Simulating the Impact of Mississippi River Flood Flows on Coastal Compound Flooding

State of the Coast May 20, 2025

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Engineer Research and Development Center

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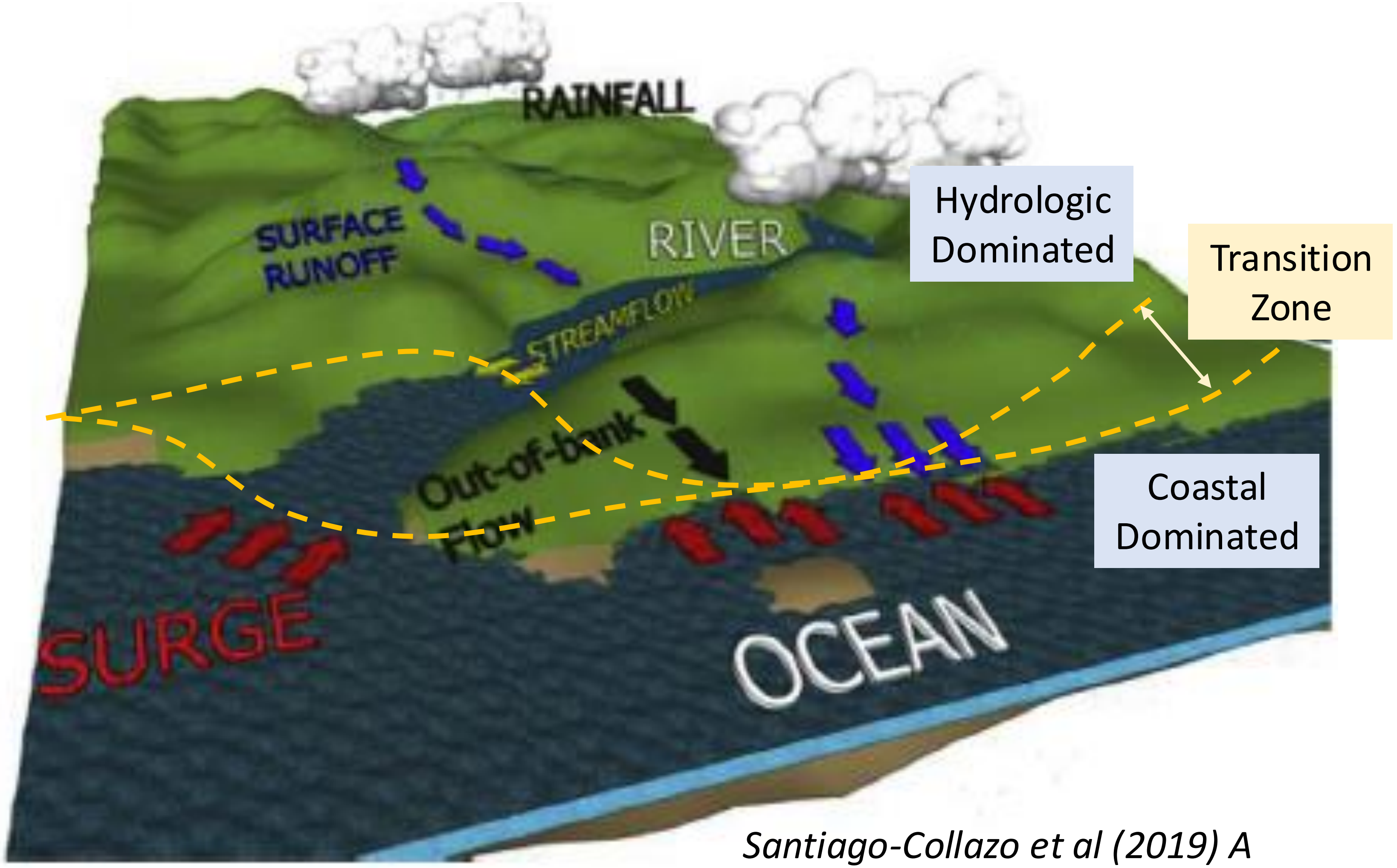
G. Savant, Technical Manager

Dynamic Solutions LLC

Background



Santiago-Collazo et al (2019) A comprehensive review of compound inundation models in low gradient coastal watersheds

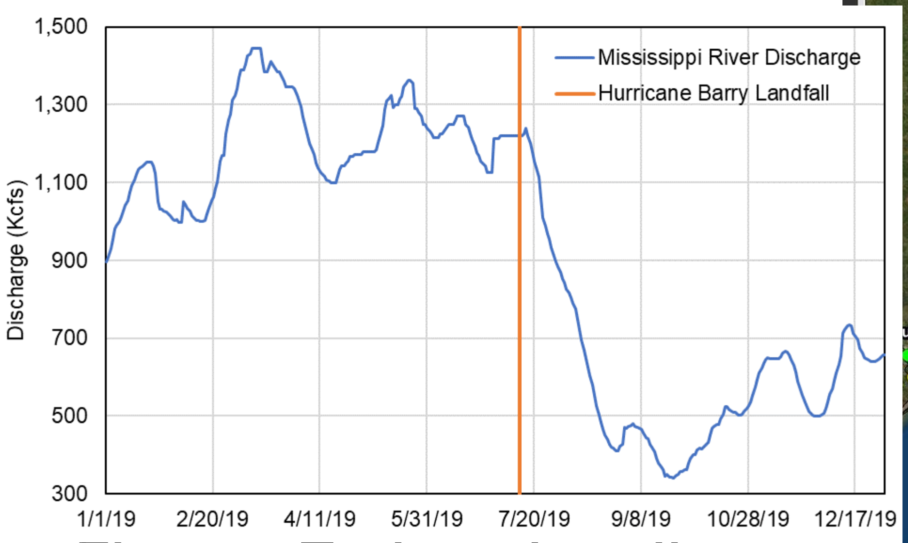
Background

- Co-occurrence of riverine flood flows and coastal storm surge on the LMR

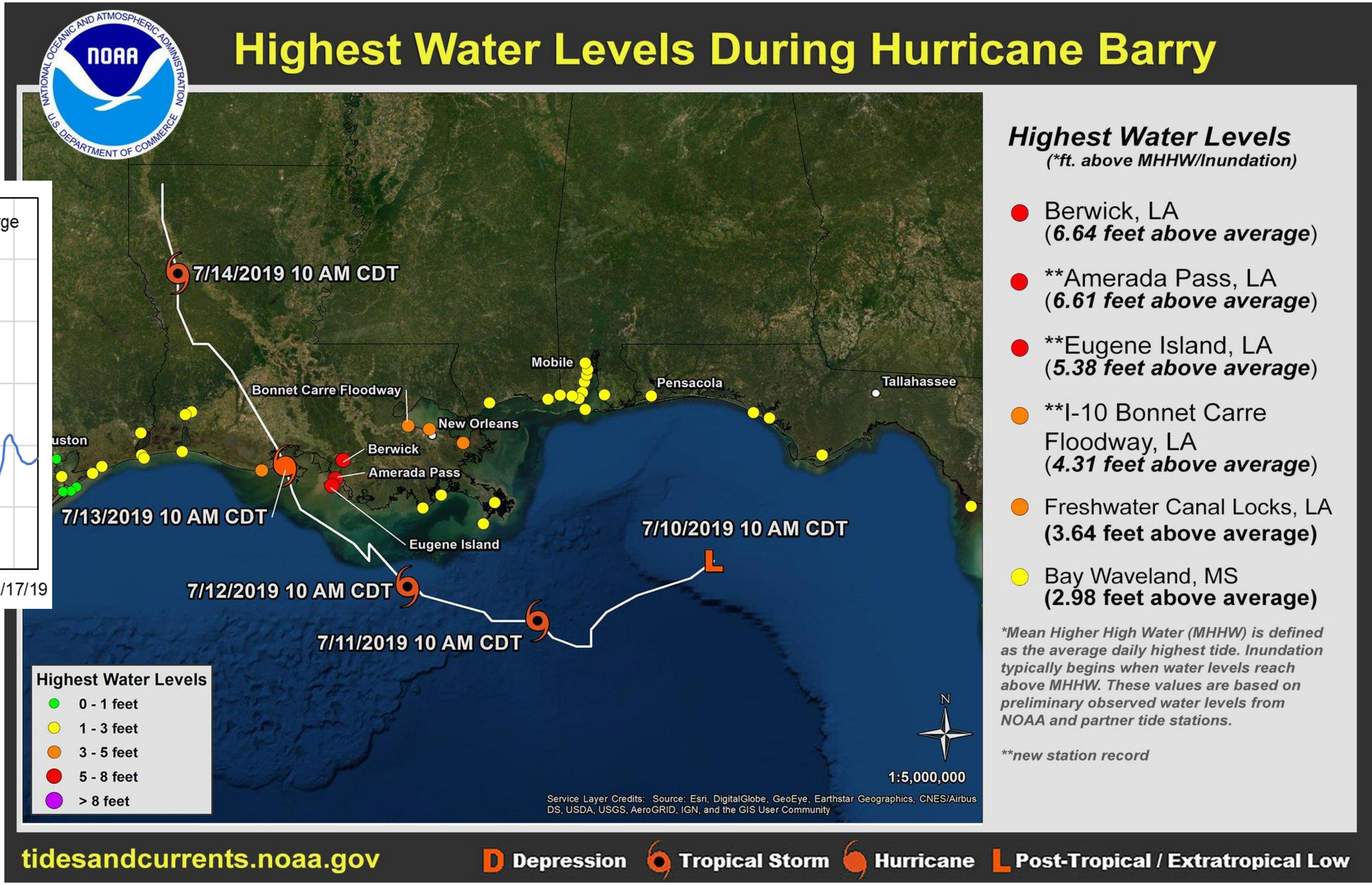
- Interaction river flow and surge can amplify flood hazards

- Understanding this interaction is important for flood protection, prediction, and mitigation

Hurricane Barry



Flow at Tarbert Landing



Goals

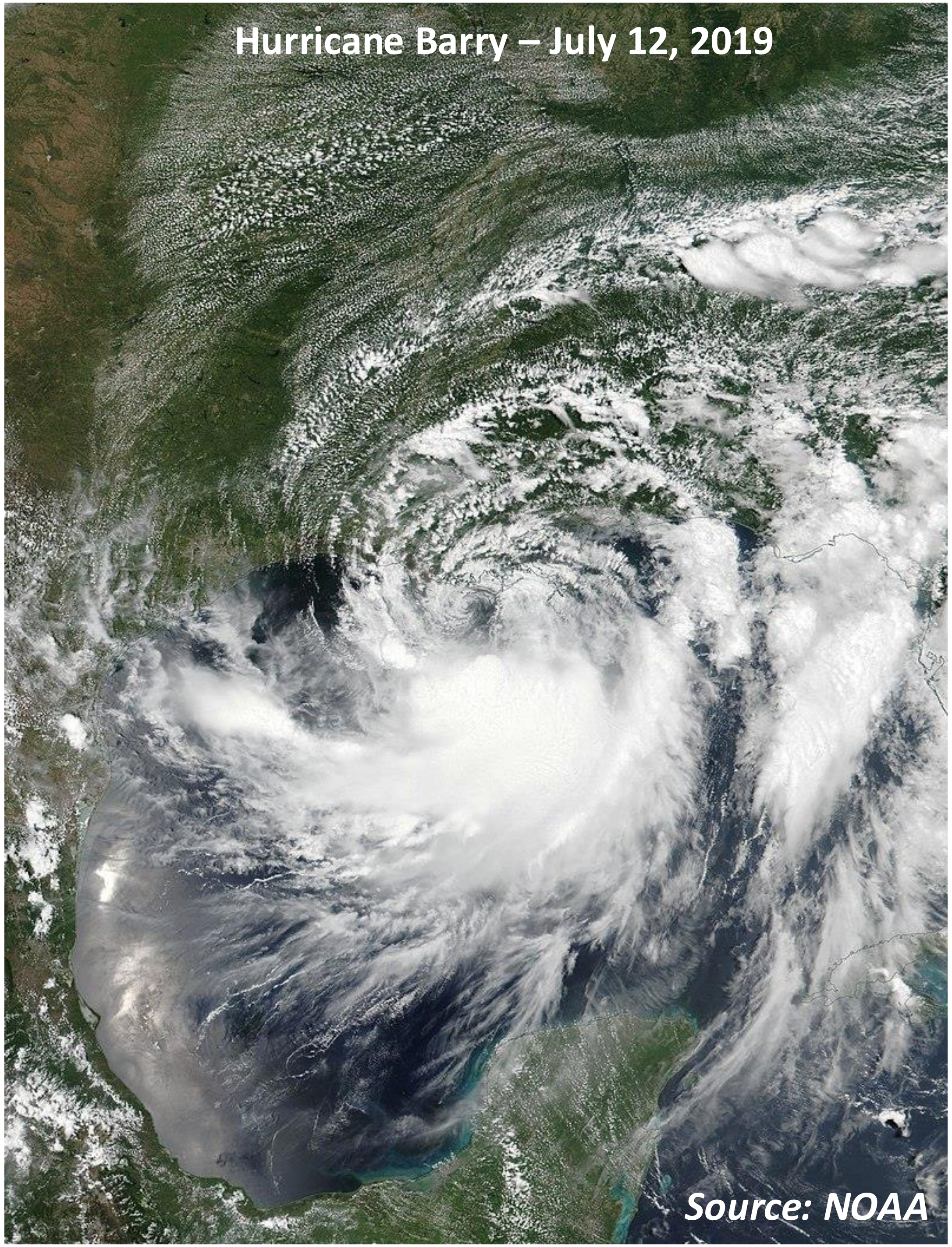
- Evaluate the interacting effects of Mississippi River flood flows on storm surge to gain a better understanding of fundamental compound flooding processes

Objectives

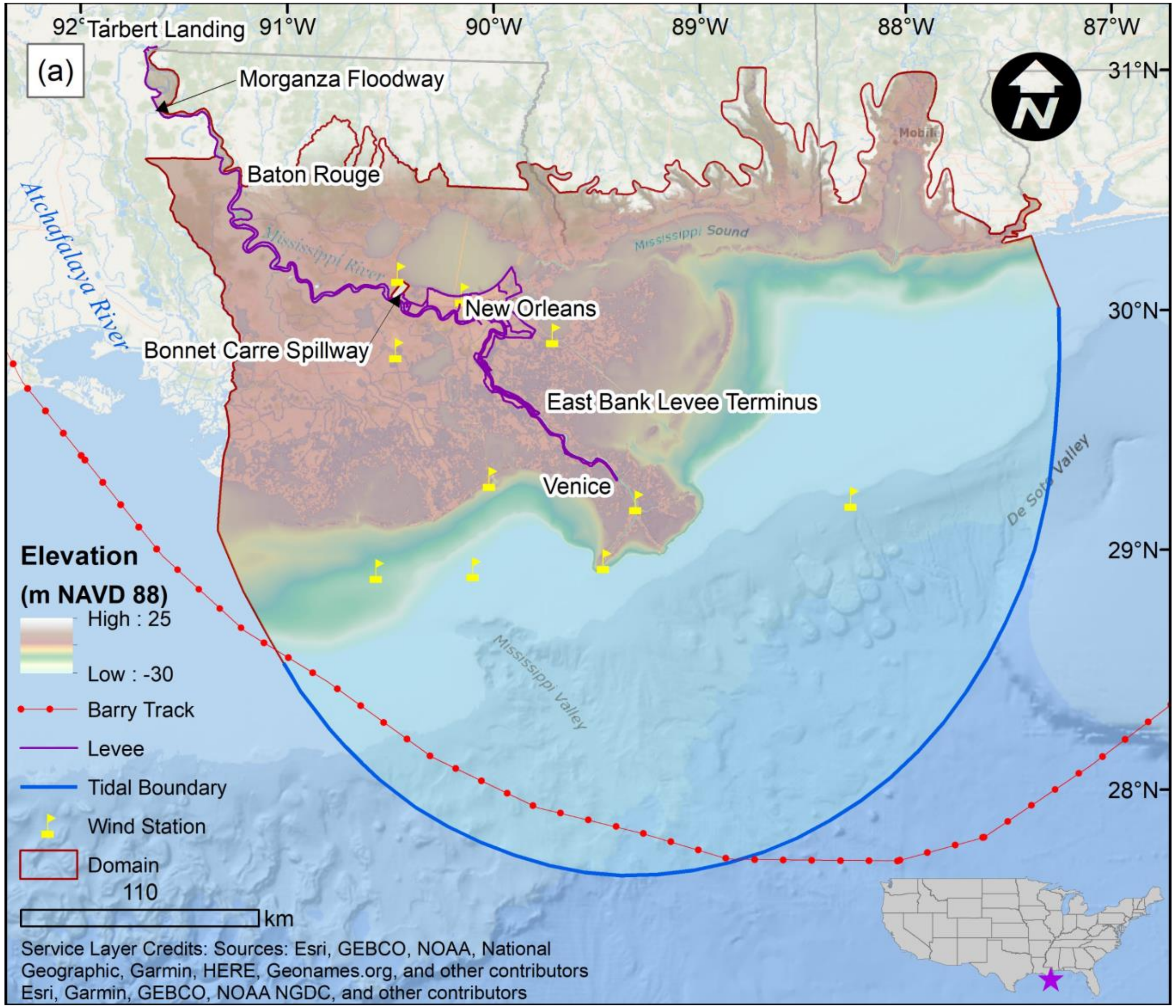
- Develop and validate a 2D AdH model of the Mississippi During Hurricane Barry

- Simulate 5 different flow scenarios

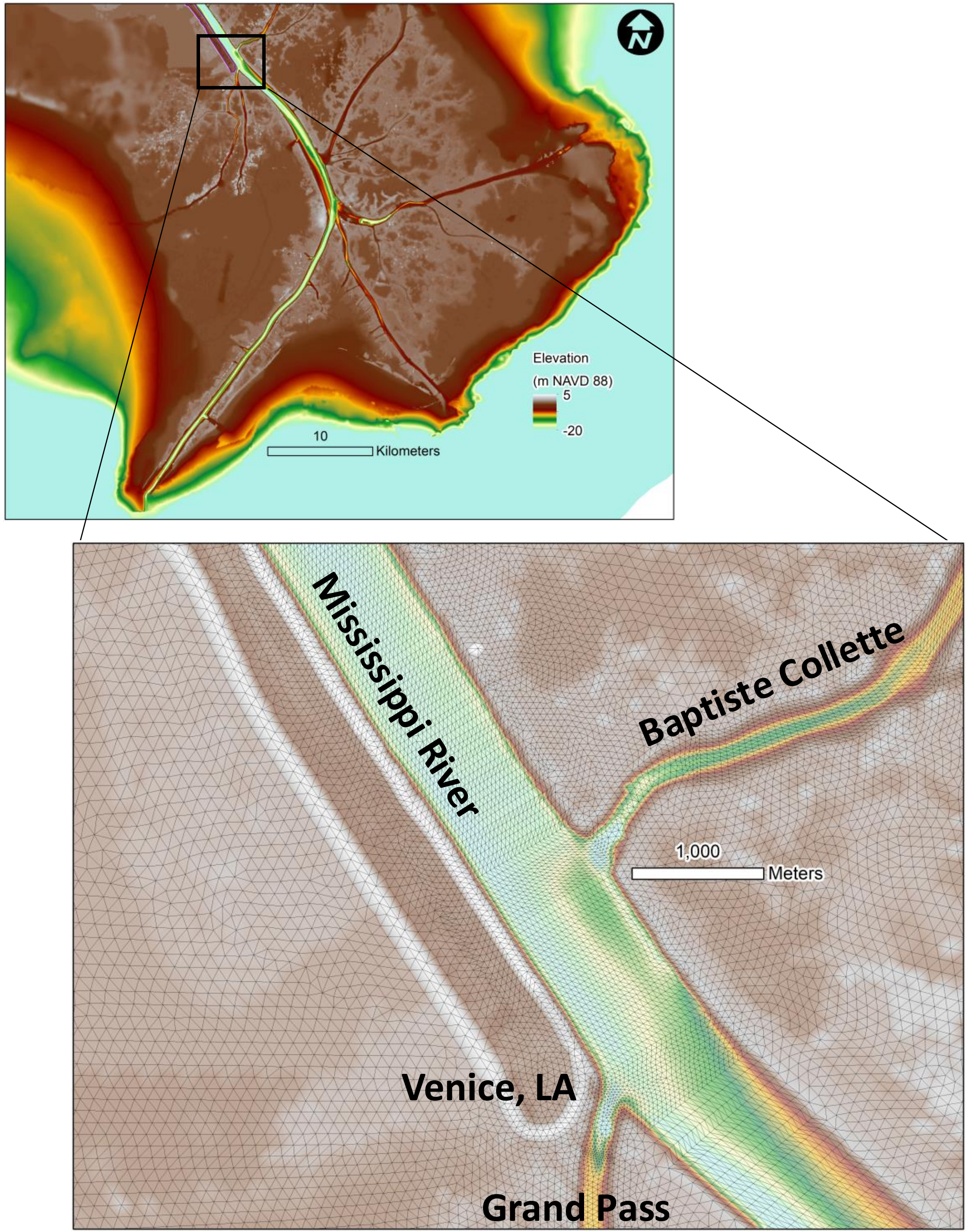
- Quantify the impacts of river flows on storm surge propagation and hazard amplification



Model Setup

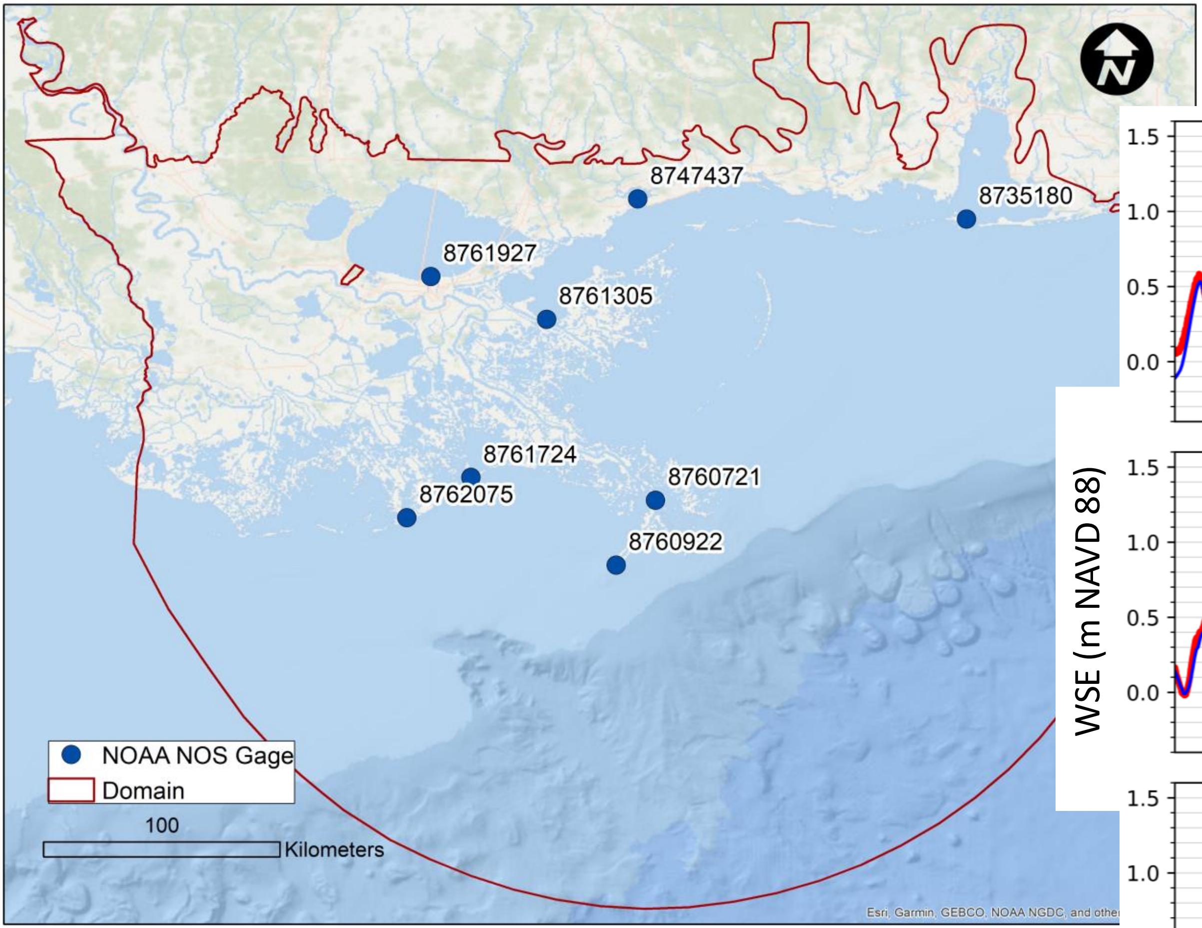


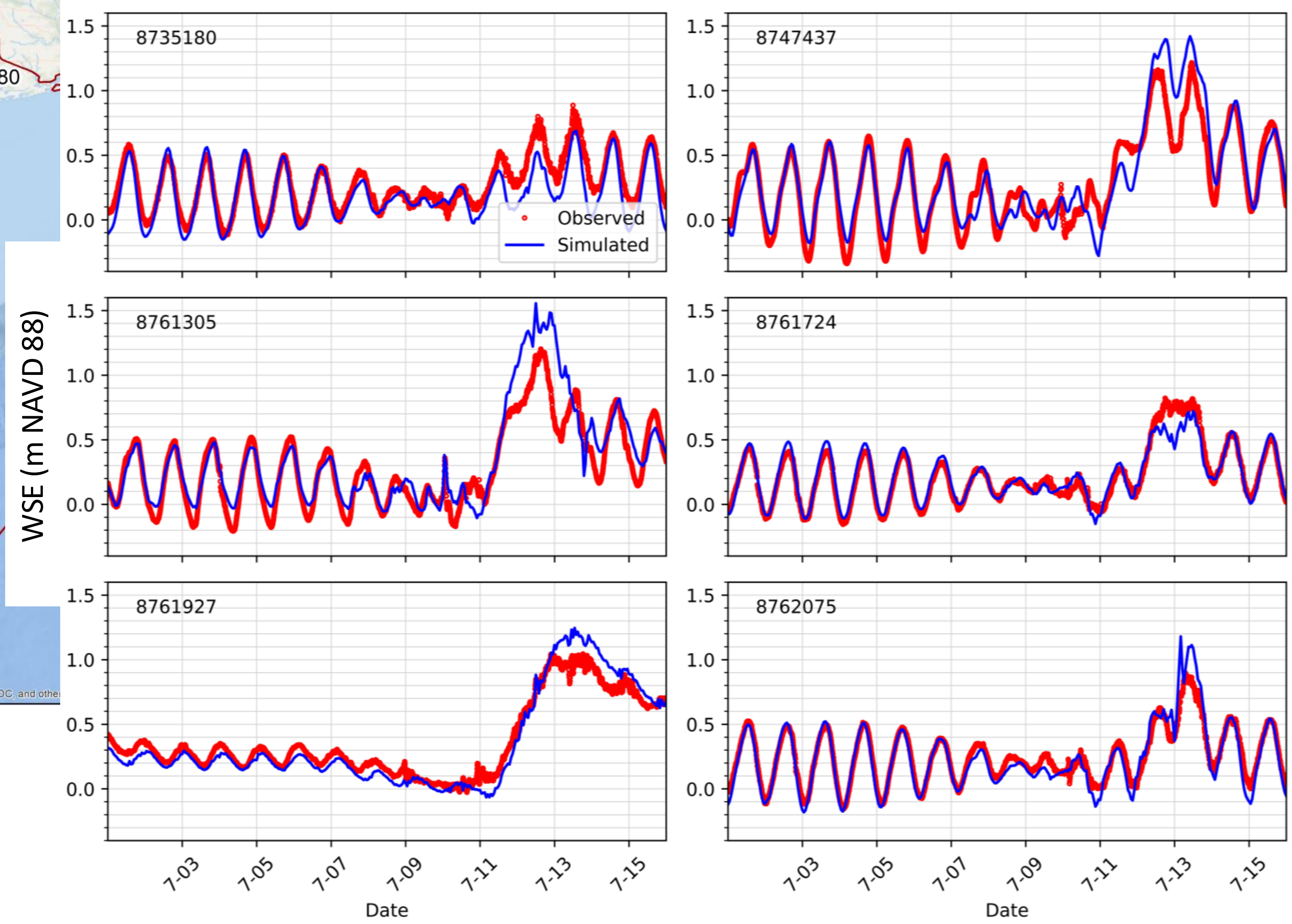
(a)
92°
Tarbert Landing
91°W
90°W
89°W
88°W
87°W
31°N
30°N
29°N
28°N
Morganza Floodway
Baton Rouge
Atchafalaya River
Mississippi River
Mississippi Sound
Mobile
New Orleans
Bonnet Carre Spillway
East Bank Levee Terminus
Venice
De Soto Valley
Mississippi Valley
Elevation
(m NAVD 88)
High : 25
Low : -30
Barry Track
Levee
Tidal Boundary
Wind Station
Domain
110
km
Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributors
Esri, Garmin, GEBCO, NOAA NGDC, and other contributors



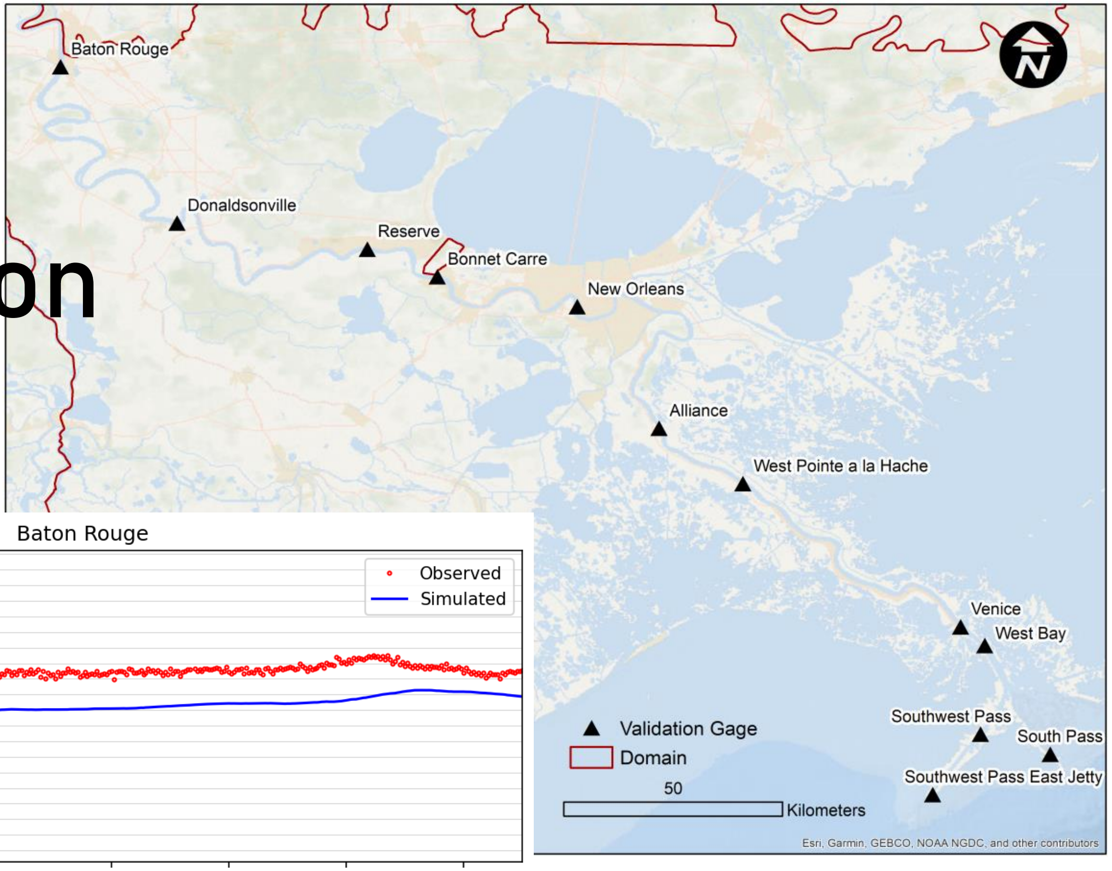
Elevation
(m NAVD 88)
5
-20
10
Kilometers
Mississippi River
Baptiste Collette
1,000
Meters
Venice, LA
Grand Pass

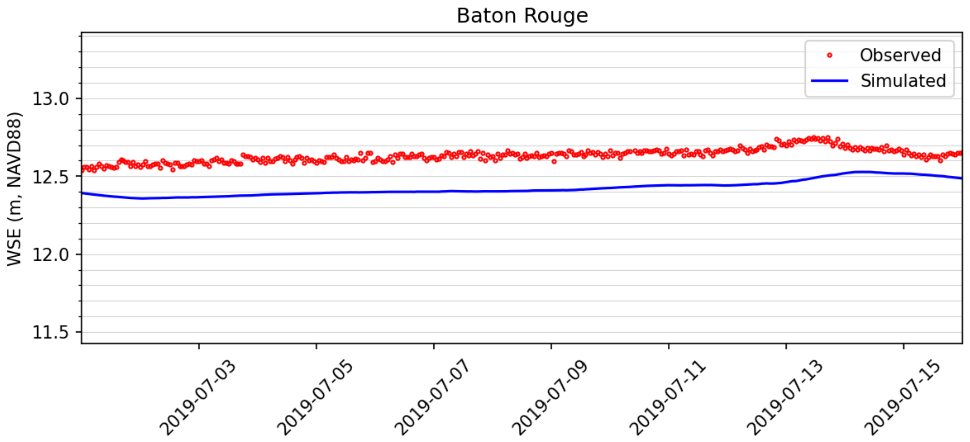
Model Validation

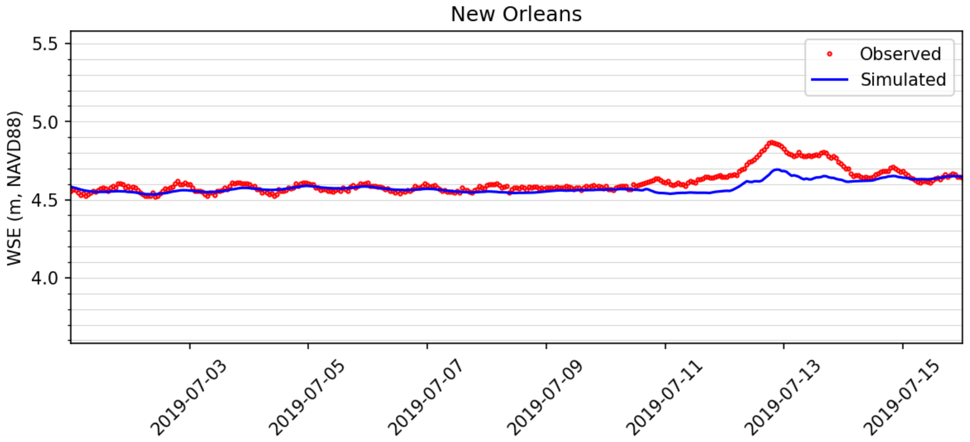


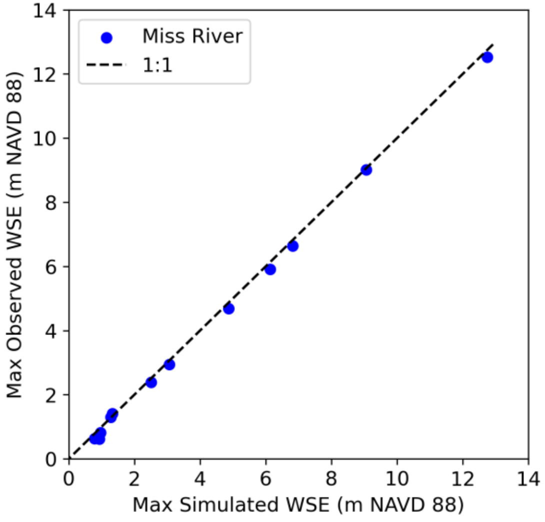


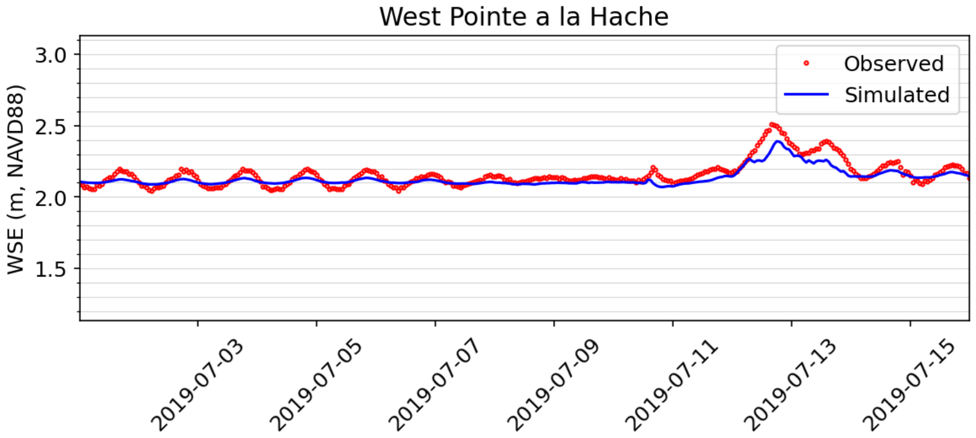
Model Validation

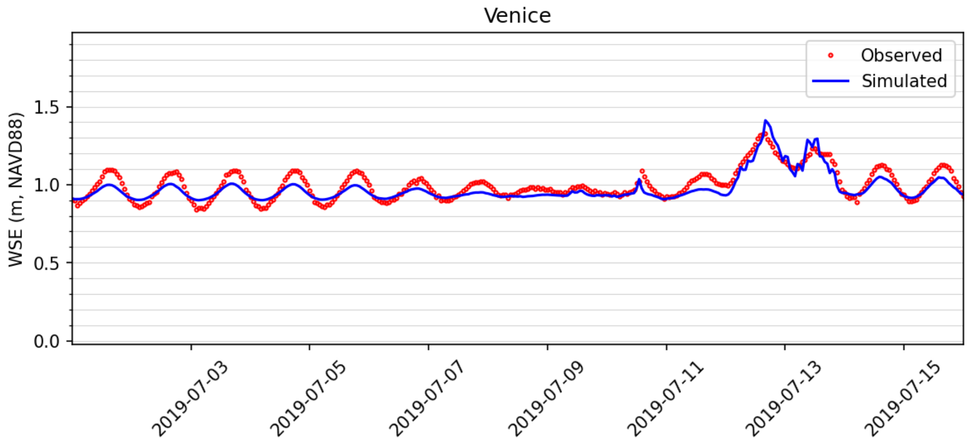


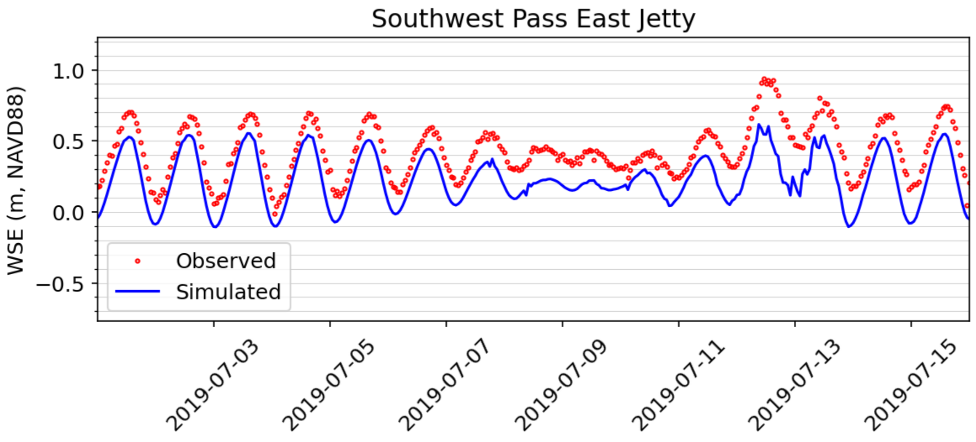




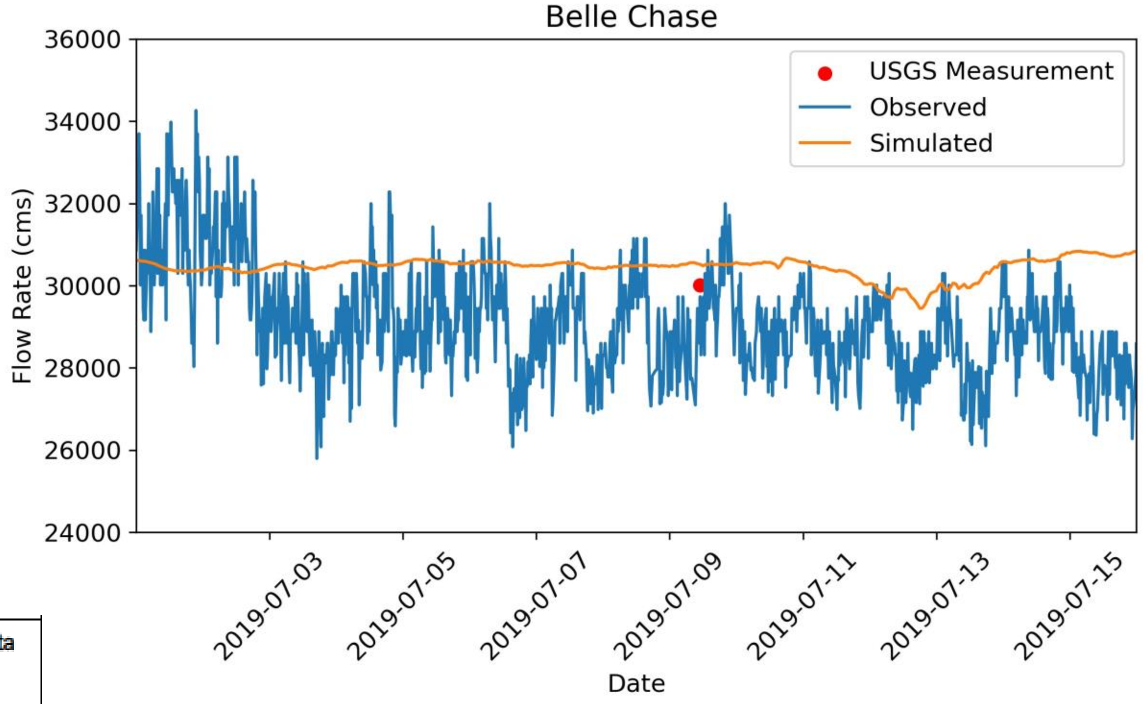








Model Validation



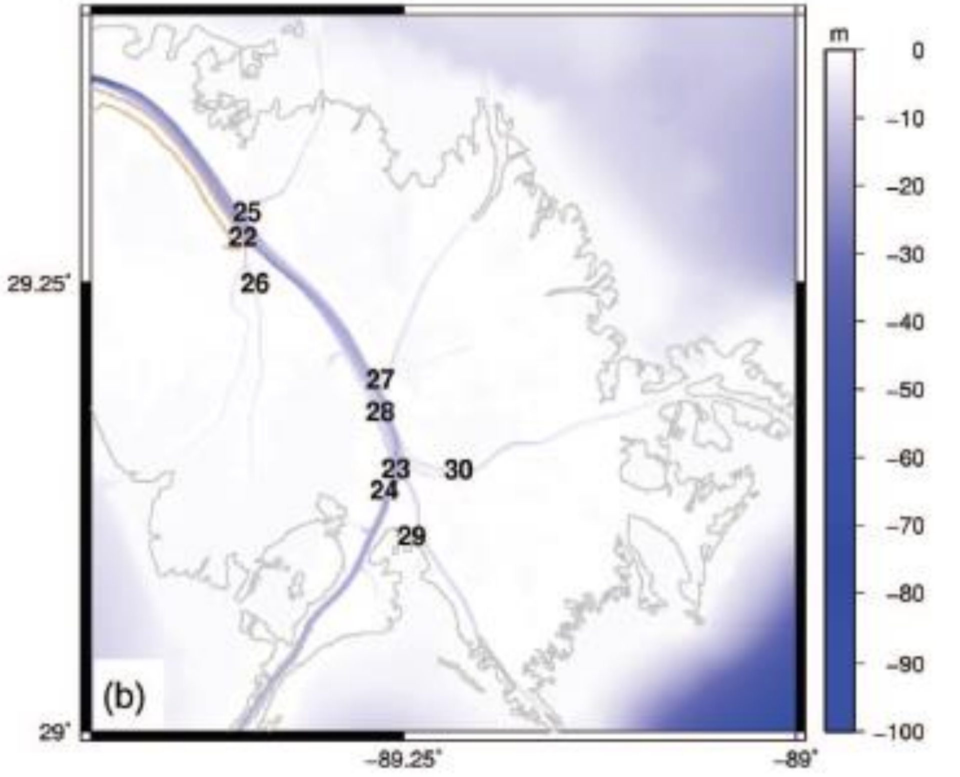
Fort St. Philip Sub-Delta 19.8 *Start 2005-10-01	
Q	
Channel	Diversion
0	0
320000	0
400000	21920
600000	48240
800000	76800
1250000	130500

MRG&P
Mississippi River Geomorphology & Potamology Program

Report 25

Model compared to published data from:

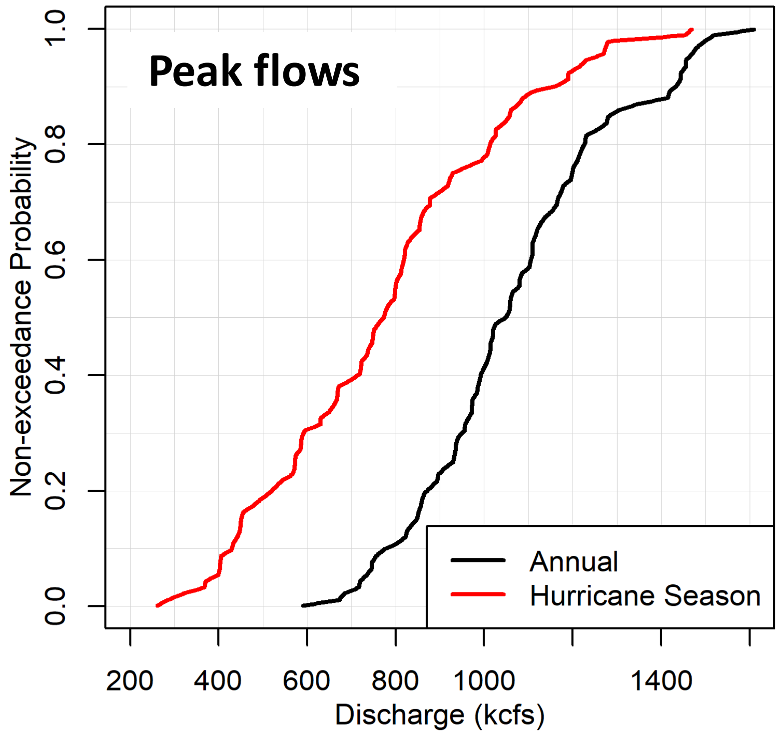
- **Martyr et al (2013)**
- **USACE MRG&P Reports**



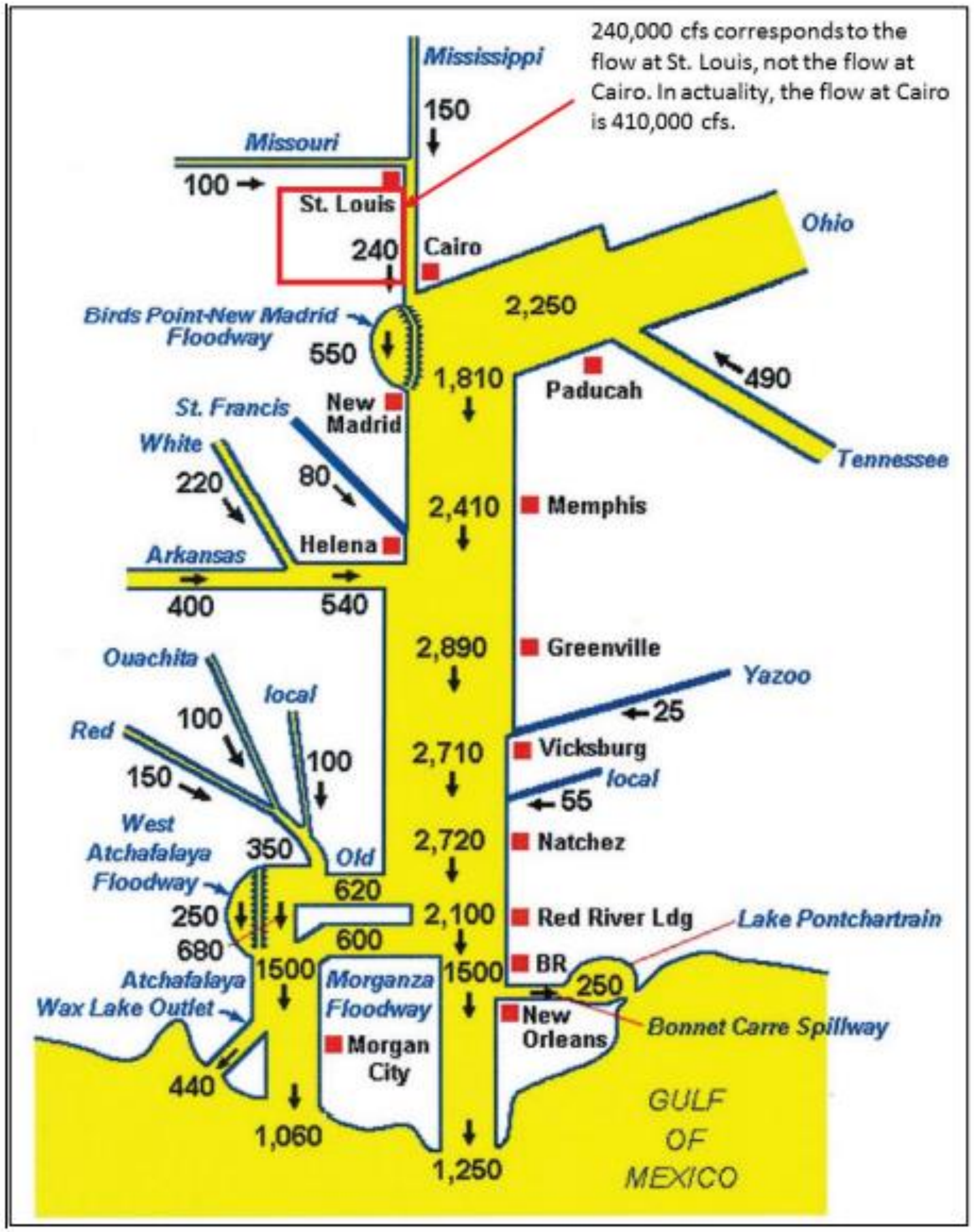
Martyr et al (2013) (shown above) Simulating hurricane storm surge in the lower Mississippi River under varying flow conditions

Flow Scenarios

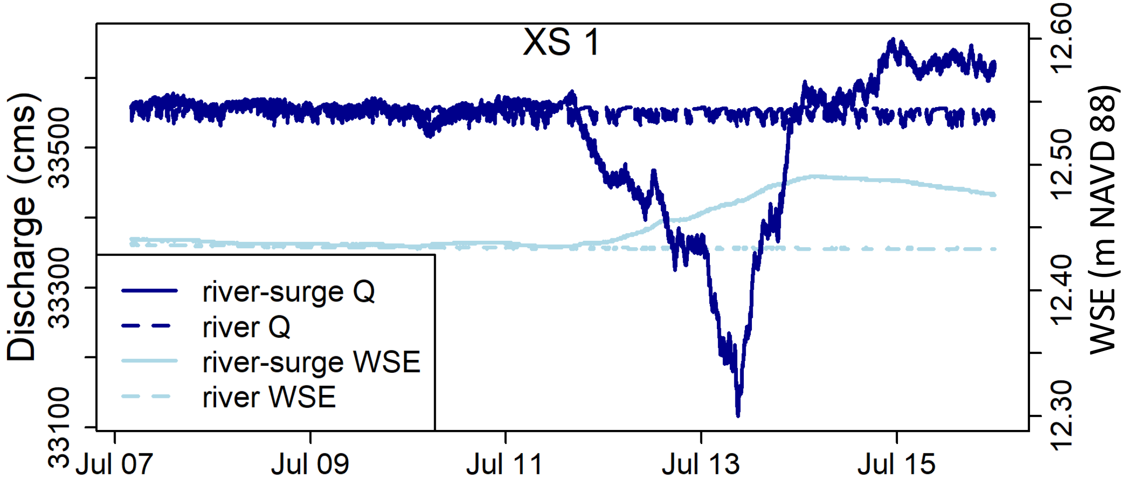
1. 1.5 Mcfs (1.25 Mcfs at New Orleans)
2. 1.18 Mcfs (Hurricane Barry)
3. 900 kcfs (75th percentile of Hurricane season peaks)
4. 700 kcfs (Median Hurricane season peak)
5. 300 kcfs (Median hurricane season flow)

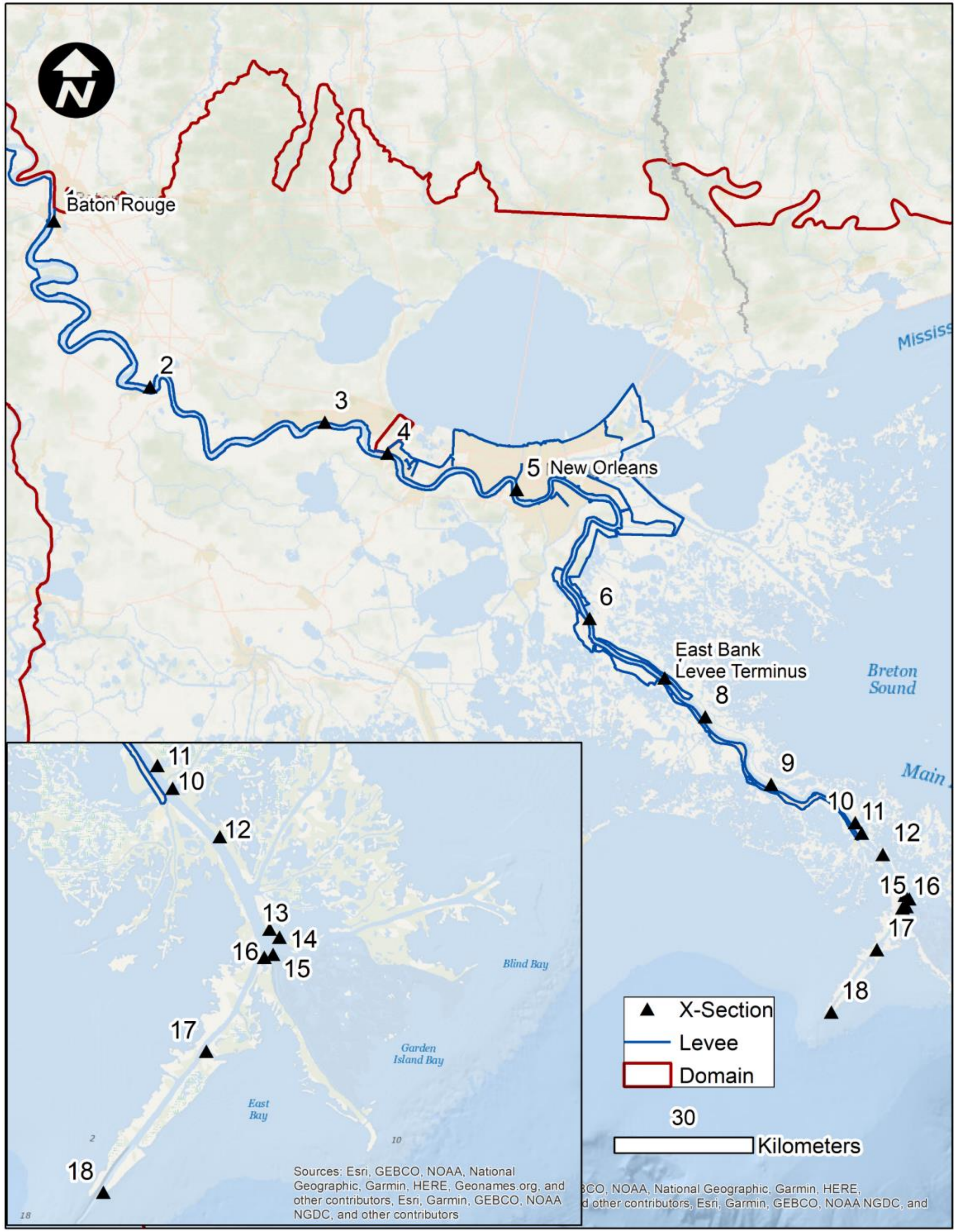


1/1/1930 – 12/31/2022 at the Mississippi River at Tarbert Landing

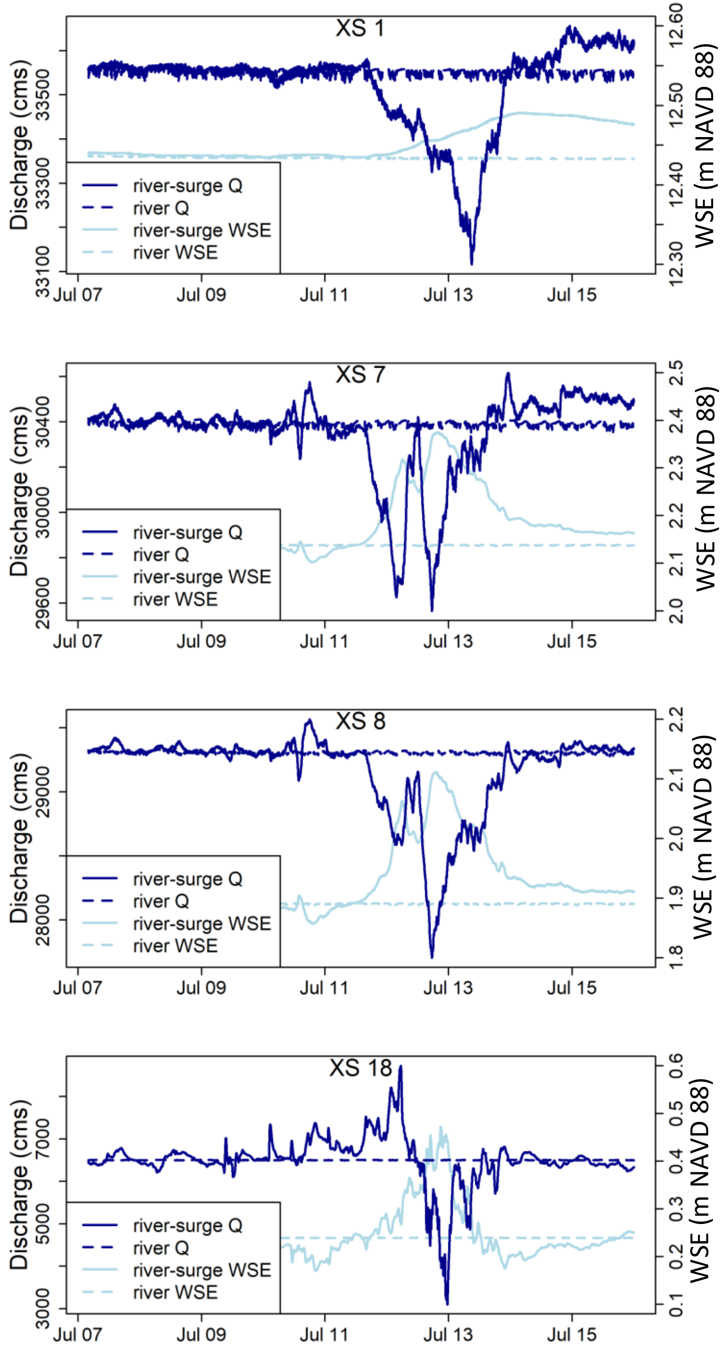


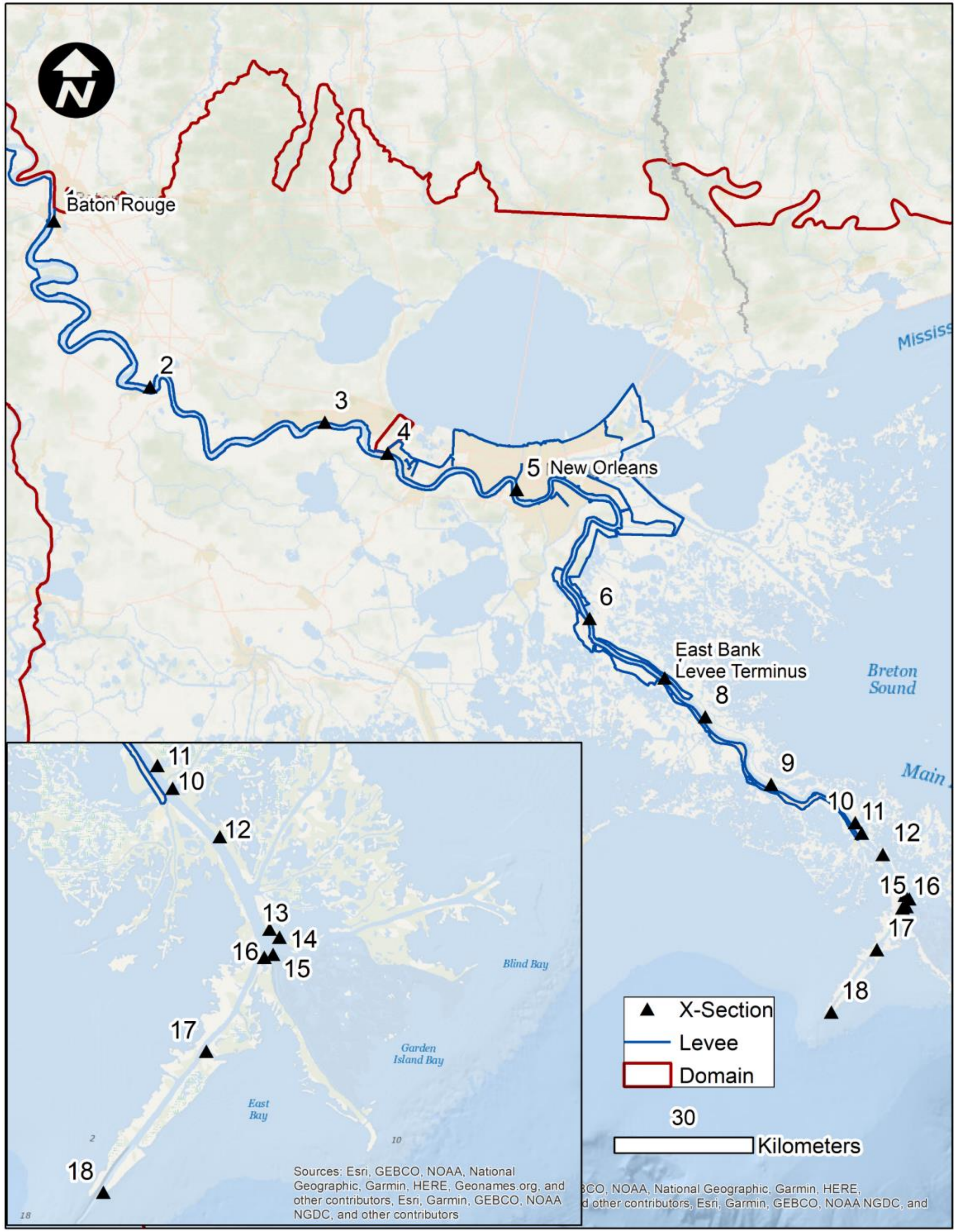
1.18 Mcfs

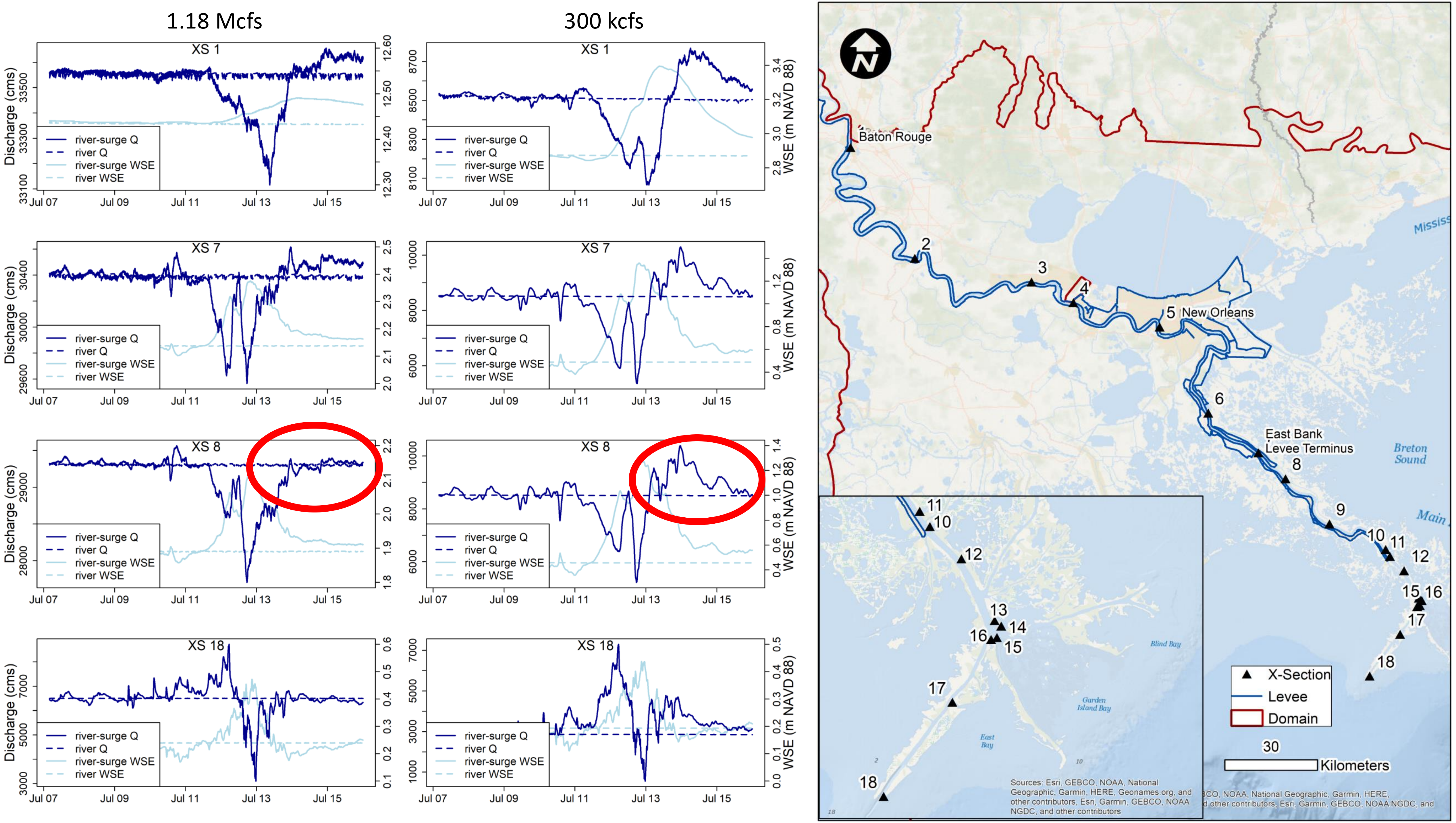

XS 1
Discharge (cms)
WSE (m NAVD 88)
33100
33300
33500
12.30
12.40
12.50
12.60
Jul 07
Jul 09
Jul 11
Jul 13
Jul 15
river-surge Q
river Q
river-surge WSE
river WSE


Baton Rouge
New Orleans
East Bank
Levee Terminus
Breton
Sound
Blind Bay
Garden
Island Bay
East
Bay
X-Section
Levee
Domain
30
Kilometers
2
3
4
5
6
8
9
10
11
12
13
14
15
16
17
18
Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributors, Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

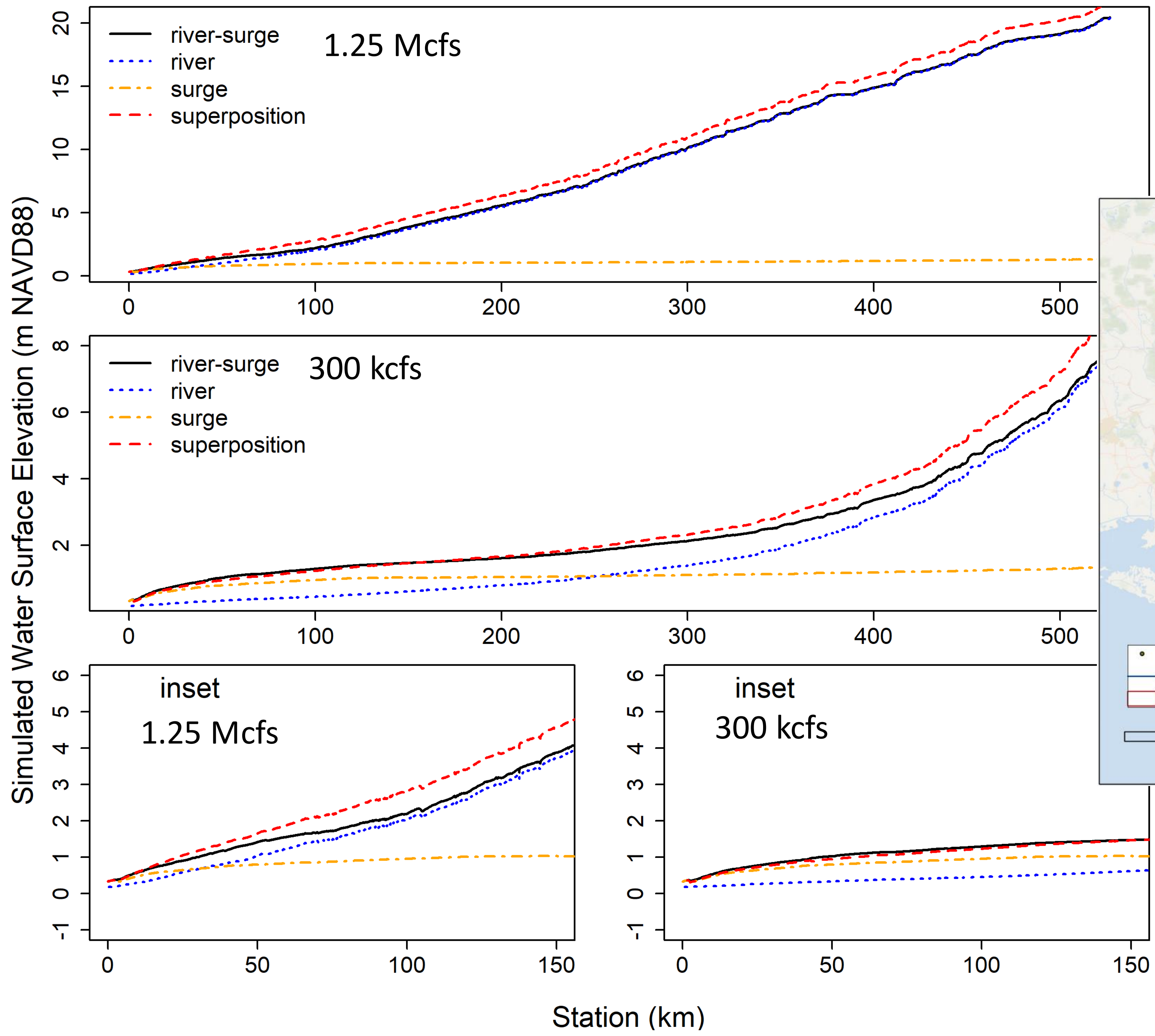
1.18 Mcfs

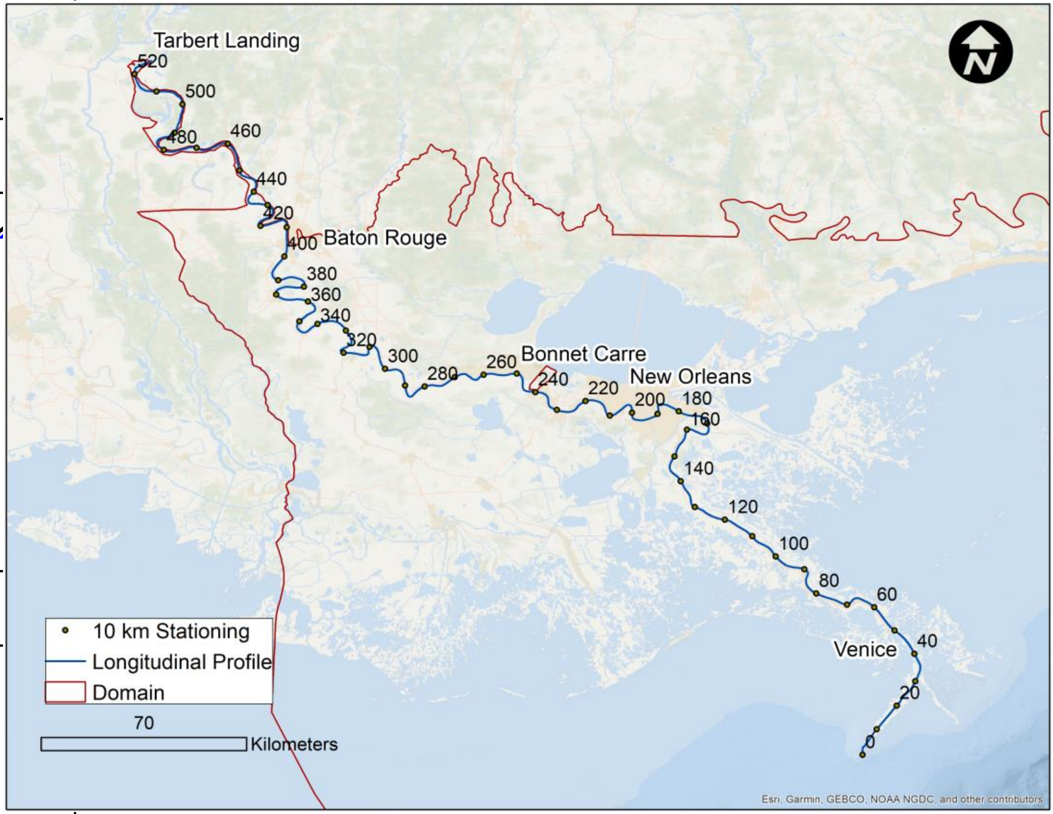

XS 1
XS 7
XS 8
XS 18
Discharge (cms)
WSE (m NAVD 88)
river-surge Q
river Q
river-surge WSE
river WSE
Jul 07
Jul 09
Jul 11
Jul 13
Jul 15
33100
33300
33500
12.30
12.40
12.50
12.60
29600
30000
30400
2.0
2.1
2.2
2.3
2.4
2.5
28000
29000
1.8
1.9
2.0
2.1
2.2
3000
5000
7000
0.1
0.2
0.3
0.4
0.5
0.6


N
Baton Rouge
New Orleans
East Bank
Levee Terminus
Breton
Sound
Main
2
3
4
5
6
8
9
10
11
12
13
14
15
16
17
18
Blind Bay
Garden
Island Bay
East
Bay
X-Section
Levee
Domain
30
Kilometers
Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributors Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

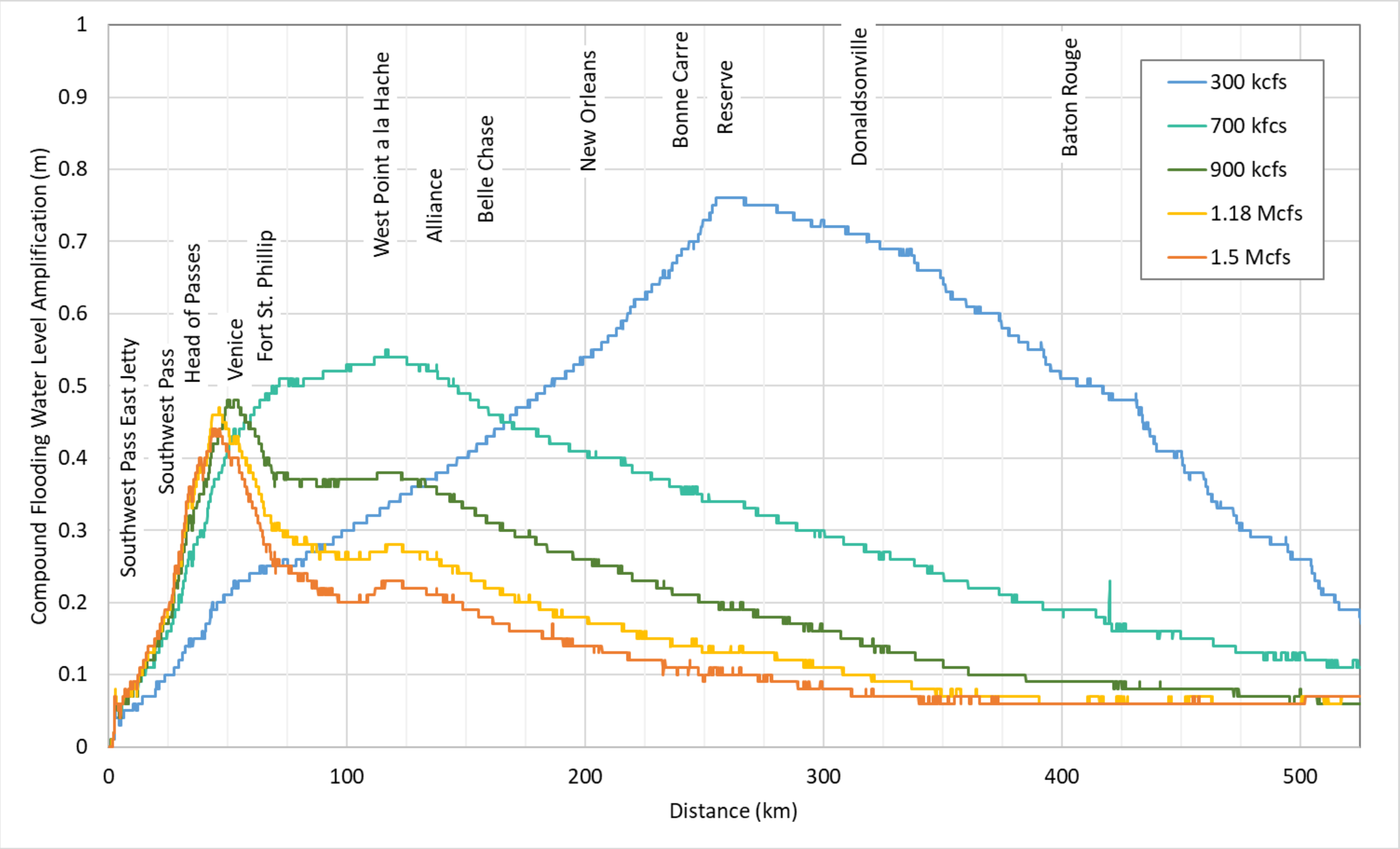

1.18 Mcfs
300 kcfs
XS 1
XS 7
XS 8
XS 18
Discharge (cms)
WSE (m NAVD 88)
river-surge Q
river Q
river-surge WSE
river WSE
Jul 07
Jul 09
Jul 11
Jul 13
Jul 15
Baton Rouge
New Orleans
East Bank
Levee Terminus
Breton
Sound
Blind Bay
Garden
Island Bay
East
Bay
X-Section
Levee
Domain
30
Kilometers
Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributors, Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

Flood Drivers

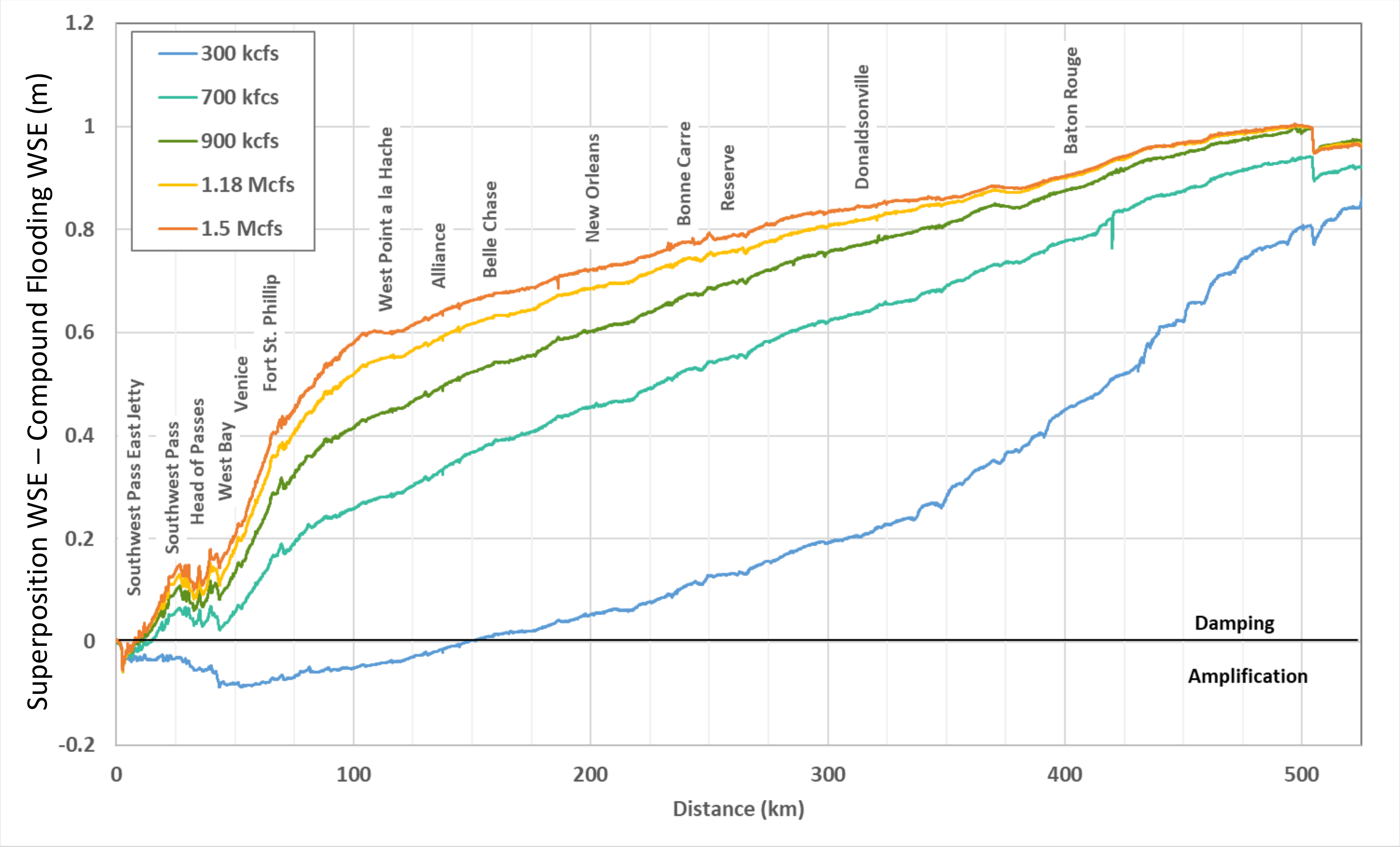


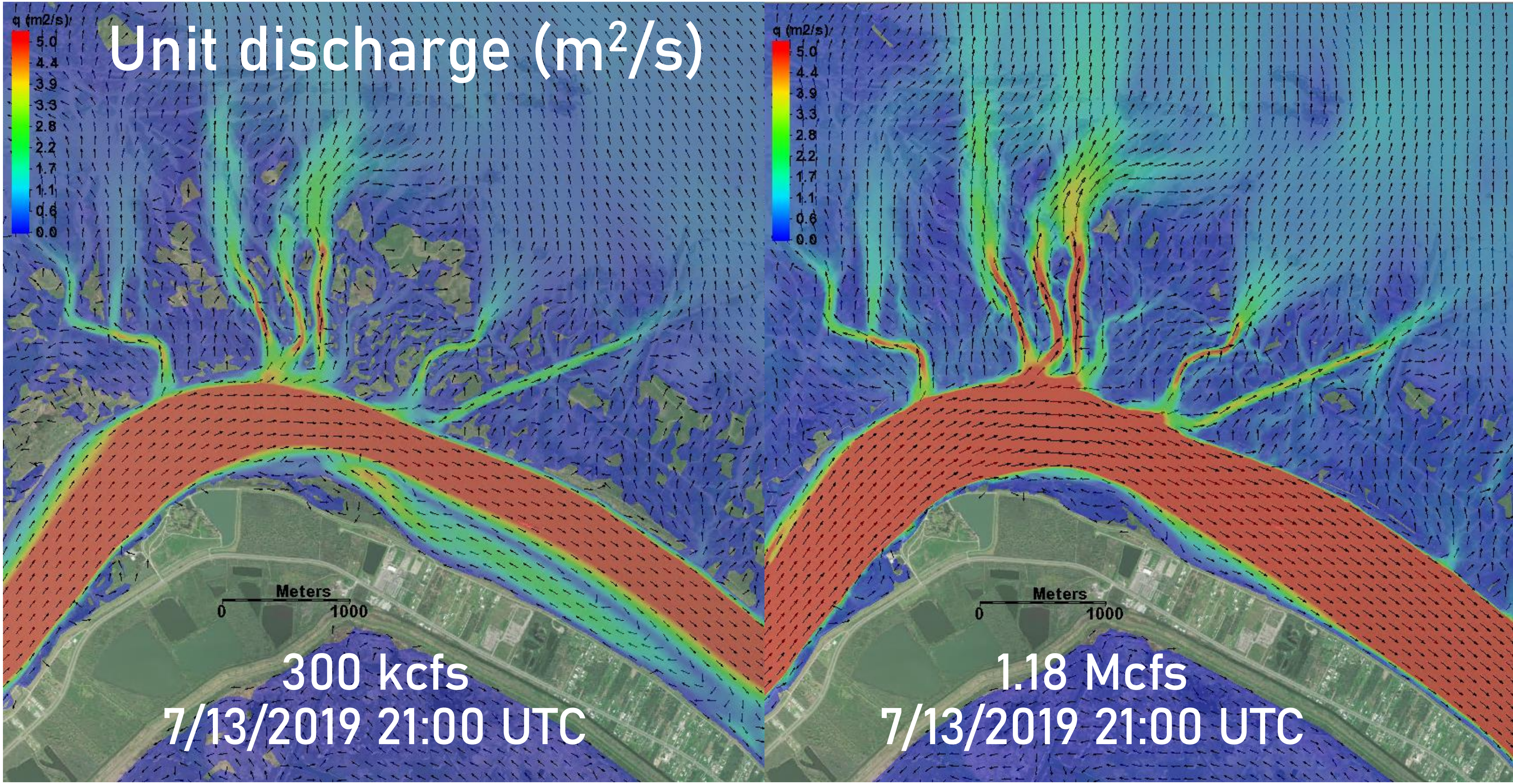


Compound Flooding Impacts



Nonlinear Impacts

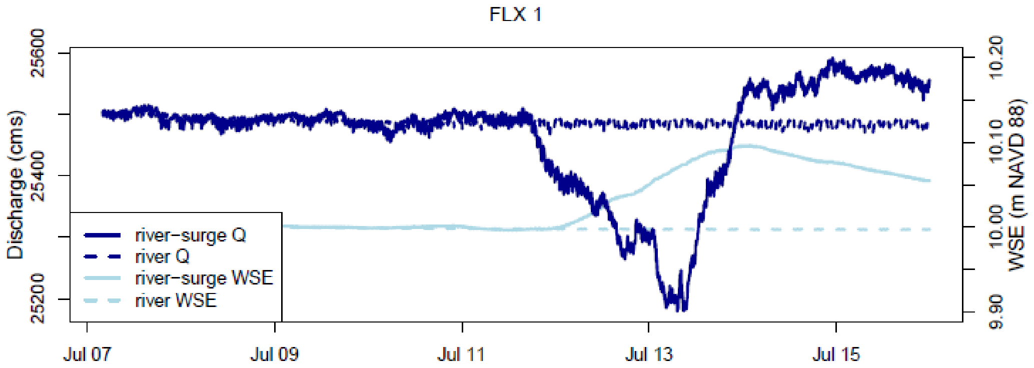


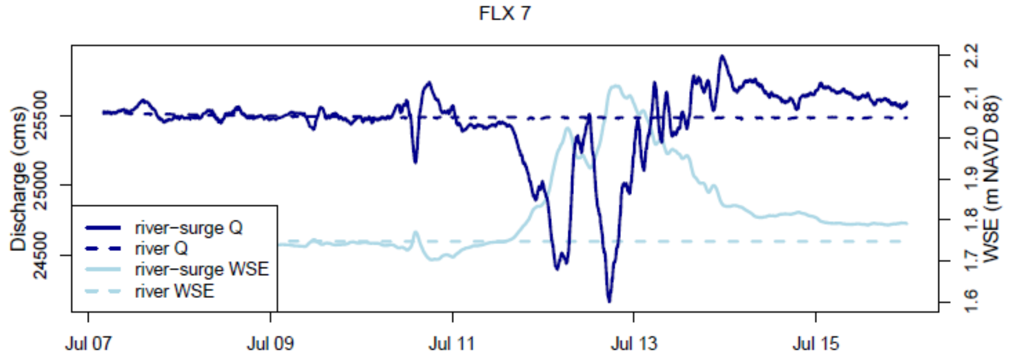

Unit discharge (m2/s)
q (m2/s)
5.0
4.4
3.9
3.3
2.8
2.2
1.7
1.1
0.6
0.0
Meters
0
1000
300 kcfs
7/13/2019 21:00 UTC
q (m2/s)
5.0
4.4
3.9
3.3
2.8
2.2
1.7
1.1
0.6
0.0
Meters
0
1000
1.18 Mcfs
7/13/2019 21:00 UTC

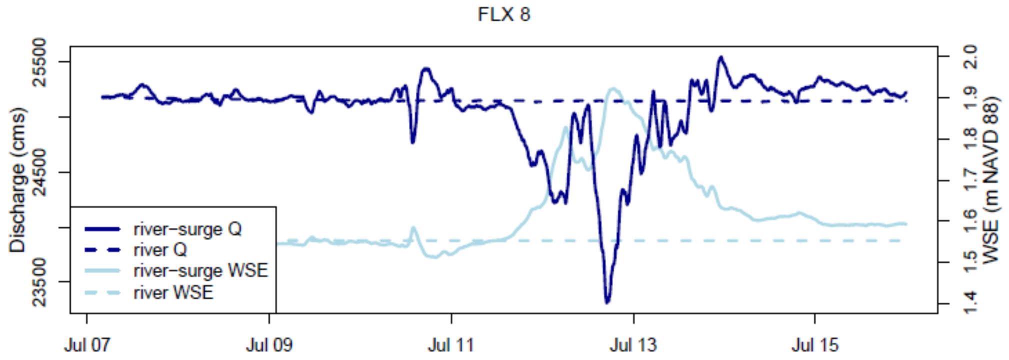
Conclusions

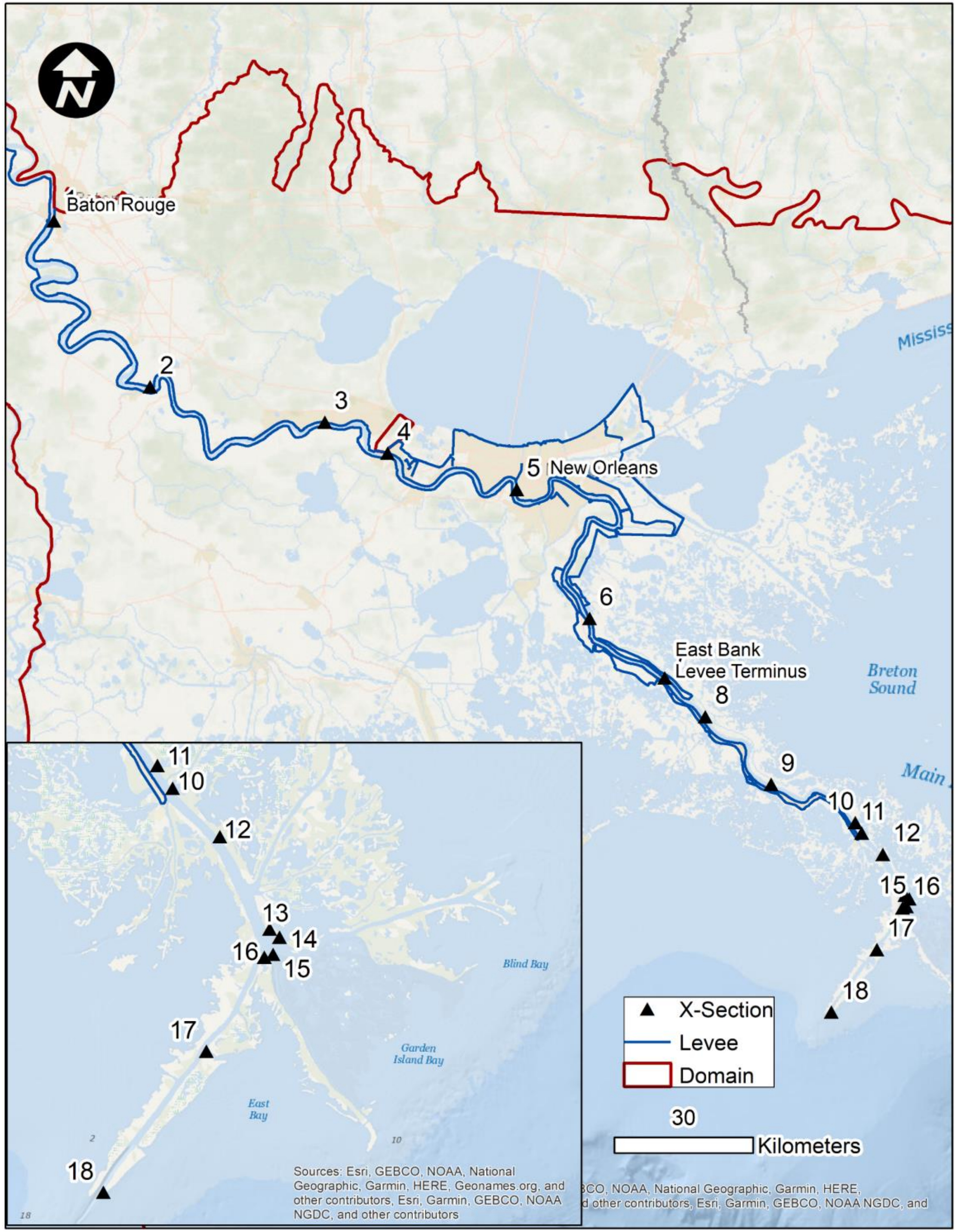
- Larger discharges increase storm surge damping, nonlinearly
- Storm surge impacts extend more than 300 miles along the Mississippi River, with the magnitude of impact increasing with decreasing discharge
- Local discharge decreases with passage of storm surge
- Levee confinement increases local discharge after surge by releasing stored mass

900kcfs

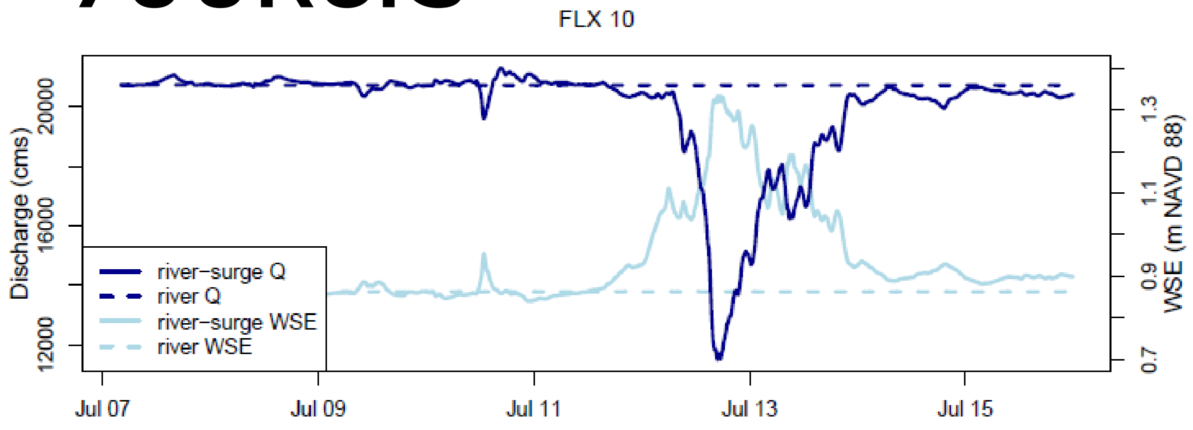

FLX 1
Discharge (cms)
25200
25400
25600
WSE (m NAVD 88)
9.90
10.00
10.10
10.20
Jul 07
Jul 09
Jul 11
Jul 13
Jul 15
river−surge Q
river Q
river−surge WSE
river WSE

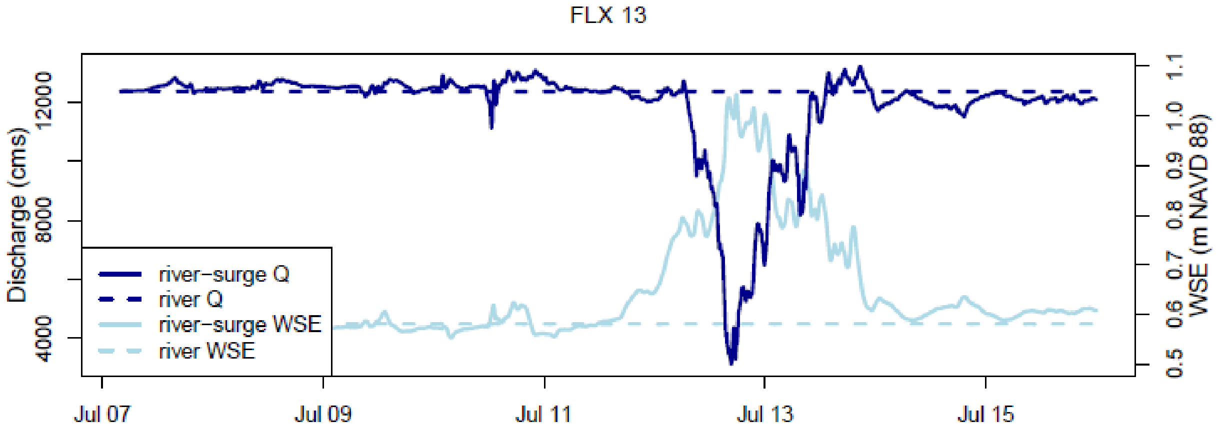

FLX 7
Discharge (cms)
24500
25000
25500
WSE (m NAVD 88)
1.6
1.7
1.8
1.9
2.0
2.1
2.2
Jul 07
Jul 09
Jul 11
Jul 13
Jul 15
river−surge Q
river Q
river−surge WSE
river WSE

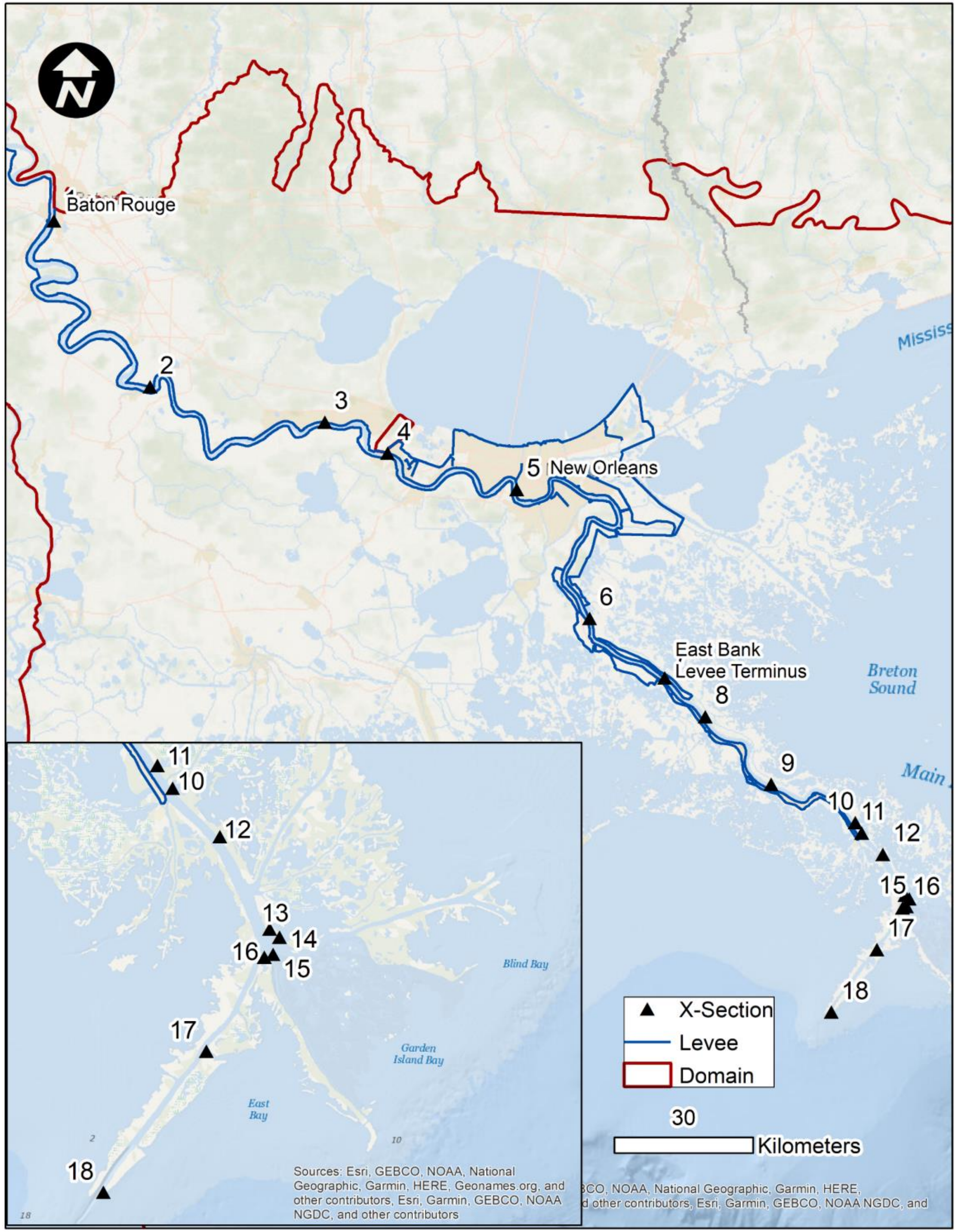

FLX 8
Discharge (cms)
23500
24500
25500
WSE (m NAVD 88)
1.4
1.5
1.6
1.7
1.8
1.9
2.0
Jul 07
Jul 09
Jul 11
Jul 13
Jul 15
river−surge Q
river Q
river−surge WSE
river WSE


N
Baton Rouge
2
3
4
5
New Orleans
6
East Bank
Levee Terminus
8
9
10
11
12
15
16
17
18
Breton
Sound
Main
X-Section
Levee
Domain
30
Kilometers
Blind Bay
Garden
Island Bay
East
Bay
13
14
Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributors, Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

900kcfs


FLX 10
Discharge (cms)
WSE (m NAVD 88)
river−surge Q
river Q
river−surge WSE
river WSE
Jul 07
Jul 09
Jul 11
Jul 13
Jul 15


FLX 13
Discharge (cms)
WSE (m NAVD 88)
river−surge Q
river Q
river−surge WSE
river WSE
Jul 07
Jul 09
Jul 11
Jul 13
Jul 15


Baton Rouge
New Orleans
East Bank
Levee Terminus
Breton Sound
Blind Bay
Garden Island Bay
East Bay
X-Section
Levee
Domain
30
Kilometers
Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributors, Esri, Garmin, GEBCO, NOAA NGDC, and other contributors