Assessing sea-level rise and flooding changes in the Sacramento-San Joaquin Delta using historical water level records

Study Period:
2021-2024

Delta Science Program
DELTA STEWARDSHIP COUNCIL

About this Project

Record keeping may feel like a simple scientific activity, but stretched over a century, long term water level records transform into a treasure trove for researchers evaluating the incremental effects of climate and landscape changes on tides, river flow, and flood risk in the Delta.

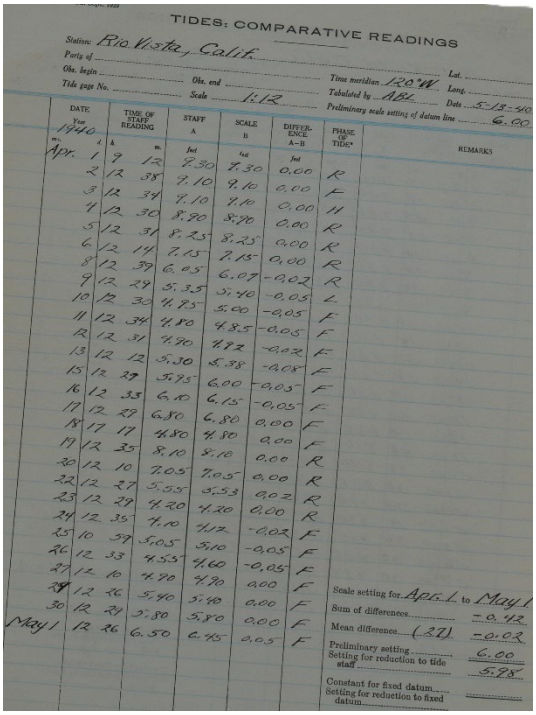
To evaluate how climate change and landscape changes have affected flooding and sea-level rise in the Delta, scientists from California Polytechnic State University (San Luis Obispo) and Portland State University digitized and analyzed over a century of 'lost and forgotten' water level changes from the Delta, stretching as far back as the 1800's. The newly recovered tidal records, obtained from California state archives and the US National Archives, contain valuable information about water level changes including historical tidal, flood, and sea-level trends. Talke's team hypothesized that water level trends are extremely variable, with some communities and wetlands much more exposed to the effects of land use, water management, and climate change than others. This may leave some regions with much less time to adapt to sea-level rise.

Lead Investigators

- Principle Investigator (PI): Stefan Talke, Cal-Poly San Luis Obispo
- Co-PI: David Jay, Portland State University

Project Objectives

- Recover, digitize, and quality assure more than 1,300 station years of water level records from the Delta, extending back to the 1800's
- Evaluate trends and spatial patterns of water level changes over the past century, including tides, subsidence, coastal sea-level rise, and the hydrodynamic effects of channel dredging, water management, and altered river flow
- Interpret how changing water levels affect tidal datums and flood hazards


TIDES: COMPARATIVE READINGS

Station: Rio Vista, Calif.

Party of

Obs. begin Obs. end

Tide gage No. Scale 1:12

Time meridian 120°W Lat.

Tabulated by ABL Long.

Preliminary scale setting of datum line 6.00

DATE Year 1940 Mo.	d	TIME OF STAFF READING h	m.	STAFF A feet	SCALE B feet	DIFFERENCE A–B feet	PHASE OF TIDE*	REMARKS
Apr.	1	7	12	7.30	7.30	0.00	R	
	2	12	38	7.10	7.10	0.00	F	
	3	12	34	7.10	7.10	0.00	H	
	4	12	30	8.90	8.90	0.00	R	
	5	12	31	8.25	8.25	0.00	R	
	6	12	14	7.15	7.15	0.00	R	
	8	12	39	6.05	6.07	-0.02	R	
	9	12	29	5.35	5.40	-0.05	L	
	10	12	30	4.95	5.00	-0.05	F	
	11	12	34	4.80	4.85	-0.05	F	
	12	12	31	4.70	4.72	-0.02	F	
	13	12	12	5.30	5.38	-0.08	F	
	15	12	29	5.95	6.00	-0.05	F	
	16	12	35	6.10	6.15	-0.05	F	
	17	12	29	6.80	6.80	0.00	F	
	18	17	17	4.80	4.80	0.00	F	
	19	12	25	8.10	8.10	0.00	R	
	20	12	10	7.05	7.05	0.00	R	
	22	12	27	5.55	5.53	0.02	R	
	23	12	29	4.20	4.20	0.00	R	
	24	12	35	4.10	4.12	-0.02	F	
	25	10	39	5.05	5.10	-0.05	F	
	26	12	33	4.55	4.60	-0.05	F	
	27	12	10	4.70	4.70	0.00	F	
	29	12	26	5.40	5.40	0.00	F	
	30	12	29	5.80	5.80	0.00	F	
May 1		12	26	6.50	6.45	0.05	F	

Scale setting for Apr. 1 to May 1

Sum of differences -0.42

Mean difference (-21) -0.02

Preliminary setting 6.00

Setting for reduction to tide staff 5.98

Constant for fixed datum

Setting for reduction to fixed datum

A Tabulation of High and Low Tides from April 1940 in Rio Vista, along the Sacramento River. Site is near the Helen Madere Memorial Bridge. Picture by S.A. Talke, US National Archives

Why this Research Matters

Flooding is an inherently local issue that communities experience viscerally. This project identified locations within the Delta that are more sensitive to flooding due to factors like climate change, subsidence, dredging, and water management. The results help California state and local agencies, local officials, engineers, and community groups improve planning for sea-level rise and climate change.

Management Application

Identifying flood-prone areas can help focus future scientific and management priorities, including protecting the environment, managing flood risk, and enhancing community resilience to climate change.

To support planning for flooding and sea-level rise, this research team assessed sea-level rise at 50 locations after accounting for the effects of wind, river flow, coastal variability, and water extractions. The improved estimates indicate that the largest rates of relative sea-level rise in the state occur in the Delta, exceeding the rate at San Francisco for 85% of Delta locations, due to vertical land movement including subsidence. Rise rates varied widely, from -2.8 mm to almost +13 mm per year. Using these rates, 'time scale' maps are being produced that show the time remaining until Delta communities may begin to experience the effects of climate change. The project will also result in publicly available digitized archival water level

records. These products are designed to provide managers with actionable tools to better allocate resources and address potential inequities. The open access publication is available here: https://www.nature.com/articles/s41598-023-49204-z.

Connections to the 2017-2021 Science Action Agenda

Invest in Assessing the Human Dimensions of Natural Resource Management

Capitalize on Existing Data through Increasing Science Synthesis

Improve understandings of Interactions between Stressors, Managed Species and Communities