Use of Watershed Hydrology to Estimate Deep-Draft Dredging Requirements

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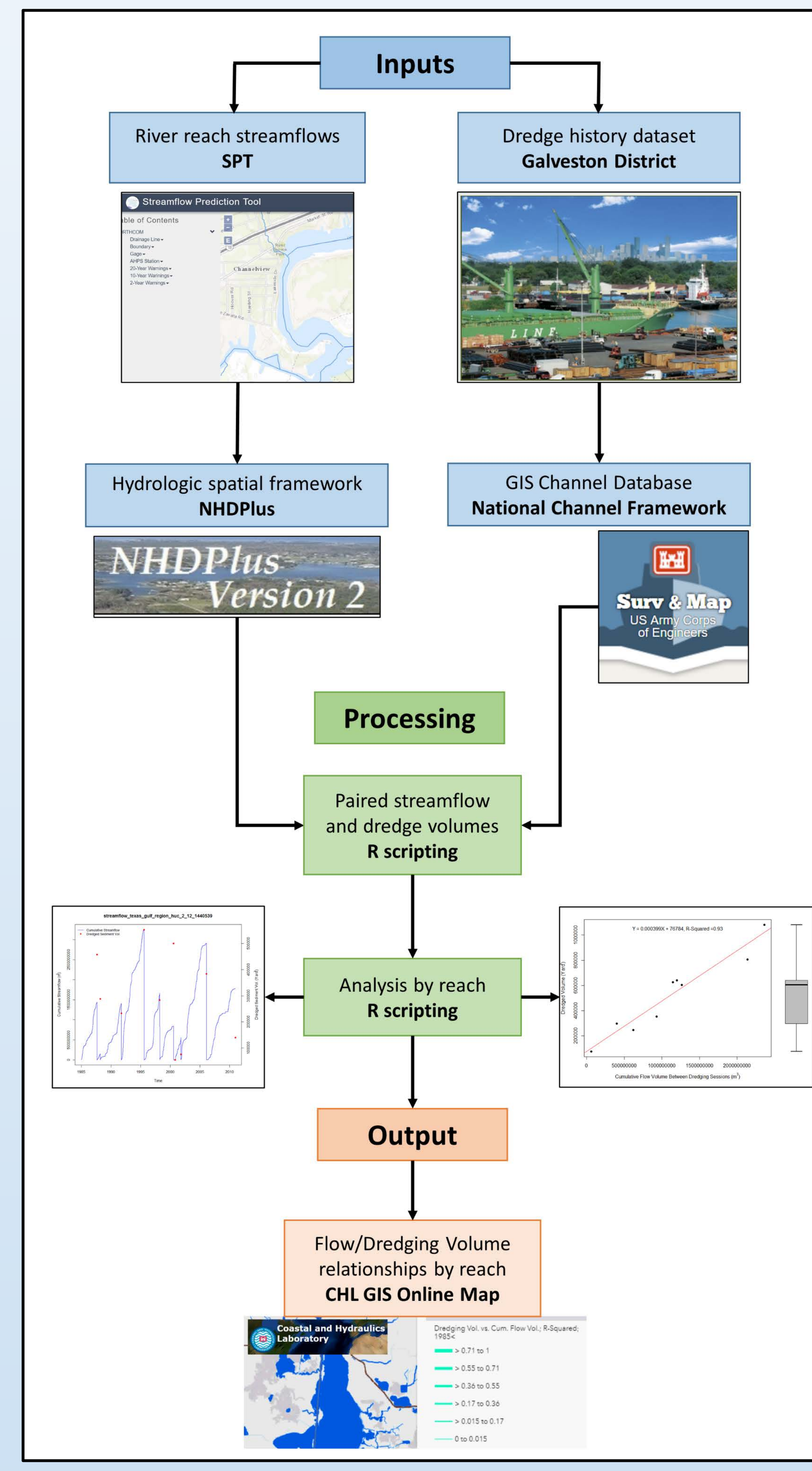
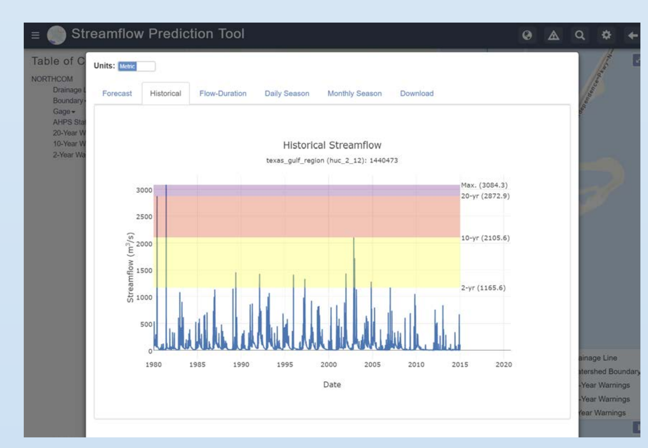
Inland hydrology impact on channels

On average, the United States Army Corps of Engineers (USACE) contracts nearly a billion dollars per year for navigation channel maintenance dredging. Due to limited funding amounts Corps-wide, USACE dredging managers must determine the extent to which navigation channels are to be maintained in a given budget year. Anecdotally and through experiential knowledge, Corps Navigation project managers know that dredging requirements will increase in the years following one or more major precipitation events in the associated watershed. This study uses the Streamflow Prediction Tool (SPT), a runoff routing model based on global weather forecast ensembles, to estimate dredging requirements by channel segment. Regression relationships between historical streamflow volumes and resulting dredged sediment volumes are used to estimate the relationship between these quantities for each watershed. Results in the test cases of the Houston Ship Channel and the Sabine and Port Arthur Harbor waterways in Texas indicate positive correlation between the calculated streamflows and subsequent dredging requirements.

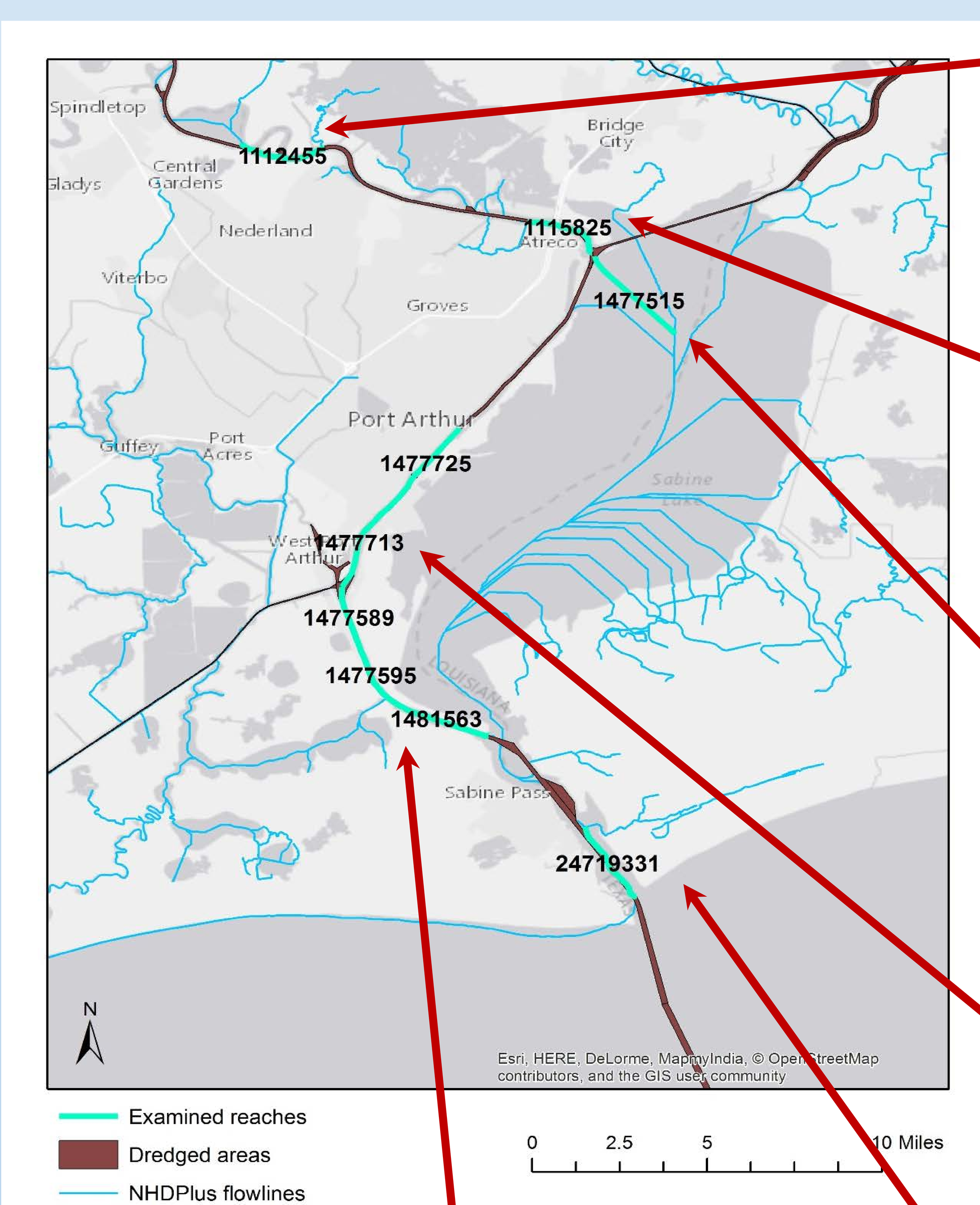
Methodology

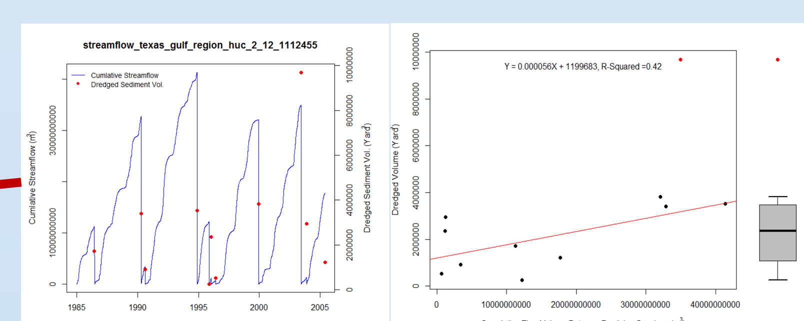
For this analysis, we took advantage of several USACE data sets and tools. Our streamflow time series for selected reaches was downloaded from the SPT. The historic dredging data came from the USACE Galveston District, and was plotted spatially using the USACE National Channel Framework GIS database. We processed these inputs via R scripting to match streamflow time series with dredged volume time series at the river reach level. We performed regression analysis of dredged volumes as a function of precipitation-driven streamflow in R, and created an online mapping tool to store the results spatially.

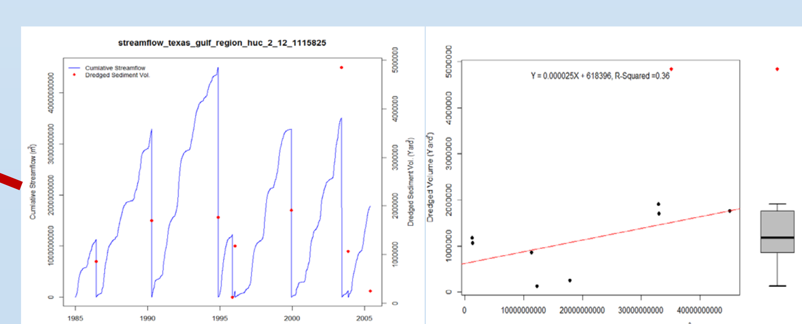


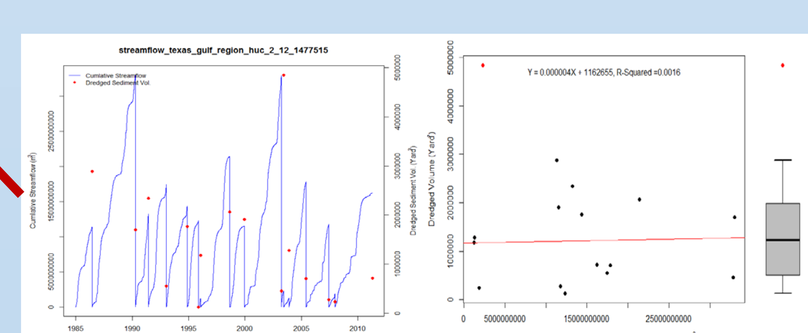


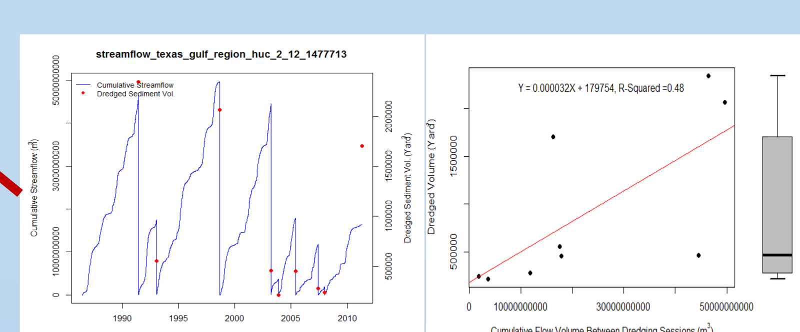
Results – Sabine Neches

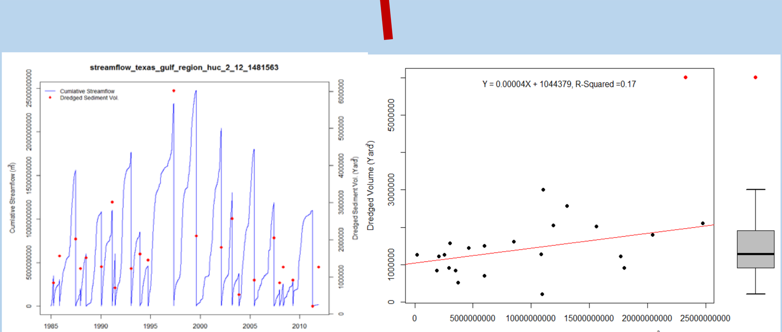


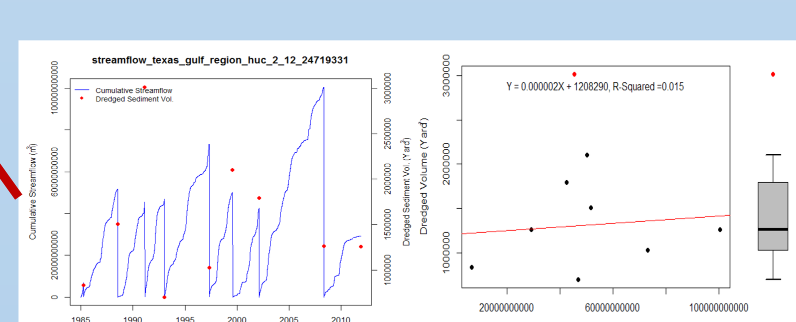




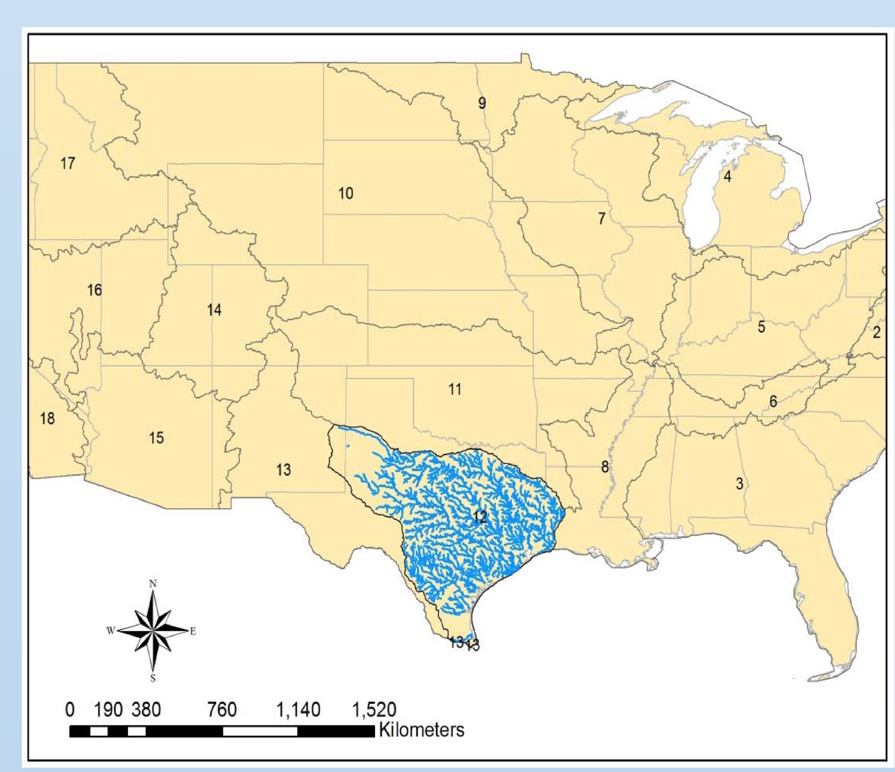






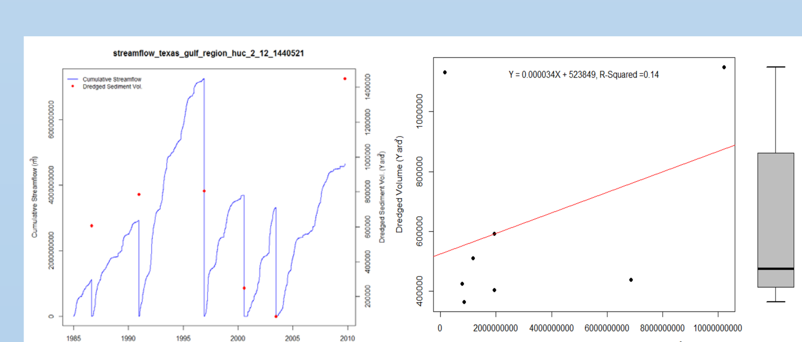


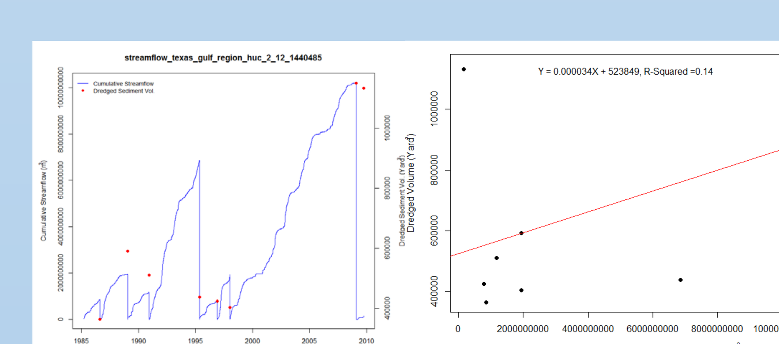
Texas coastal sites



For initial investigation of the link between cumulative streamflow and dredging volumes, we selected three study areas in Texas Gulf Coast Regions: Sabine and Port Arthur Harbor, the Houston, Galveston, and Texas City Harbor system, and Corpus Christi Harbor. We selected these test sites to represent a wide range of Texas coastal riverine systems, and to take advantage of available dredging records and calculated stream flow time series. Within these study areas, specific channels were chosen for analysis.

Results – Houston Ship Channel





Results – Summary of test sites

Study Area	Stream ID	Drainage Area, square km	Number of dredging events	R-squared value
Sabine Neches	1112455	25,931	11	0.42
	1115825	26,058	9	0.36
	1477515	26,064	15	0.00
	1477595	26,220	15	0.26
	1477713	26,204	12	0.48
	1477589	26,215	16	0.29
	1477725	26,201	11	0.55
	1481563	27,705	23	0.17
	24719331	53,730	12	0.02
Houston Ship Channel	1440485	1,192	8	0.14
	1440511	2,012	8	0.32
	1440521	2,578	6	0.10
	1440525	1,205	9	0.93
	1440539	1,578	10	0.33
Corpus Christi Harbor	1432855	15	2	NA - 2 events
	1636549	2	2	NA - 2 events
	3172512	43,334	4	0.00

The **average R squared value** for the examined **Houston Ship Channel** reaches is **0.36**, slightly higher than the average R-squared value for the **Sabine Neches** reaches, **0.28**. Stream reaches that **performed best** when comparing dredged volumes to cumulative flow were generally **upstream of bays and lakes**. This is likely due to **coastal effects** on sediment deposition, which are not addressed in the flow rates generated by the SPT.