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Data Article

Dataset of terrestrial fluxes of freshwater, nutrients, carbon, and iron to the Southern California bight, U.A.A.☆

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ABSTRACT

The Southern California Bight (SCB) is an upwelling-dominated, open embayment on the U.S. West Coast and receives discharges of anthropogenically-enhanced freshwater, nutrients, carbon, and other materials. These inputs include direct point sources discharged from wastewater treatment (WWT) plants via ocean outfalls and point, non-point, and natural sources discharged via coastal rivers. We assembled a daily time series over 1971–2017 of discharges from large WWT plants $\geq$ 50 million gallon per day (MGD) and 1997–2017 from small WWT plants and coastal rivers. Constituents include nitrogen, phosphorus, organic carbon, alkalinity, iron, and silica. Data from research studies, several government and non-government agency databases containing discharge monitoring reports, river flow gauges, and other collateral information were compiled to produce this dataset. Predictive models and expert analysis addressed unmonitored sources and data gaps. The time series of terrestrial discharge and fluxes are provided with location of coastal discharge point or tributary. The data are deposited in a repository found in Sutula et al. [1].

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Specifications Table

Subject	Pollution
Specific subject area	Coastal exports, terrestrial discharge, nutrients and carbon
Type of data	Figures Tables in Excel file
How data were acquired	Accessed databases of primary data sources, including hard copy and electronic.
Data format	Analyzed and filtered (Excel spreadsheet)
Parameters for data collection	Institutional knowledge and National Pollutant Discharge Elimination System Permits were used to identify the point sources discharging to rivers and the ocean in the Southern California Bight. Water quality sampling and gauge data were compiled for known Bight coastal rivers and streams at the scale of the National Hydrography Dataset Plus (NHD+) from multiple data sources, comprising of point, non-point, and natural sources. Predictive models were used to predict flow and water quality for unmonitored watersheds and/or missing data for specific constituents.
Description of data collection	Collaborated with organizations to collect identified point and non-point sources.
Data source location	Primary data sources: Southern California Coastal Water Research Project US Environmental Protection Agency Enforcement and Compliance History Online California Integrated Water Quality System Project California Environmental Data Exchange Network Santa Barbara Coastal Long Term Ecological Research US Geological Survey California Department of Water Resources California State Water Resources Control Board Los Angeles Department of Public Works Orange County Public Works Los Angeles City Sanitation Los Angeles County Sanitation District Orange County Sanitation District City of San Diego International Boundary & Water Commission Tetra Tech Two predictive models were used for rivers: Hydrologic Simulation Program FORTRAN (HSPF) [2] Rationale model (rainfall-runoff model) [3,4].
Data accessibility	Data can be downloaded from this repository: https://doi.org/10.5281/zenodo.4448224

Value of the Data

- This record consists of spatially and temporally explicit time series data of flow and constituent concentrations compiled for a period of over 20 years for 75 rivers, 23 coastal wastewater treatment plants, and 18 inland WWT plants discharging into the Southern California Bight (SCB). A portion of these data were not previously readily available to the public until now. Data gaps were addressed through expert analysis. Constituent fluxes include nitrogen (N), phosphorus (P), carbon (C), iron (Fe), silica (Si), and carbonate system parameters (alkalinity and pH).
- This dataset can support several disciplines related to coastal ecology and oceanography (coastal nitrogen and carbon cycling, phytoplankton ecology, harmful algal blooms, fisheries and food webs, coastal hypoxia, acidification, etc.), point and non-point source management, and marine policy.
- These data are useful for coastal nutrient and carbon export studies, trend analyses, source attribution, and modeling applications.
- These data from a densely populated and highly urbanized region can benefit predictive and global studies focused on nutrient, carbon, and freshwater export.

1. Data Description

This article presents a dataset of daily flow and constituent data for 75 rivers, 23 WWT plants discharging to ocean outfalls, and 18 WWT plants discharging to coastal rivers in the Southern

Table 1
Locations delineating the stretch of coast that encompasses each subregion in the 'natural_rivers.xlsx' file and in Sutula et al. [5].

Subegion	Latitude (°N) Start	Longitude (°E) Start	Latitude (°N) End	Longitude (°E) End
Santa Barbara	34.3433	−119.4218	34.4763	−120.4858
Ventura	34.0205	−118.7796	34.3433	−119.4218
Santa Monica	33.7618	−118.4228	34.0205	−118.7796
San Pedro	33.6664	−118.0175	33.7618	−118.4228
Orange County	33.1906	−117.3849	33.6664	−118.0175
North San Diego	32.8136	−117.2715	33.1906	−117.3849
South San Diego	32.5300	−117.1228	32.8136	−117.2715

California Bight (SCB).Riverine inputs that contain these point, non-source and natural sources are summarized as well. Constituent data include nitrogen (N), phosphorus (P), carbon (C), iron (Fe), silica (Si), and carbonate system parameters.

The repository contains five files, each for a type of flow: rivers, large publicly owned treatment works (POTW) defined as flows ≥ 50 million gallons per day or 2.19 m^3 s^{-1}, small POTWs with flows < 2.19 m^3 s^{-1}, inland POTWs discharging to watersheds, and river runoff.

Table 2 names all land-based sources discharging to the SCB, lists the location of discharge, and denotes the latitude and longitude of discharge to the ocean.

The spreadsheet 'rivers_1997_2017_daily.xlsx' contains the data from 1997 to 2017 for 75 rivers alphabetically. River constituents include daily discharge volume and seasonal mean concenrations of ammonium, nitrate+nitrite, phosphate, silicate, total N, total P, organic N, organic P, total organic C, total and dissolved Fe, alkalinity, and salinity. These data include point, non-point and natural sources combined.

File 'major_potw_1971_2017.xlsx' contains data from 1971 to 2017 for the four large POTWs in the SCB, Hyperion Treatment Plant (htp), Joint Water Pollution Control Plant (jwpcp), Orange County Sanitation District (ocsd), and Point Loma Wastewater Treatment Plant (plwtp). Constituents in this file are discharge volume, ammonium, nitrate, nitrite, phosphate, silicate, total N, total P, organic N, organic P, total organic C, total and dissolved Fe, alkalinity, salinity, dissolved oxygen, temperature, pH, and biological oxygen demand.

The file 'minor_potw_1997_2017.xlsx' contains data from 1997 to 2017 for the 19 small POTWs alphabetically. Constituents in this file are discharge volume, ammonium, nitrate, nitrite, phosphate, silicate, total N, total P, organic N, organic P, total organic C, total and dissolved Fe, alkalinity, salinity, dissolved oxygen, temperature, pH, and biological oxygen demand.

Fig. 1 shows the sum of volume fluxes, total N, and total P fluxes as time series for the period 1997–2017 from rivers, large POTWs, and small POTWs.

The 'inland_POTW.xlsx' file contains averaged data from the year 2009, unless otherwise noted, for the 18 inland POTWs. The region and city are given for each plant. The discharge volume, total N, total P, dissolved inorganic N, and dissolved inorganic P are listed for each plant.

The 'natural_rivers.xlsx' file contains summarized annually averaged input of natural riverine sources for each subregion of the SCB. The latitude and longitude locations of division between subregions are shown in Fig. 1 of Sutula et al. [5] and described explicitly here in Table 1. The approximate watershed area of each region is given and constituents in this file are total N, total P, dissolved inorganic N, and dissolved inorganic P.

2. Experimental Design, Materials and Methods

Data were collected over several months from primary data sources that include government agencies, private organizations, and online database tools. The list of sources contacted and from which data were compiled include: Southern California Coastal Water Research Project (SCCWRP), U.S. Environmental Protection Agency Enforcement and Compliance History Online

Table 2
Names of all discharge sources and locations. Latitude and longitude denote the point of discharge to the ocean.

Discharge Name	Discharge Point	Latitude (°N)	Longitude (°E)
	Rivers		
Agua Hedionda Lagoon	Coast	33.1377	−117.3550
Aliso Creek	Coast	33.2614	−117.4510
Arroyo Burro Creek	Coast	34.4019	−119.7431
Arroyo Honda Creek	Coast	34.4665	−120.1415
Arroyo Sequit Creek	Coast	34.0394	−118.9380
Arroyo Trabuco Creek	Coast	33.4560	−117.6844
Atascadero Creek	Coast	34.4105	−119.8300
Ballona Creek	Coast	33.9561	−118.4570
Bell Canyon	Coast	34.4264	−119.9153
Bolsa Chica Westminster Channel	Anaheim Bay	33.7286	−118.0950
Bonita Creek	Newport Bay	33.5868	−117.8840
Buena Vista Creek	Buena Vista Lagoon	33.1599	−117.3670
Calleguas Creek	Coast	34.0986	−119.0990
Canada De La Gaviota	Coast	34.4673	−120.2269
Carbon Canyon	Coast	34.0278	−118.6550
Carpinteria Creek	Coast	34.3849	−119.5310
Chollas Creek	Coast	32.6596	−117.2470
Costa Mesa Channel	Newport Bay	33.5868	−117.8840
Coyote Creek	Tributary to San Gabriel River	33.7358	−118.1280
Cristianitos Creek	Tributary to San Mateo Creek	33.3770	−117.5990
Devereux Lagoon	Devereux Lagoon	34.4090	−119.8900
Dominguez Channel	Coast	33.7085	−118.2474
E Garden Grove Wintersburg Channel	Bolsa Bay	33.6767	−118.0410
Encinas Creek	Coast	33.0818	−117.3200
Escondido Creek	Coast	33.0100	−117.2920
Franklin Creek	Coast	34.3914	−119.5358
Goleta Tecolotito Creek	Coast	34.4105	−119.8300
Laguna Canyon	Coast	33.5331	−117.7900
Las Flores Canyon	Coast	34.0270	−118.6420
Las Flores Creek	Coast	33.2843	−117.4760
Little Sycamore	Coast	34.0468	−118.9710
Los Angeles Harbor	Harbor	33.7350	−118.2130
Los Angeles River	Coast	33.7408	−118.2190
Los Penasquitos Lagoon	Los Penasquitos Lagoon	32.9221	−117.2710
Malibu Creek	Creek	34.0294	−118.6820
Marle Canyon	Creek	34.0209	−118.7220
Mission Bay	Mission Bay	32.7529	−117.2610
Mission Creek	Coast	34.4126	−119.6864
Montecito Creek	Coast	34.4089	−119.6420
Moro Canyon	Coast	33.5567	−117.8280
Otay River	Mission Bay	32.6596	−117.2470
Pena Canyon	Coast	34.0305	−118.6090
Prima Deshecha Canada	Coast	33.4279	−117.6410
Redondo Beach King Harbor	Harbor	33.8379	−118.3950
Refugio Creek	Coast	34.4657	−120.0693
Revolon Slough	Coast	34.0986	−119.0990
Rincon Creek	Coast	34.3705	−119.4790
Salt Creek	Coast	33.4757	−117.7290
San Diego Creek	Newport Bay	33.5868	−117.8840
San Diego River	Coast	32.7529	−117.2610
San Dieguito River	Coast	32.9661	−117.2820
San Gabriel River	Coast	33.7358	−118.1280
San Jose Creek	Tributary to San Gabriel River	34.4105	−119.8300
San Juan Creek	Coast	33.4521	−117.6920
San Luis Rey River	Coast	33.1993	−117.3970
San Marcos Creek	Batiquitos Lagoon	33.0818	−117.3200
San Mateo Creek	Coast	33.3770	−117.5990
San Onofre Creek	Coast	33.3713	−117.5930
San Pedro Creek	Coast	34.4105	−119.8300

(*continued on next page*)

Table 2 (*continued*)

Discharge Name	Discharge Point	Latitude (°N)	Longitude (°E)
Santa Ana Delhi Channel	Newport Bay	33.5868	−117.8840
Santa Ana River	Coast	33.6292	−117.9660
Santa Clara River	Coast	34.2196	−119.2740
Santa Margarita River	Coast	33.2221	−117.4210
Santa Monica Canyon	Coast	34.015	−118.5310
Segunda Deshecha	Coast	33.4279	−117.6410
Solstice Canyon	Coast	34.0182	−118.7680
Sweetwater River	Mission Bay	32.6596	−117.2470
Tecolote Creek	Mission Bay	32.7529	−117.2610
Tijuana River	Coast	32.5464	−117.1360
Topanga Creek	Coast	34.0297	−118.5960
Trancas Canyon	Coast	34.0229	−118.8470
Tuna Canyon	Coast	34.0297	−118.5960
Ventura River	Coast	34.2717	−119.3150
Walnut Canyon	Coast	33.9987	−118.8100
Zuma Canyon Lagoon	Coast	34.0054	−118.8290
Large POTW			
Hyperion Treatment Plant	Ocean	33.9120	−118.5214
Joint Water Pollution Control Plant	Ocean	33.6892	−118.3167
Orange county Sanitation District	Ocean	33.5767	−118.0100
Point Loma Wastewater Treatment Plant	Ocean	32.6653	−117.3236
Small POTW			
Aliso Creek Ocean Outfall	Ocean	33.5453	−117.8150
Avalon Wastewater Treatment Facility	Ocean	33.3049	−118.3630
Southern Regional Tertiary Treatment Plant	Ocean	33.1611	−117.3930
Carpinteria Sanitary District Wastewater Treatment Plant	Ocean	34.3849	−119.5310
El Estero Wastewater Treatment Facility	Ocean	34.3888	−119.6710
Encina Ocean Outfall	Ocean	33.1103	−117.3510
Fallbrook Wastewater Treatment Plant	Ocean	33.1611	−117.3930
Goleta Sanitary District	Ocean	34.4017	−119.8241
Hale Ave. Resource Recovery	Ocean	33.0048	−117.2990
Montecito Sanitary District Wastewater Treatment Facility	Ocean	34.4098	−119.6560
Oceanside Ocean Outfall	Ocean	33.1611	−117.3930
Oxnard Wastewater Treatment Plant	Ocean	34.1262	−119.1890
San Clemente Island Wastewater Treatment Plant	Ocean	33.0102	−118.5480
San Elijo Water Reclamation Ocean Outfall	Ocean	33.0048	−117.2990
San Juan Creek Outfall	Ocean	33.4362	−117.6990
South Bay International Wastewater Treatment Plant	Ocean	32.5373	−117.1880
South Bay Water Reclamation Plant	Ocean	32.5373	−117.1880
Summerland Sanitary District	Ocean	34.4122	−119.6090
Terminal Island Water Reclamation	Ocean	33.7154	−118.2540
Inland POTW			
Burbank Water Reclamation Plant	Los Angeles River	33.7408	−118.2190
Camarillo Valley Wastewater Treatment Plant	Calleguas Creek	34.0986	−119.0990
Glendale Water Reclamation Plant	Los Angeles River	33.7408	−118.2190
Hill Canyon Wastewater Treatment Plant	Calleguas Creek	34.0986	−119.0990
Los Angeles County Sanitation District	San Gabriel River	33.7358	−118.1280
Long Beach Wastewater Reclamation Plant	San Gabriel River	33.7358	−118.1280
Los Coyotes Water Reclamation Plant	San Gabriel River	33.7358	−118.1280
Michaelson Treatment Plant	San Diego Creek	33.5868	−117.8840
Ojai Valley Wastewater Treatment Plant	Ventura River	34.2717	−119.3150
Padre Dam Wastewater Reclamation Facility	San Diego River	32.7529	−117.2610
San Jose Water Reclamation Plant	San Gabriel River	33.7358	−118.1280
Saugus Water Treatment Plant	Santa Clara River	34.2196	−119.2740
Simi Valley County Sanitation	Calleguas Creek	34.0986	−119.0990
Tapia Wastewater Treatment Plant	Malibu Creek	34.0294	−118.6820
Tillman Treatment Plant	Los Angeles River	33.7408	−118.2190
Valencia Wastewater Reclamation Plant	San Gabriel River	33.7358	−118.1280
Ventura Wastewater Reclamation Plant	Santa Clara River	34.2196	−119.2740
Whittier Narrows Water Reclamation Plant	San Gabriel River	33.7358	−118.1280

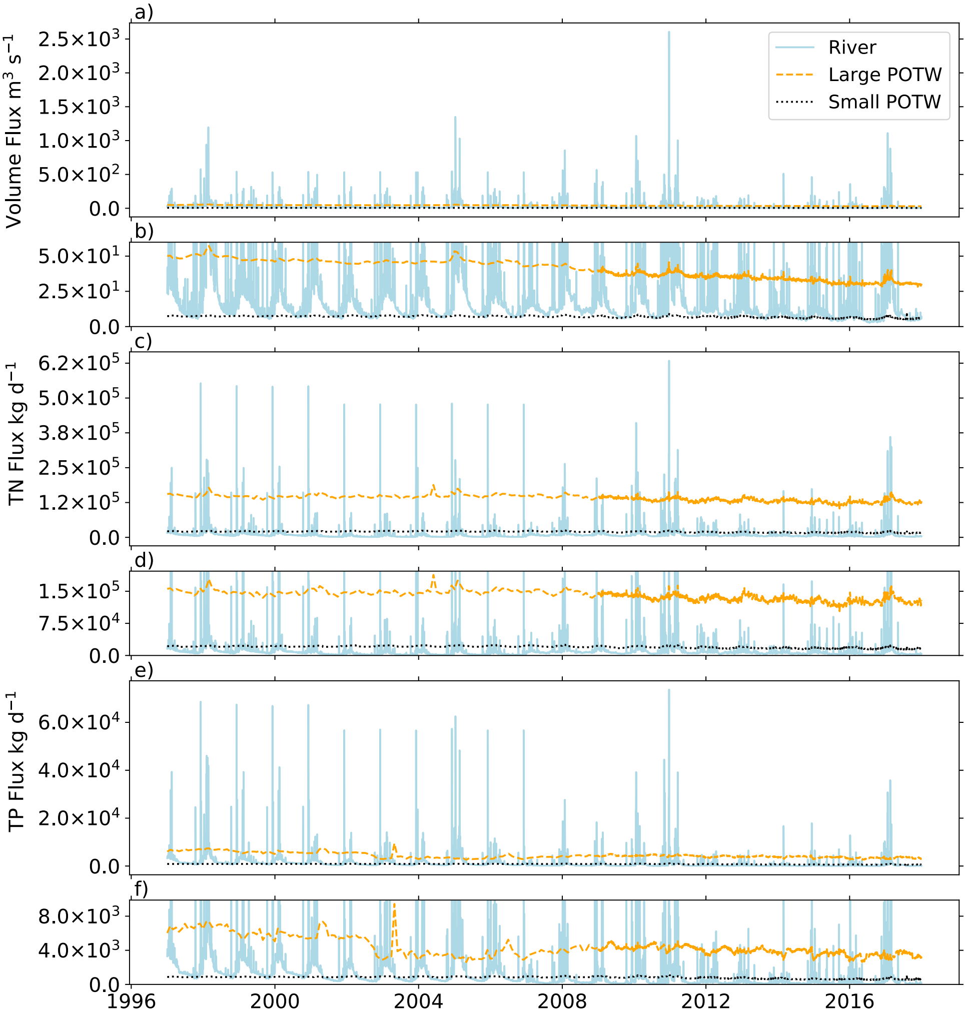

Fig. 1. Time series of each flow type of volume flux, total N, and total P fluxes summed for 1997–2017. b), d), and f) are zoomed in version of a), c), and e) to show the magnitudes of each flow type. Data plotted here come from files 'rivers_1997_2017_daily.xlsx', 'major_potw_1971_2017.xlsx', and 'minor_potw_1997_2017.xlsx'.

(EPA ECHO), California Integrated Water Quality System Project (CIWQS), California Environmental Data Exchange Network (CEDEN), Santa Barbara Coastal Long-Term Ecological Research (SBC LTER [6]), U.S. Geological Survey (USGS), California Department of Water Resources (DWR), California State Water Resources Control Board, Los Angeles Department of Public Works (LADPW), Orange County Public Works (OCPW), Los Angeles City Sanitation (LASAN), Los Angeles County Sanitation District (LACSD), Orange County Sanitation District (OC San), City of San Diego, International Boundary & Water Commission (IBWC) and Tetra Tech.

Data for the time period of 1997–2017 were prioritized. Often, data for the large and small POTWs were reported at a monthly or quarterly basis and were extrapolated to daily values. Data gaps in constituent concentrations were addressed through expert analyses. These analyses included interpolation between data points, extrapolation from historical sampling, and/or using ratios of related constituents to calculate other constituents (e.g., biological oxygen demand is related to total organic carbon).

Large POTW data extend over the time period of 1971–2017. Data were collected through online electronic databases (i.e. EPA ECHO, CIWQS after 2007) and by direct request from the respective sanitary districts (before 2007).

River flow data were largely collected from gauge data from the organizations SCCWRP, USGS, CEDEN, DWR, LADPW, and OCPW. Where flow data were missing, a rainfall-runoff model was used, which is originally described in Ackerman and Schiff [3] and employed to quantify nutrient and carbon loading in Sengupta et al. [4]. River alkalinity and silicate were derived based on an empirical statistical model based on geology, soils and other natural gradients per the methodology of Olson and Hawkins [7] (see also supplemental information in Sutula et al. [5]). Santa Margarita River watershed discharge and constituents were modeled based from a Hydrologic Simulation Program-FORTRAN (HSPF) model of that watershed [2].

Three-quarters of the Tijuana River watershed lies in Mexico. Dry weather and low-volume wet weather flow from the Tijuana River, which include in-stream discharges from Mexican primary wastewater treatment plants, are diverted at the U.S.-Mexican border and sent for treatment at the South Bay International Treatment Plant and other wastewater facilities in Mexico. Occasionally, sewage spills and large storm events cause “transboundary” discharges that flow freely (undiverted) to the Tijuana River and the U.S. coastal waters. Tijuana River flow and constituent data were derived from the IBWC Tijuana River gauge at the international border and their 2018–2019 water quality report, respectively [8]. IBWC-reported transboundary flows were incorporated into the flow data as well.

Riverine constituent concentration data were derived from SCCWRP research study data, SBC LTER [6], and CEDEN unless otherwise noted. Instantaneous constituent concentration values from these datasets were aggregated into four periods: 1) winter storm, 2) summer storm, 3) winter dry weather (base flow) and 4) summer dry weather. “Summer” is defined as May through October, while “winter” is designated as November though April. For each river, wet weather storm flows were designated by taking the median of all flows during the months of November to April (Southern California wet/winter season). Flows greater than twice this wet weather median were considered storm events and were assigned summer storm or winter storm concentrations based on which month the flow occurred. Wet weather concentrations were assigned to these storm days plus each of the three days following a wet weather event, which is defined by SCB stormwater managers as the typical time to return to base flow conditions. All remaining days were designated as dry weather base flow and assigned their respective seasonal concentrations.

Ethics Statement

Not applicable.

CRediT Author Statement

Martha Sutula: Conceptualization, Methodology, Funding acquisition, Project administration, Visualization, Writing - original draft; **Minna Ho:** Conceptualization, Methodology, Data curation, Validation, Visualization, Writing - original draft; **Ashmita Sengupta:** Conceptualization, Methodology, Data curation, Writing - original draft; **Fayçal Kessouri:** Funding acquisition, Project administration; **Karen McLaughlin:** Data curation, Writing - review & editing; **Kenny McCune:** Data curation, Methodology **Daniele Bianchi:** Validation, Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships which have, or could be perceived to have, influenced the work reported in this article.

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