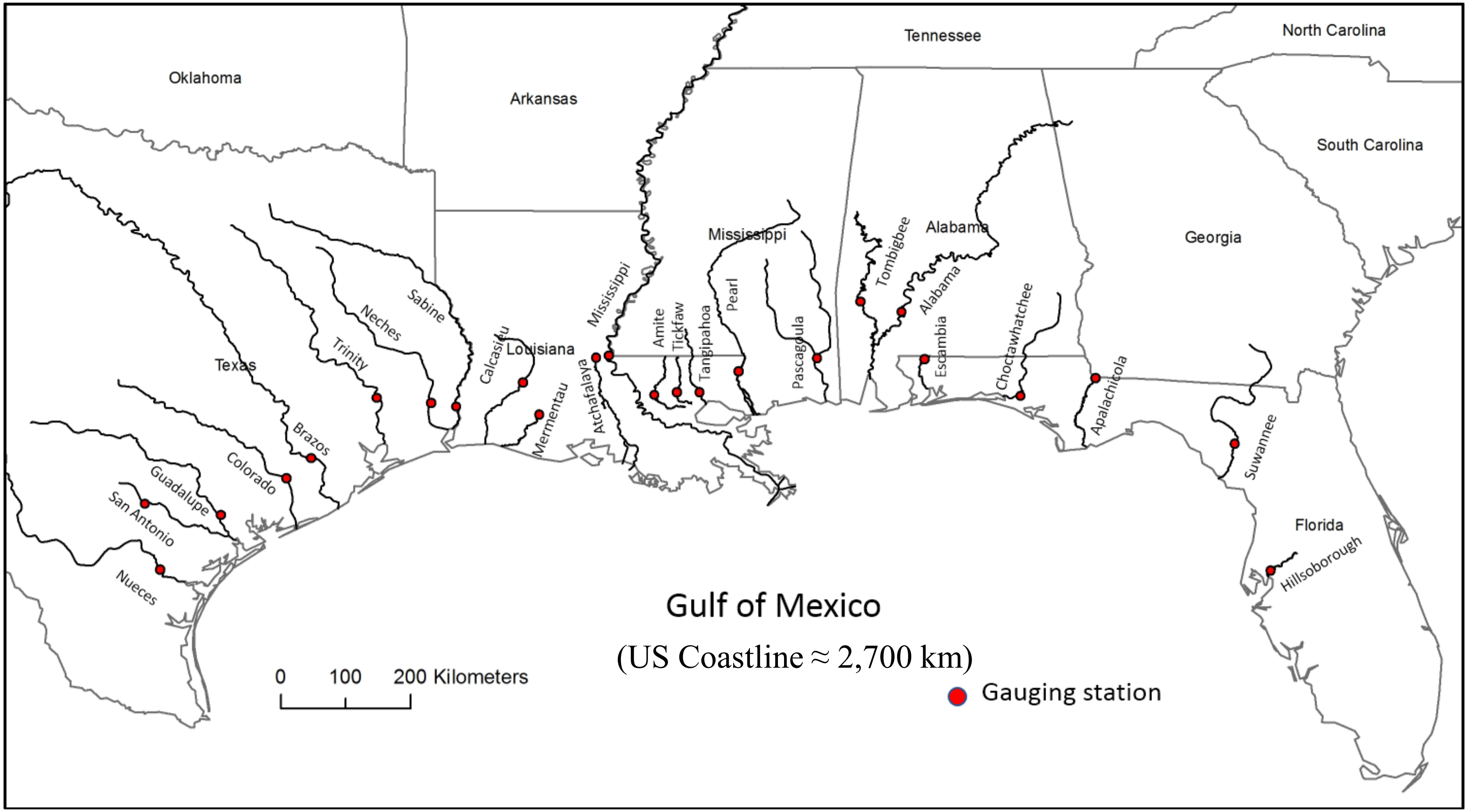
Suwannee
Nutrients input
Sediment transport
Salinity level
Gulf of Mexico
thermal dynamics
~1,550,000 km^2
~2,500,000 km^3
Ecosystem
Q1: What is the total annual inflow of freshwater to the GOM?
Q2: How have flows from these rivers changed over time?

Identifying gauge stations



Determining data availability

State	River	DA (mi^2)	Total DA (mi^2)	Time period
Alabama	Alabama River	21,473	39,890	1975-2017
	Tombigbee	18,417		1960-2017
Florida	Apalachicola	17,200	35,441	1922-2017
	Choctawhatchee	4,384		1930-2017
	Escambia	3,817		1934-2017
	Hillsborough	650		1938-2017
	Suwannee	9,390		1932-2017
Louisiana	Amite	1,280	1,203,232	1938-2017
	Atchafalaya	65,595		1935-2017
	Calcasieu	1,700		1922-2017
	Mermentau	1,381		1989-2017
	Mississippi	1,125,810		1930-2017
	Pearl	6,573		1938-2017
	Tangipahoa	646		1938-2017
	Tickfaw	247		1940-2017
Mississippi	Pascagoula	6,590	6,590	1930-2017
Texas	Brazos	45,107	145,547	1930-2017
	Colorado	42,003		1938-2017
	Guadalupe	5,198		1934-2017
	Neches	7,951		1904-2017
	Nueces	16,660		1939-2017
	Sabine	9,329		1924-2017
	San Antonio	2,113		1925-2017
	Trinity	17,186		1924-2017

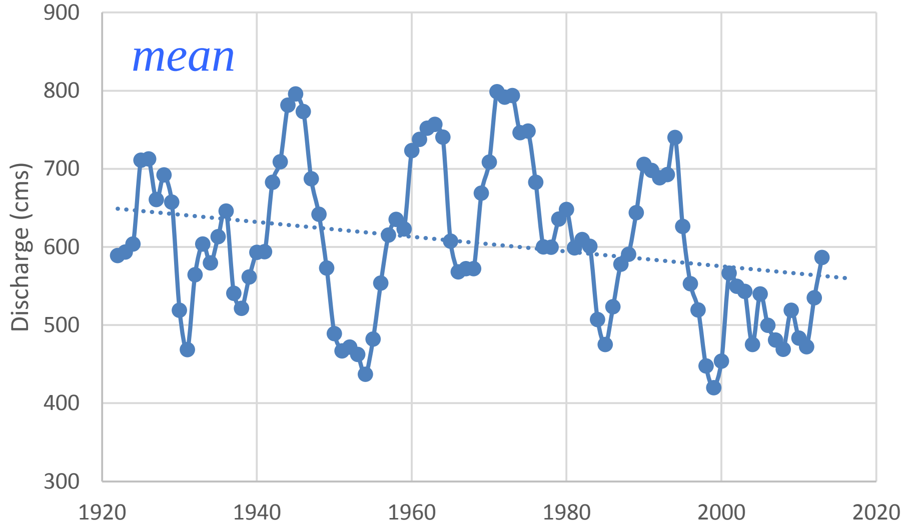
Conducting hydroinformatic analysis

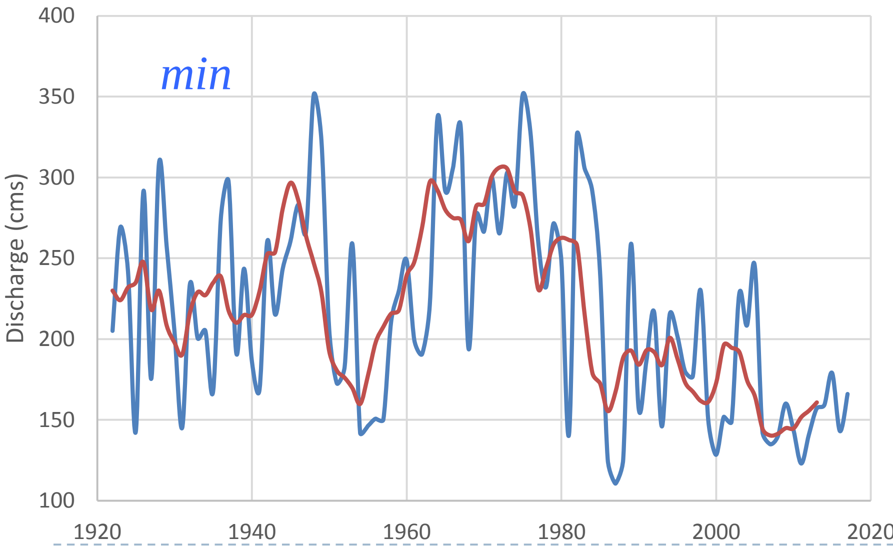
- General statistical analysis.
- Mann-Kendall trend test.
- Autoregressive modeling of river discharge time series.

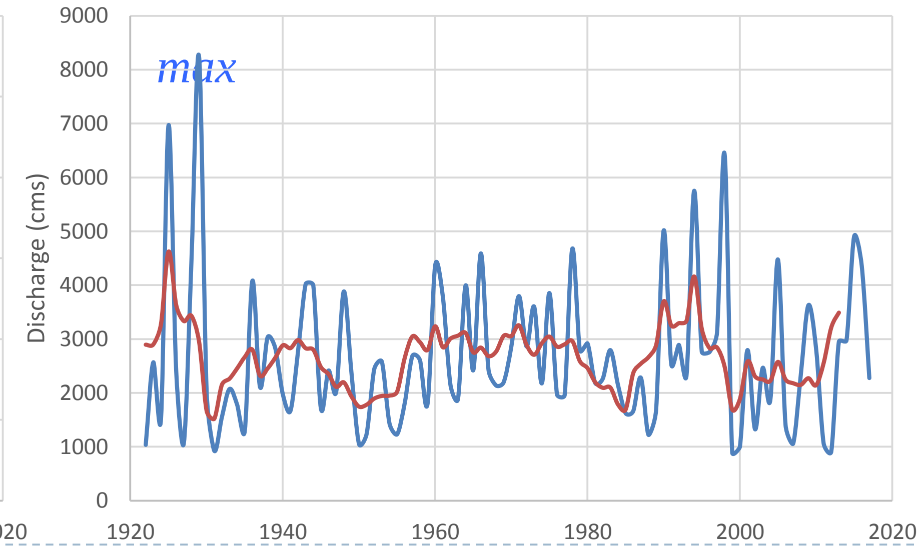
Results and Discussion

Long-term trends of discharge

Apalachicola (Florida)

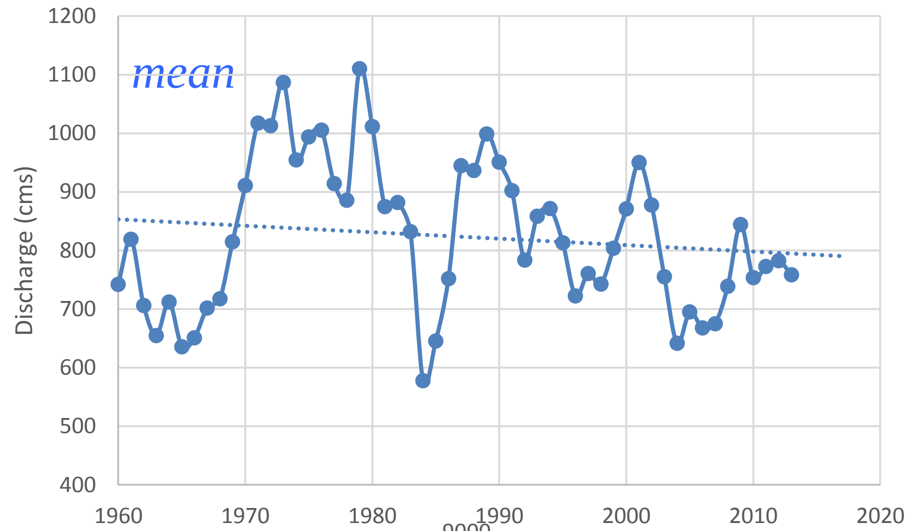


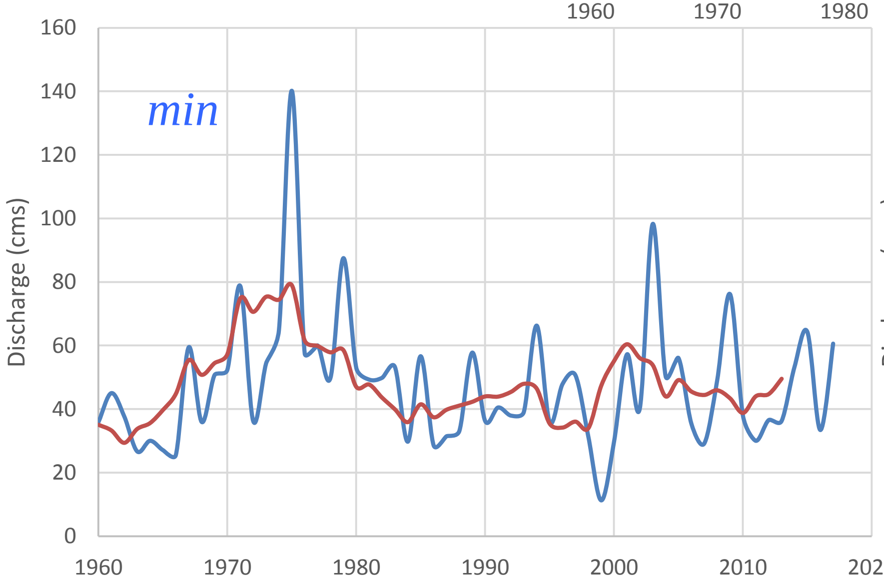


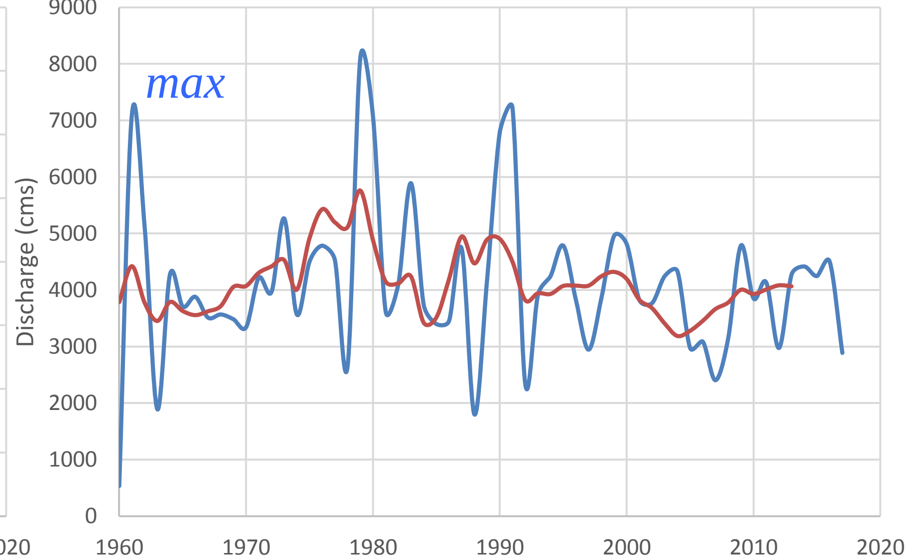


Long-term trends of discharge

Tombigbee
(Alabama)

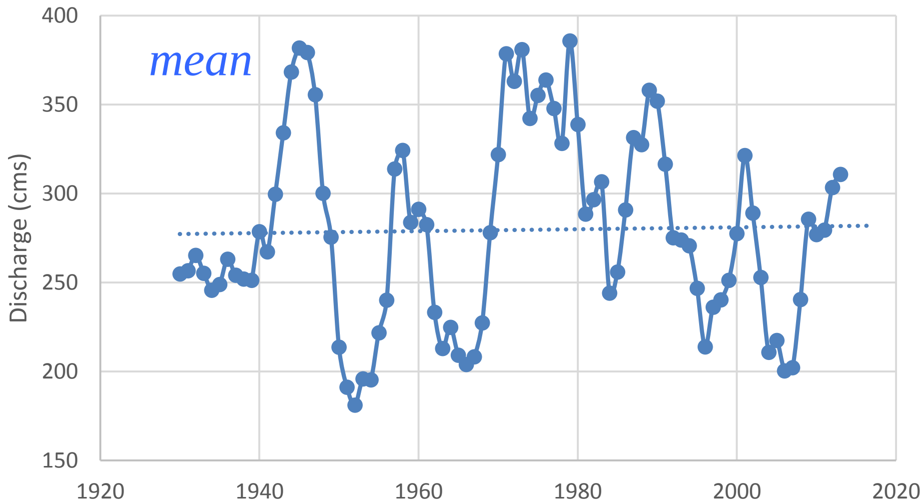


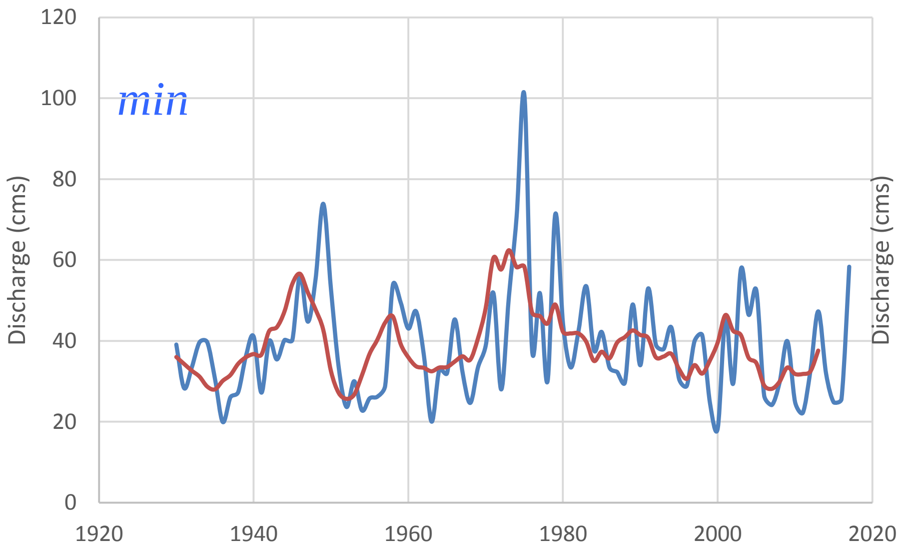


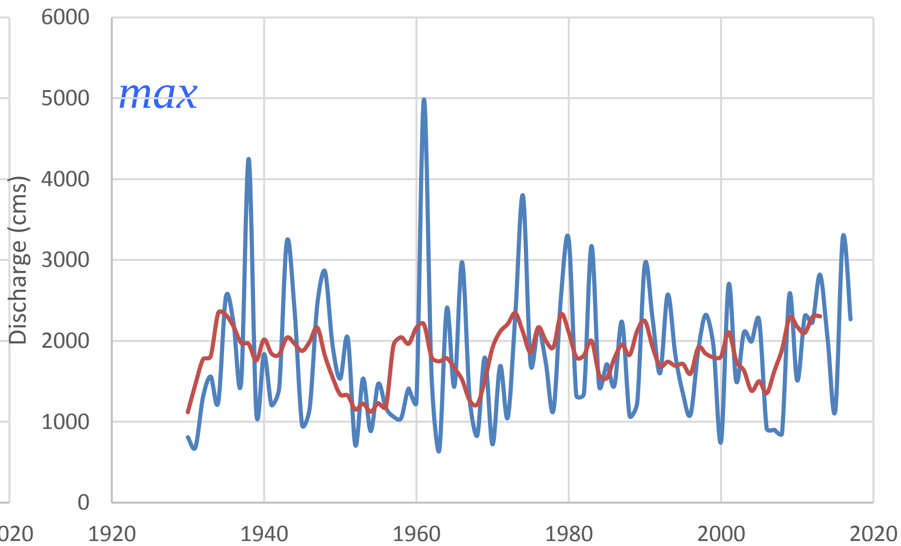


Long-term trends of discharge

Pascagoula (Mississippi)

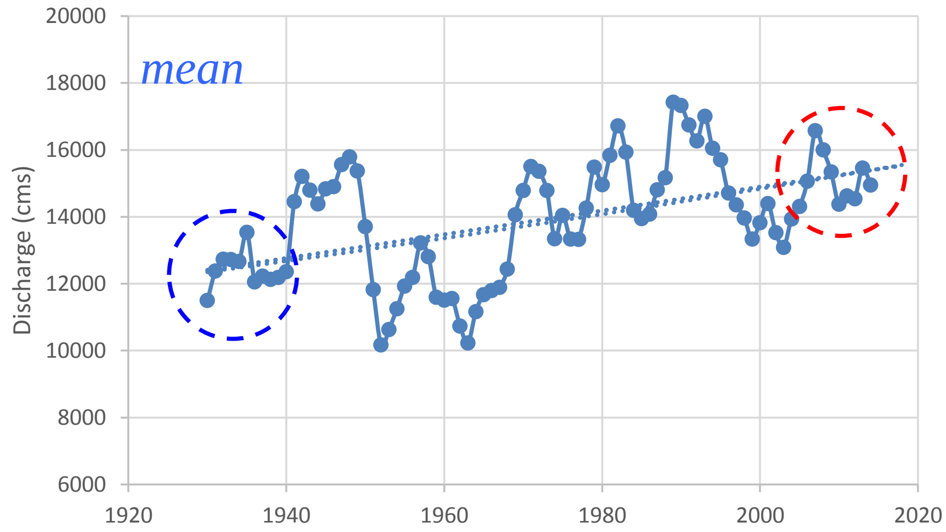






Long-term trends of discharge

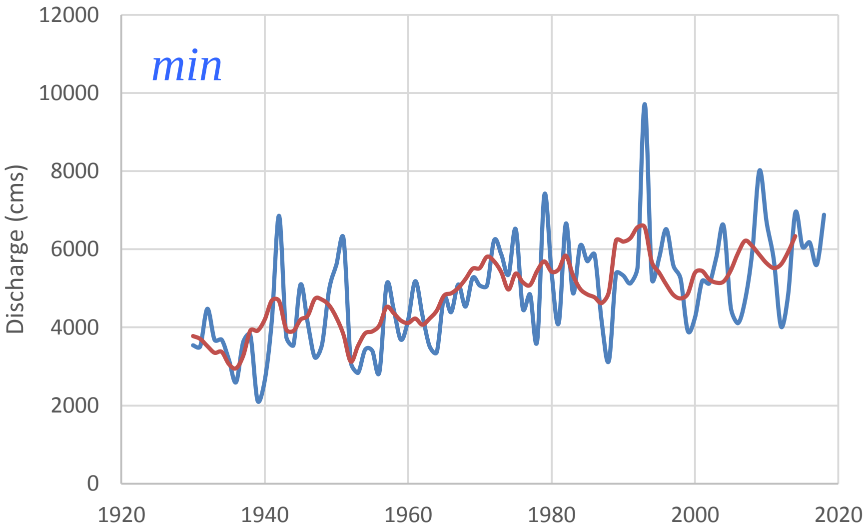
Mississippi
(Louisiana)

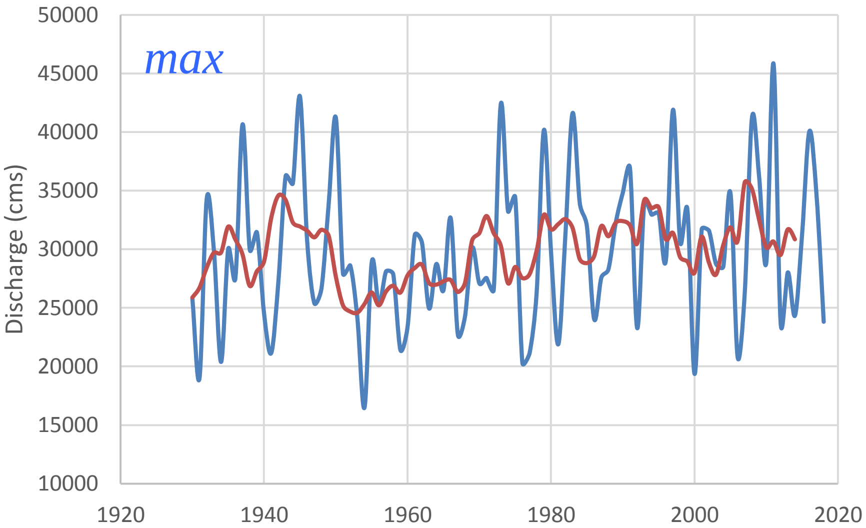


12,500

v.s.

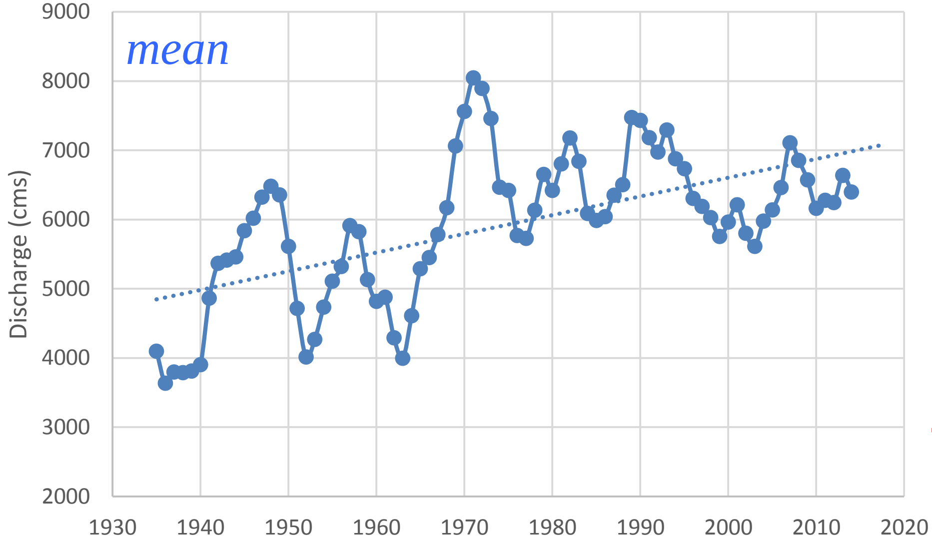
15,600 (~25%)





Long-term trends of discharge

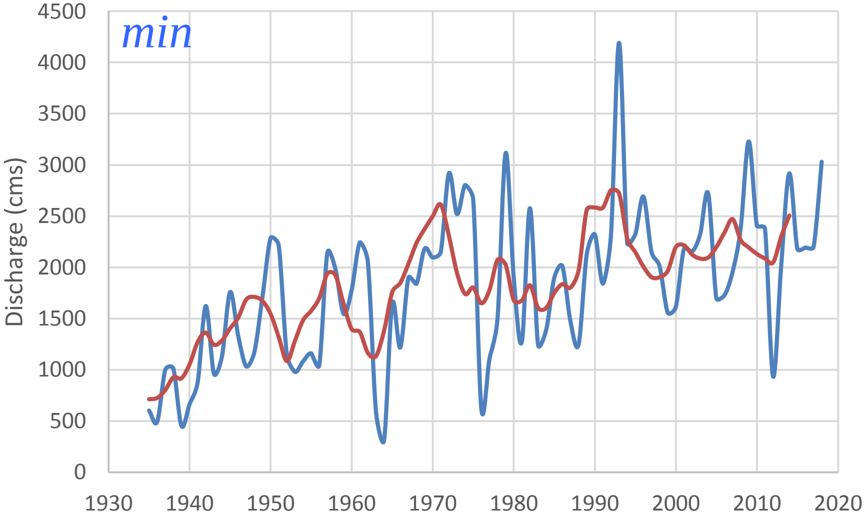
Atchafalaya
(Louisiana)

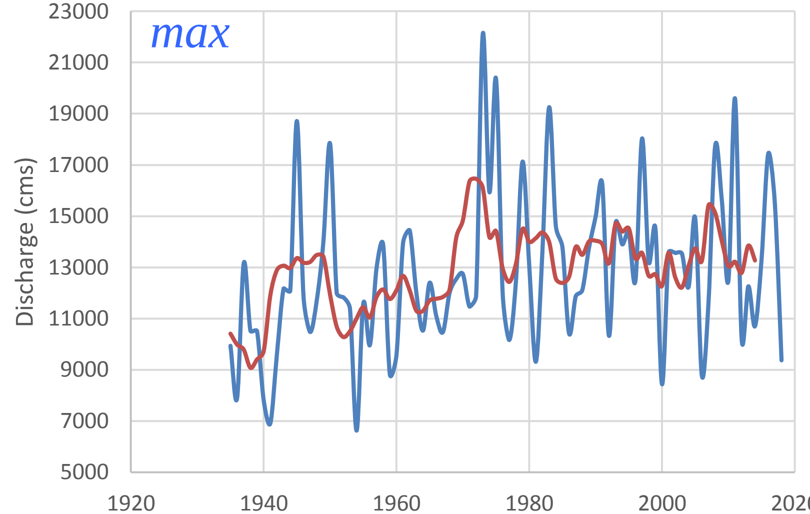


6,800

v.s.

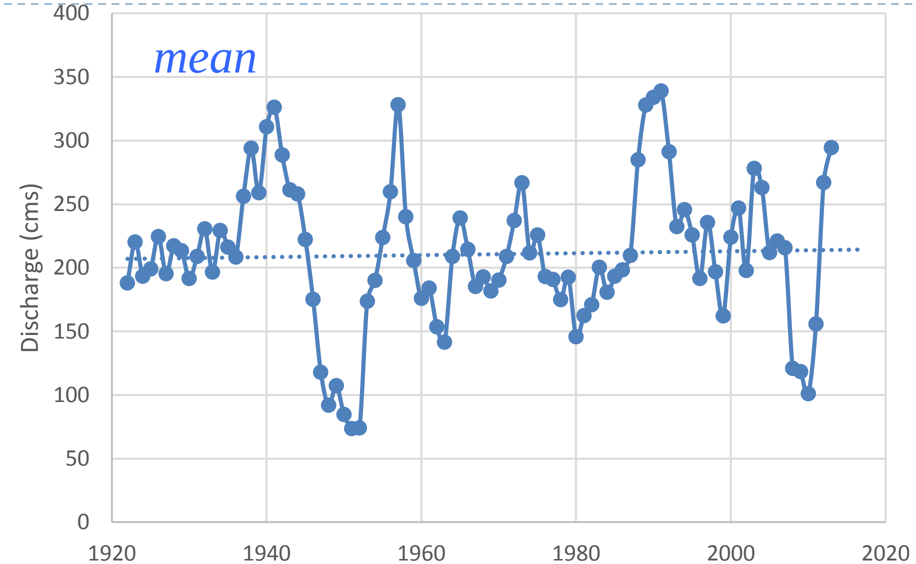
4,000 (~70%)

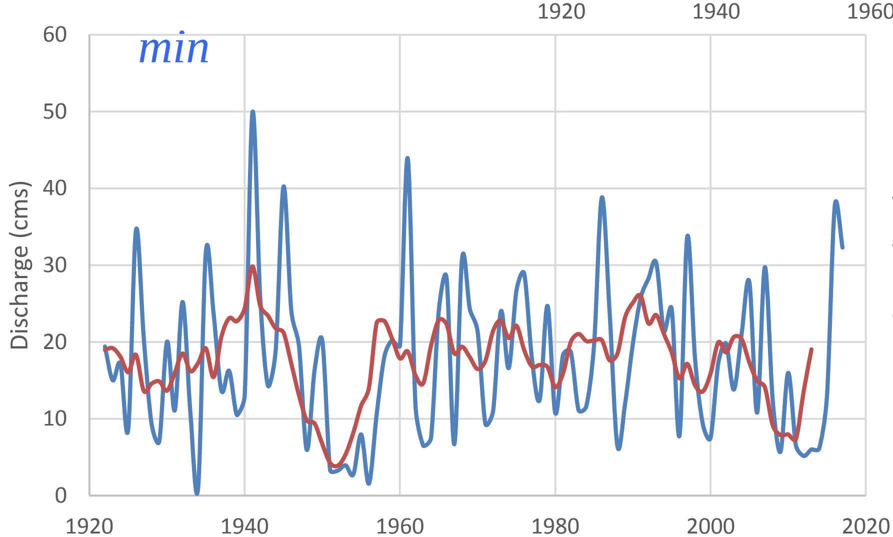


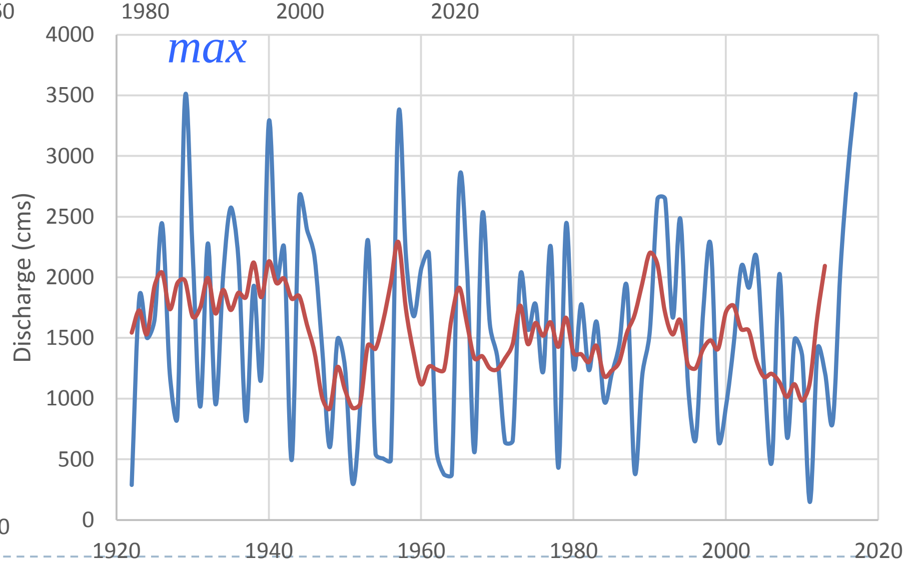


Long-term trends of discharge

Brazos
(Texas)







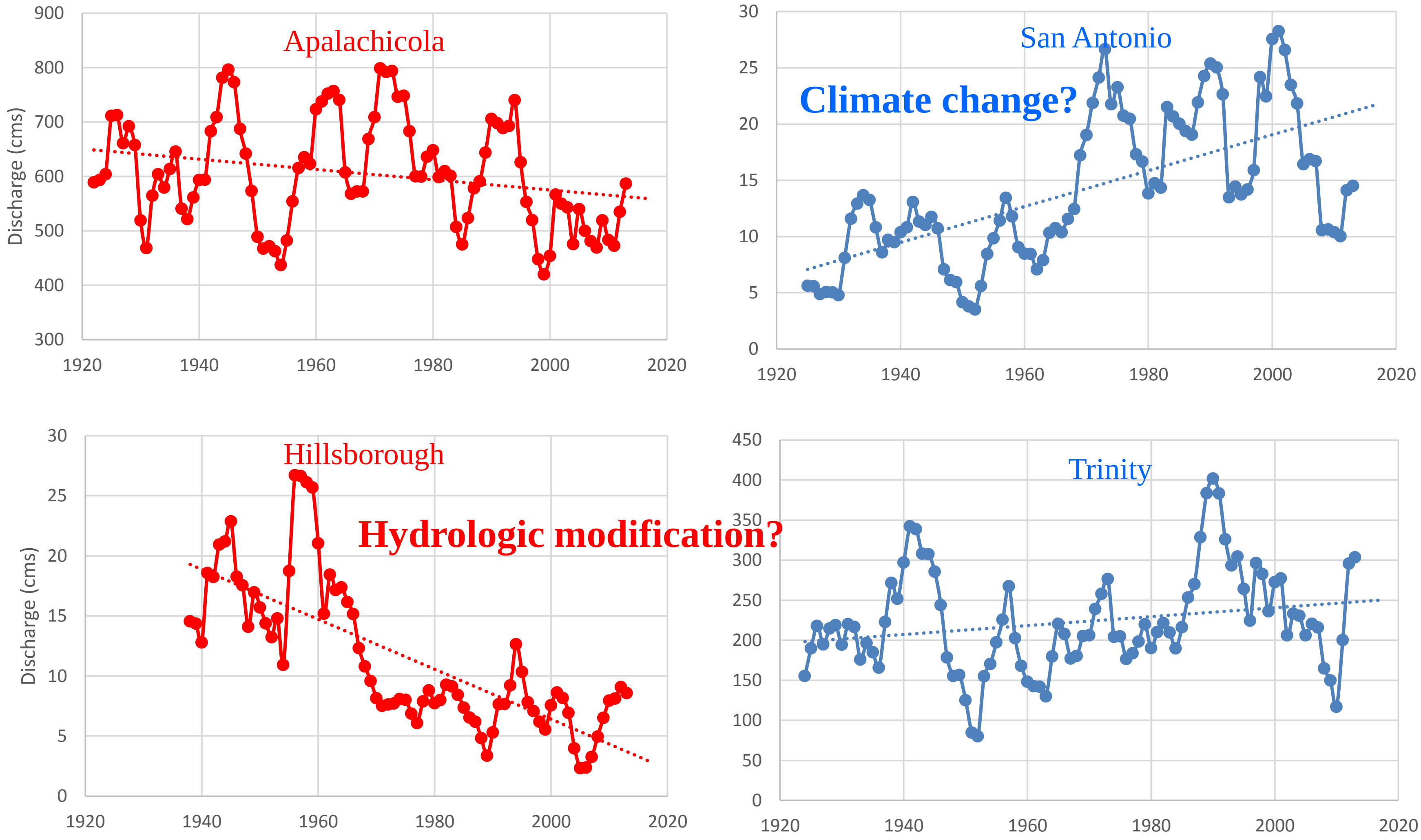
Mann-Kendall trend test

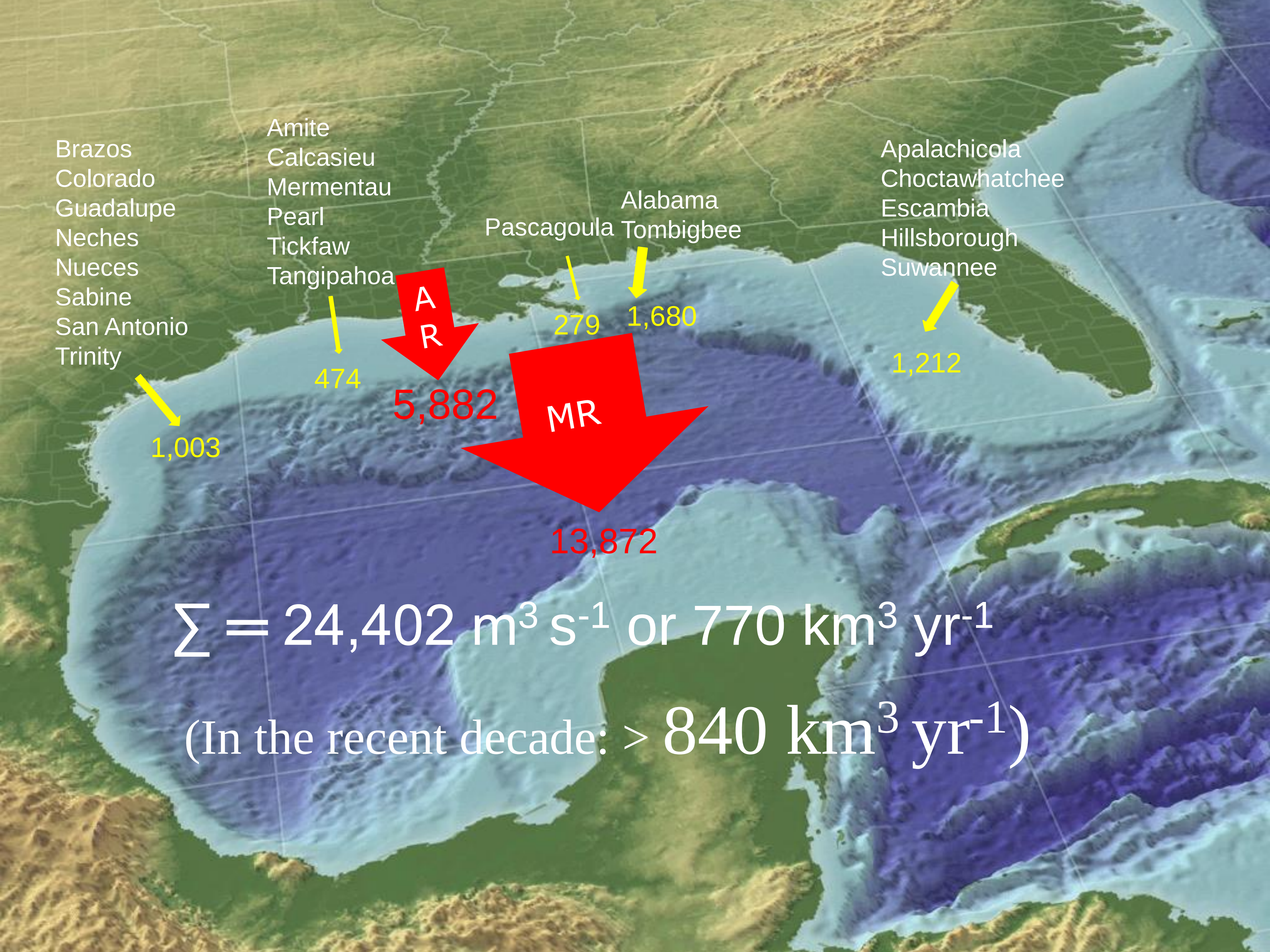
State	River	Average Q (cms)	Mann-Kendall trend test
Florida	Hillsborough	11	1 (↓)
	Suwannee	227	1 (↓)
	Apalachicola	605	1 (↓)
	Choctawhatchee	197	1 (↓)
	Escambia	172	0
Alabama	Alabama River	859	1 (↓)
	Tombigbee	821	0
Mississippi	Pascagoula	279	0
Louisiana	Pearl	282	0
	Tangipahoa	33	0
	Tickfaw	11	0
	Amite	59	0
	Mississippi	13872	1 (↑)
	Atchafalaya	5882	1 (↑)
	Mermentau	58	0
	Calcasieu	31	1 (↓)
Texas	Sabine	232	0
	Neches	169	1 (↓)
	Trinity	225	1 (↑)
	Brazos	214	0
	Colorado	75	1 (↓)
	Guadalupe	55	0
	SanAntonio	14	1 (↑)
	Nueces	19	0

decline or no change

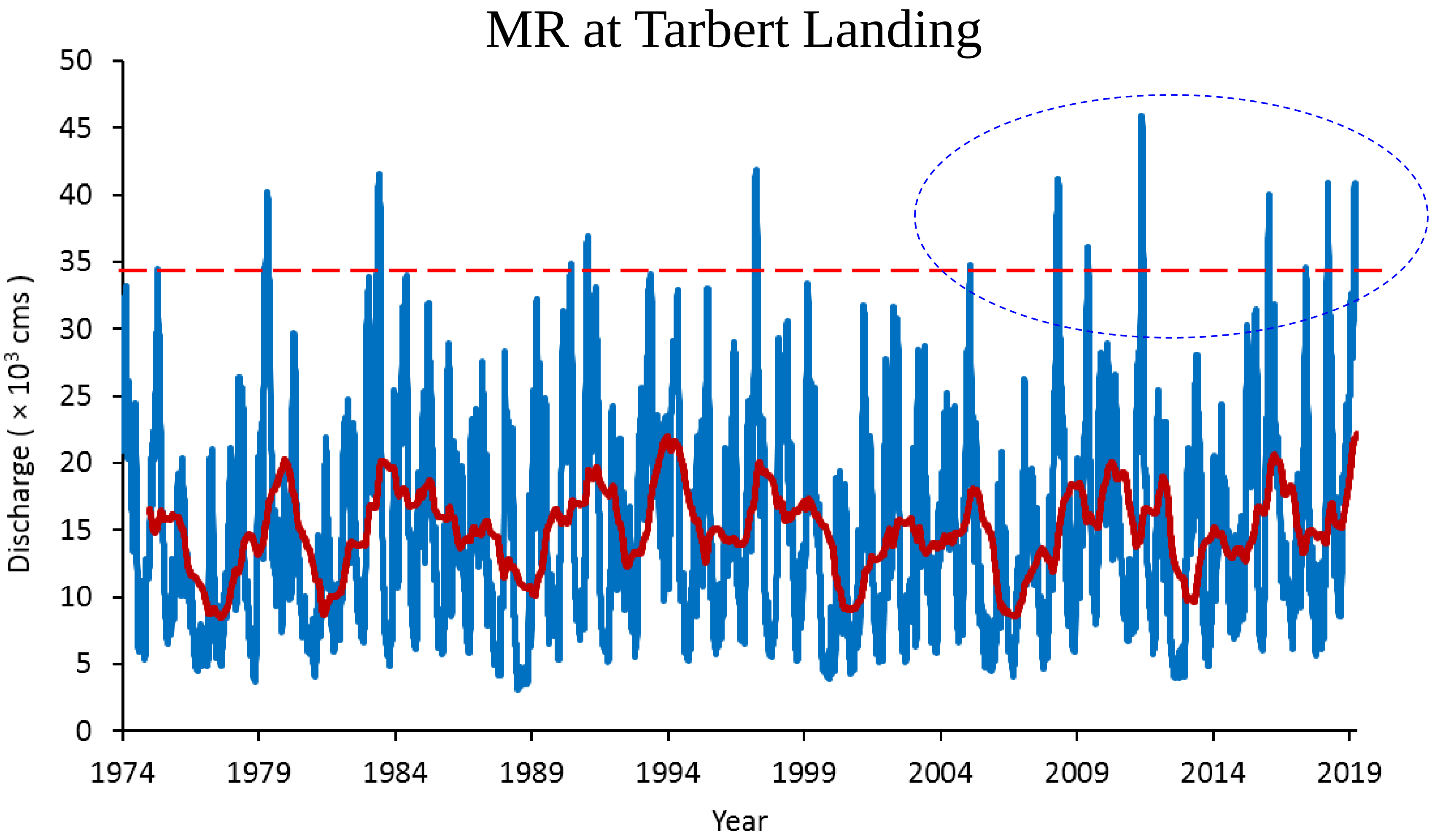
mostly increase

Florida v.s. Texas

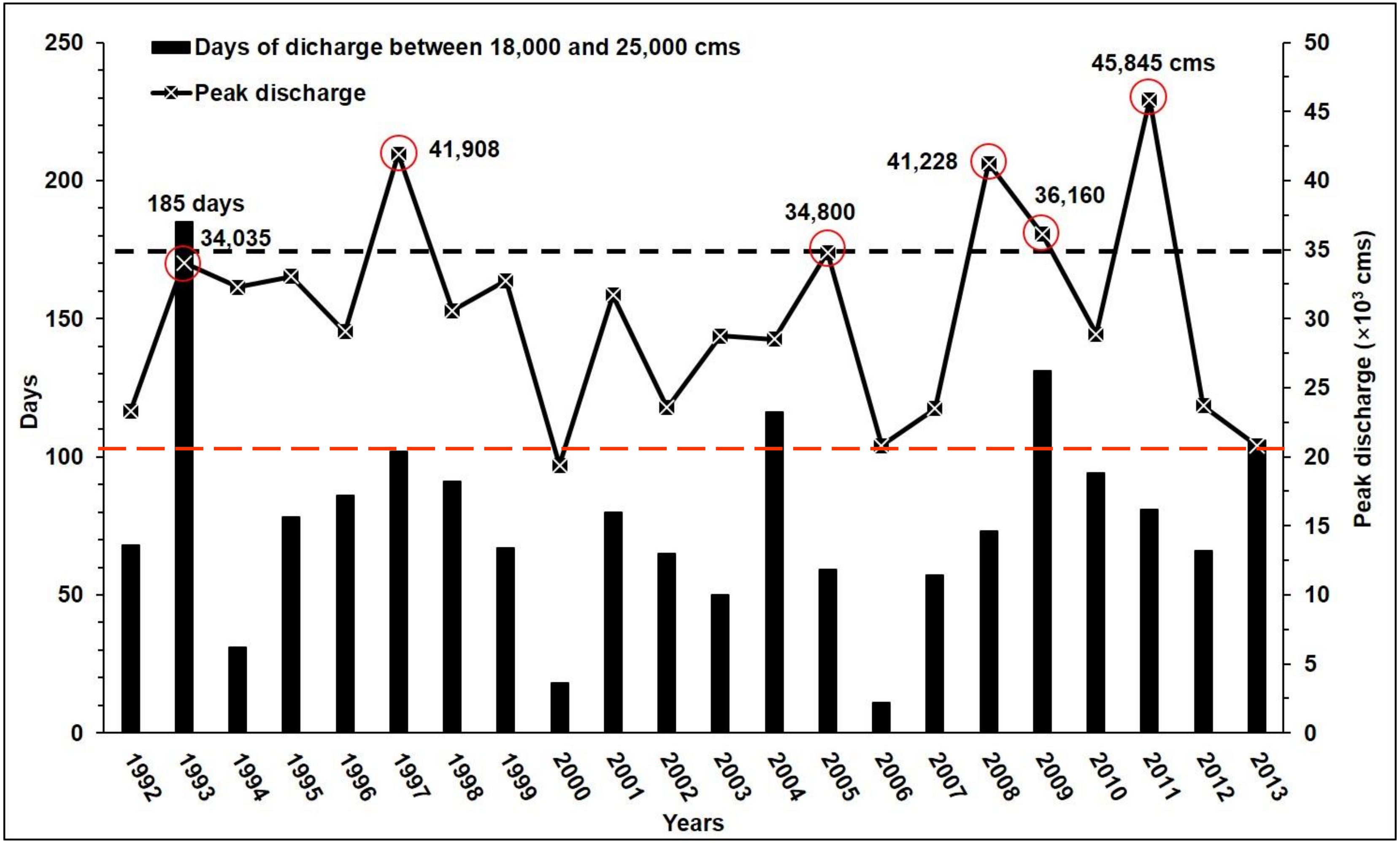



Brazos
Colorado
Guadalupe
Neches
Nueces
Sabine
San Antonio
Trinity
1,003
Amite
Calcasieu
Mermentau
Pearl
Tickfaw
Tangipahoa
474
A
R
5,882
Pascagoula
279
Alabama
Tombigbee
1,680
MR
13,872
Apalachicola
Choctawhatchee
Escambia
Hillsborough
Suwannee
1,212
$\sum = 24{,}402\ m^3\ s^{-1}$ or $770\ km^3\ yr^{-1}$
(In the recent decade: > $840\ km^3\ yr^{-1}$)

Increasing high flow frequency

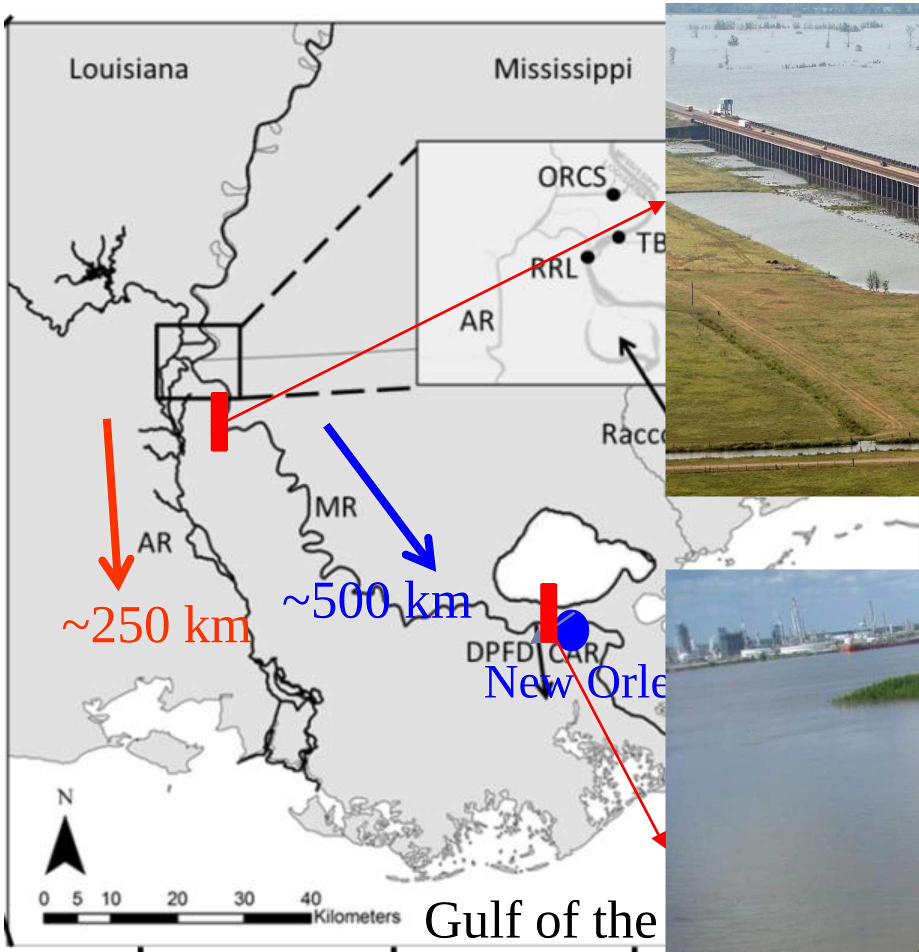


Increasing high flow duration



Wang & Xu (Journal of Geophysical Research, 2018)

Much more frequent spillway opening



13 Spillway openings; 10 in the past 40 yrs

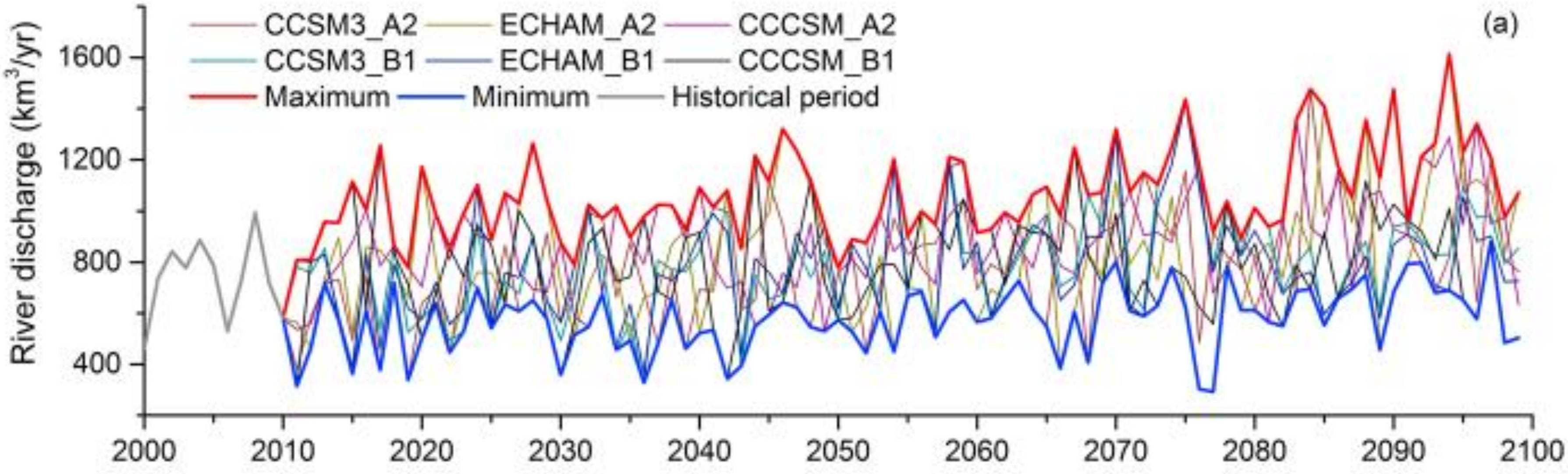
Year	Days	Bays Opened	Flow capacity (cfs)
1937	48	285	203,571
1945	57	350	250,000
1950	38	350	250,000
1973	75	350	250,000
1975	13	225	160,714
1979	45	350	250,000
1983	35	350	250,000
1997	31	298	212,857
2008	31	160	114,286
2011	42	330	235,714
2016	22	210	203,000
2018	30	186	198,000
2019	44	206	TBA

Source: USACE

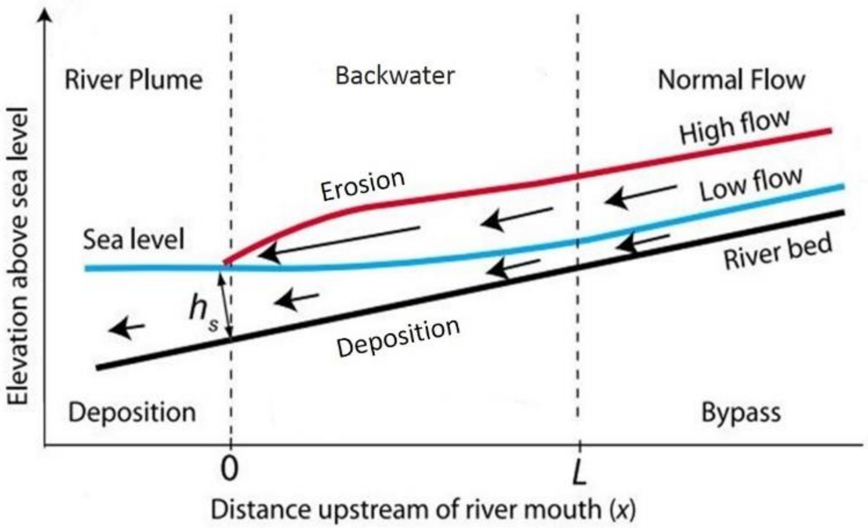
Projected future discharge

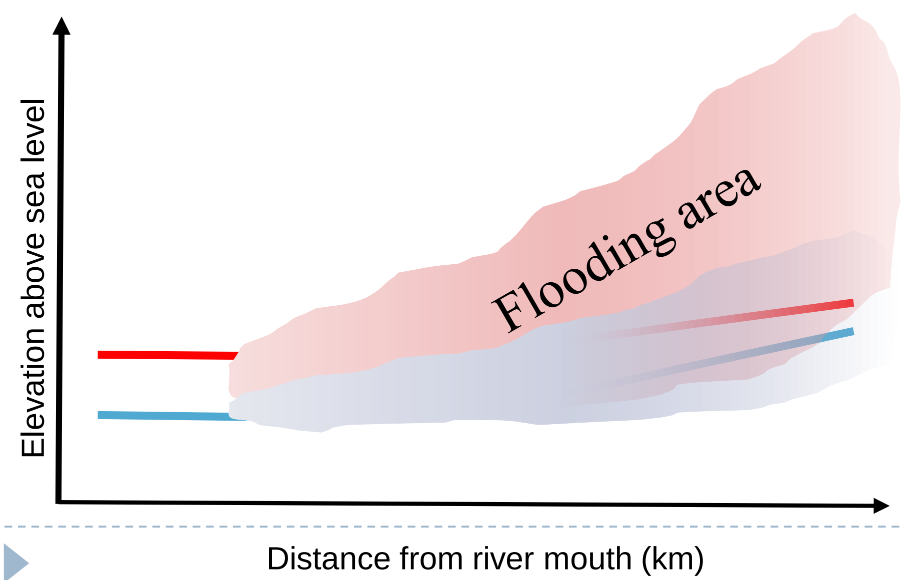
Tao et al. (2014): Increasing Mississippi river discharge throughout the 21st century influenced by changes in climate, land use, and atmospheric CO_2. *Geophy. Res. Let.*

increased by 11 - 60%!



Closing Thoughts – Flooding risk



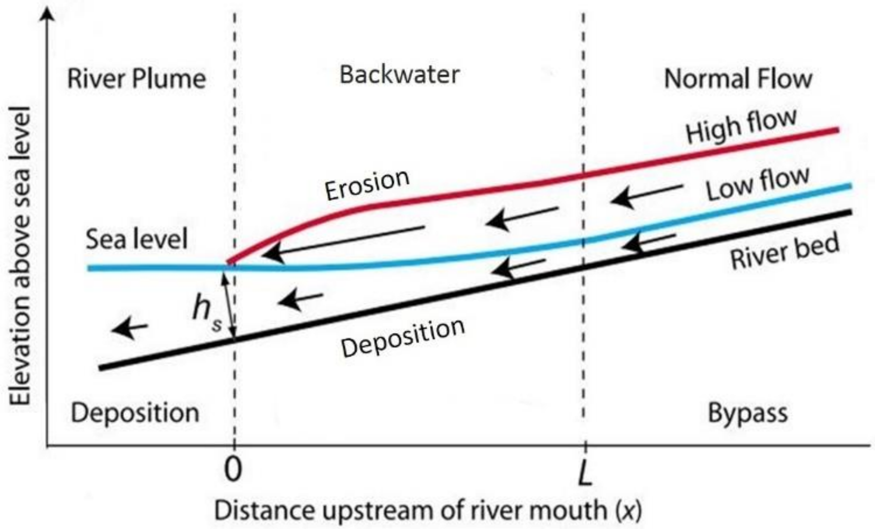


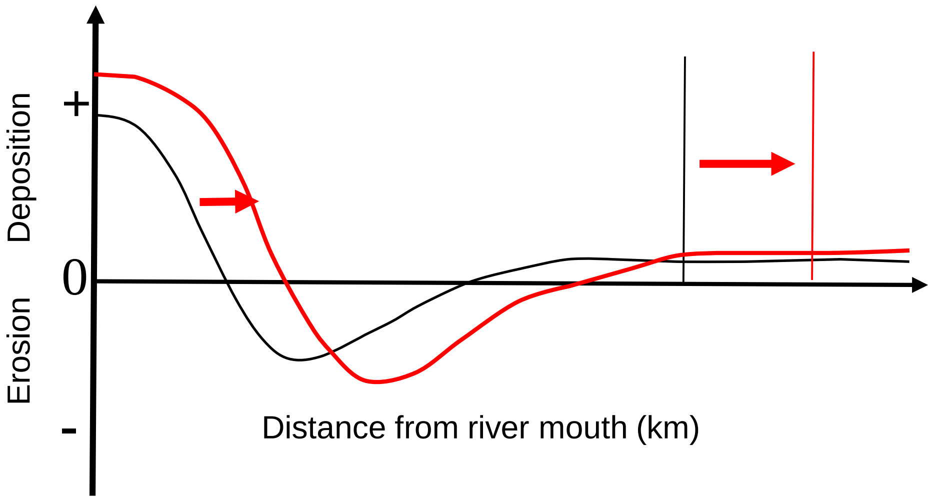
Increasing river discharge will increase risk of large area backwater flooding in low-lying coastal areas under sea level rise and/or during tropical storm surges (a non-linear relation).


Hurricane Isaac
8/30/2012


8/13/2016

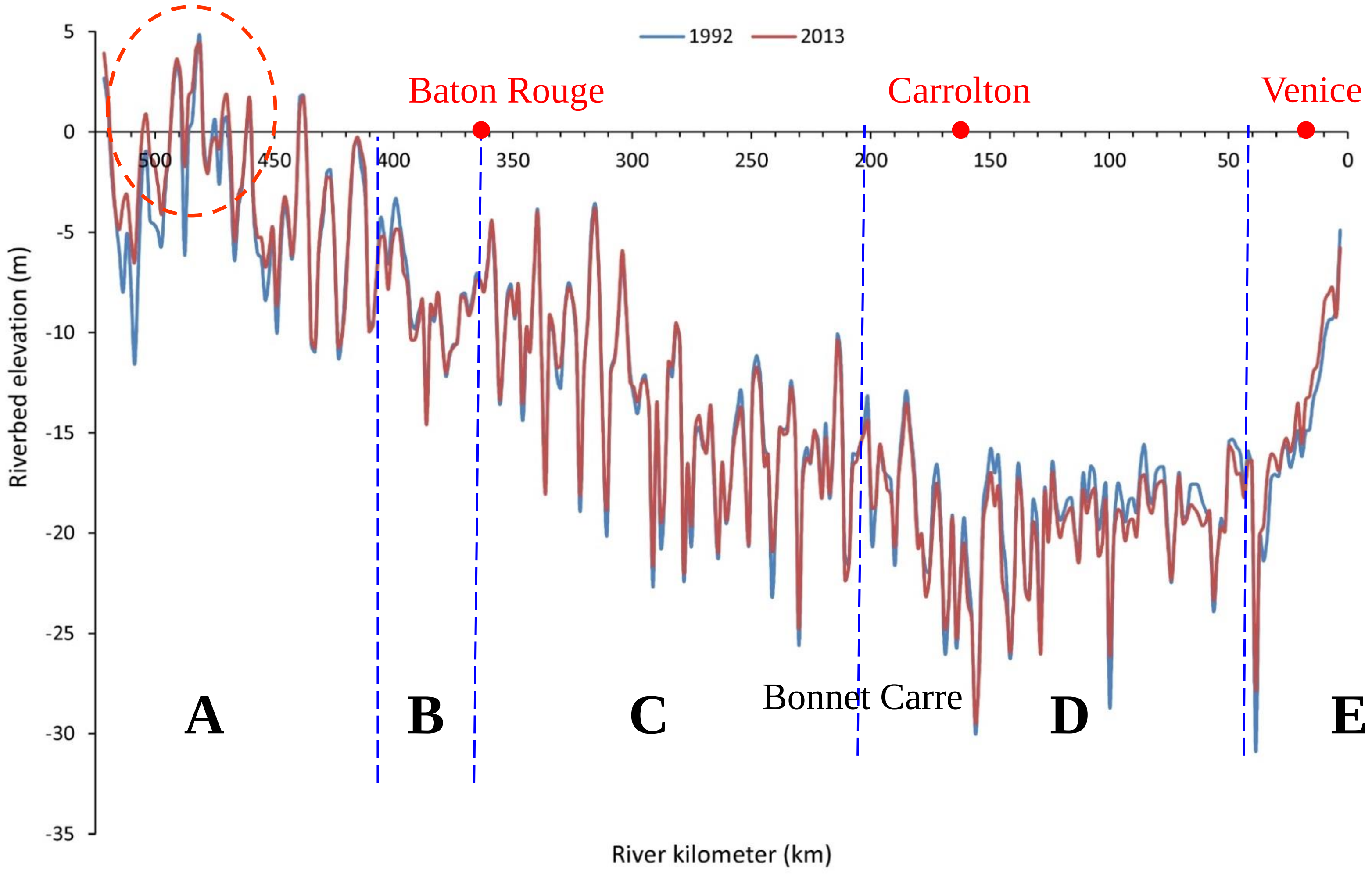
Closing Thoughts – Channel aggradation





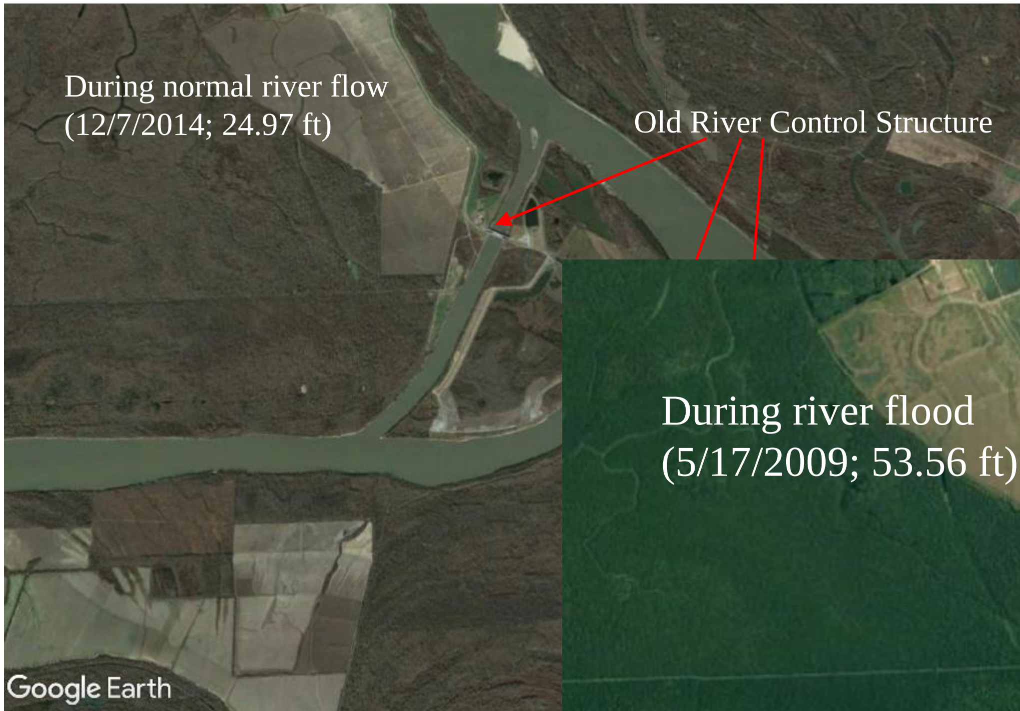
Increasing river discharge will affect riverine sediment transport, deposition, and channel dynamics, potentially causing long-term and large-scale damages.

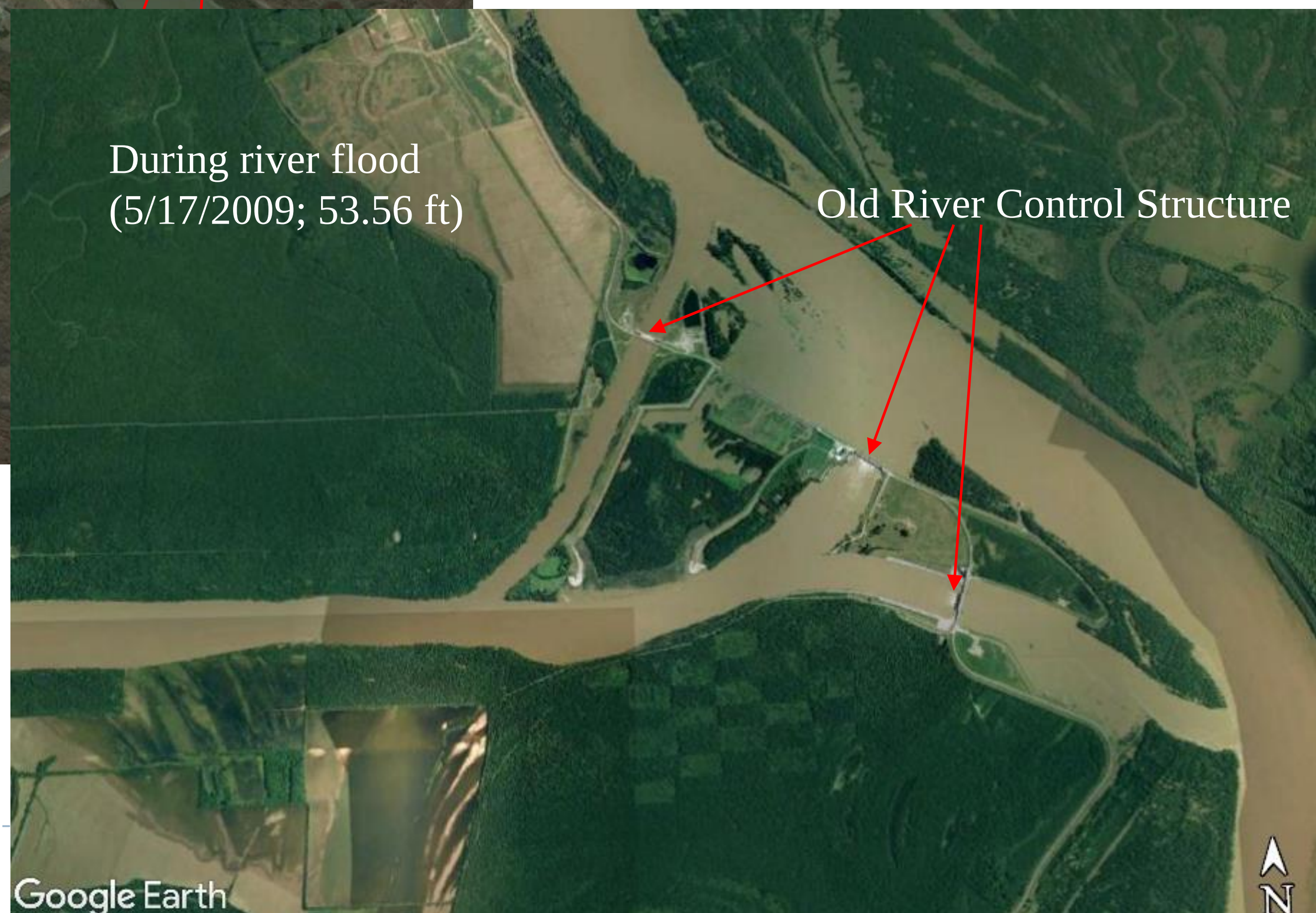
Riverbed Change from ORCS to Head Pass



Wang & Xu (Journal of Geophysical Research, 2018)

Potential consequence of upstream channel aggradation near the ORCS





Closing Thoughts

- ❑ Increasing river discharge will increase risk of large area backwater flooding in low-lying coastal areas under sea level rise and/or during tropical storm surges.
- ❑ Increasing river discharge will affect riverine sediment transport, deposition, and channel dynamics, potentially causing long-term and large-scale damages.
- ❑ Adaptation and mitigation strategies for minimizing future impacts of compound flooding are urgently needed.


Thanks
Questions and comments?