

Tijuana River Contamination from Urban Runoff and Sewage: A Public Health Crisis at the Border

Lead Authors: Paula E. Stigler Granados, PhD, MS^{1*}, Karilyn E. Sant, PhD, MPH², Penelope J.E. Quintana, PhD, MPH², Eunha Hoh, PhD, MS²
Contributing Authors: Eyal Oren, PhD, MS^{3,5}, Nicolas Lopez-Galvez, PhD, MPH², Miguel Angel Zavala Perez, PhD, MS^{2,4}, Yu NI, PhD, MPH⁵

¹Division Head, Environmental Health, School of Public Health (SPH), San Diego State University (SDSU), ² Division of Environmental Health, SPH SDSU, ³ Director, SPH SDSU, ⁴Division Environmental Health, Imperial Valley Campus SDSU, ⁵Division of Epidemiology, SPH SDSU

*Corresponding Author: pstiglergranados@sdsu.edu

Date of Release: February 13, 2024

Introduction

The Tijuana River flows north from Tijuana into the Tijuana River and Estuary (TJRE) in the US, emptying into the Pacific Ocean at Imperial Beach, CA (Figure 1). The TJRE is severely contaminated by untreated sewage, industrial waste, and urban run-off due to inadequate infrastructure and urbanization and the watershed is classified as an impaired water body according to the U.S. Clean Water Act.¹⁻⁷ This contamination is a persistent environmental and **public health threat** with major economic, legal, social, and **health implications** for the nearby California communities such as San Ysidro and Imperial Beach, who have long been concerned about this devastating problem. Threats to public health include known concerns posed by any exposure to untreated sewage in the U.S., but of special concern and specific to this watershed are the unusual threats to health from pollutants arising in Mexico, including human and livestock diseases eradicated in California, pathogens carrying antibiotic-resistant genes, and industrial and municipal chemicals not permitted to be discharged into the environment in California, among others. Heavy rainfall events, including the recent Hurricane Hilary, have caused further damage to the aging infrastructure and continue to overwhelm the systems on both sides of the border, exacerbating concerns.⁸ Extreme events related to climate change are only anticipated to become more frequent and intense, increasing the urgency for a solution to this crisis.⁹⁻¹¹ Contaminated water is flowing into the ocean year-round, and, especially after rain events, has forced beach closures in the region for several years (Figure 2)^{12,13}; however, this problem does not just adversely affect beachgoers and surfers exposed to contaminated seawater. Exposures impact the health of people who live and work nearby like children, seniors, lifeguards, military personnel, border patrol officers and other at-risk populations.¹⁴ Current regulation and monitoring measures are inadequate in relation to known contaminants yet the potential health risks to surrounding communities from **harmful viruses, bacteria and parasites as well as toxic chemicals in water and air**, presenting a pressing **public health crisis**.¹⁵⁻¹⁸

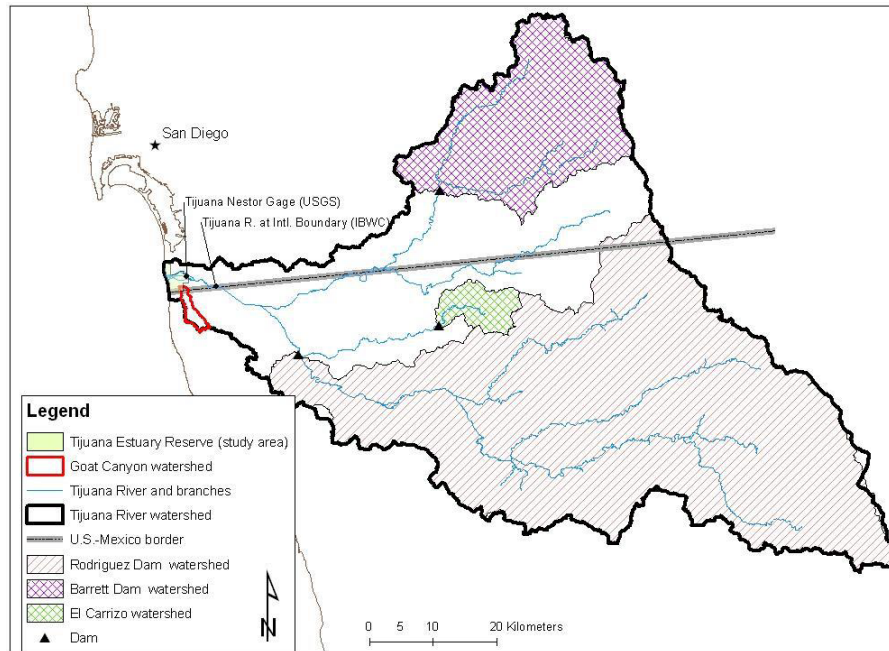


Figure1. Map of the Tijuana River Watershed, from Biggs, et.al. ¹⁹

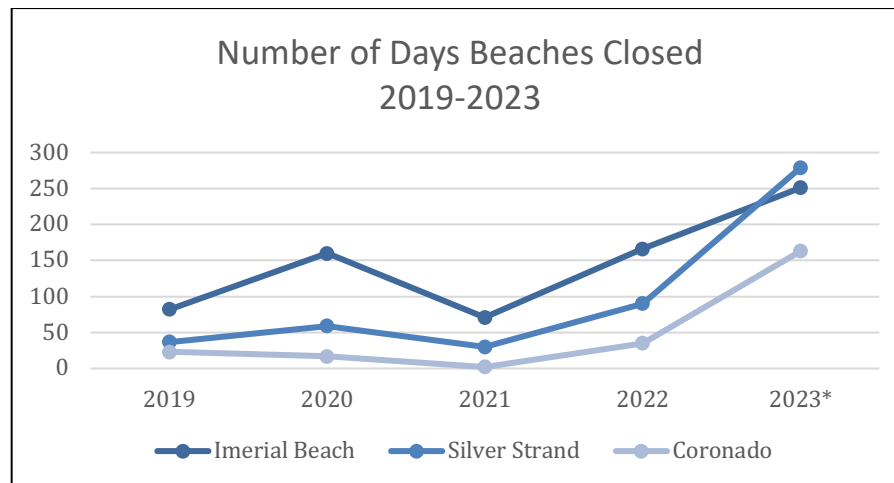


Figure 2. Beach closures due to contamination, 2019-2023, *data as of October 20, 2023 from San Diego County Department of Environmental Health and Quality

What's in the soil, water, and the air?

Water Contamination

Multiple studies over the last decade done by our team at SDSU and other regional experts have shown the presence of **serious pathogens** such as viruses and bacteria, including SARS-CoV-2 and Hepatitis in the water sampled from the TJRE.^{2,5,13,20-25} These pathogens pose a serious health risk to both humans and aquatic species.²⁶⁻²⁹ One recent example of an emerging zoonotic pathogen of concern impacting our local

aquatic system was documented in bottle nosed dolphins found stranded in San Diego. The animals were found to have died from sepsis caused by a bacterium called *Erysipelothrix rhusiopathiae*, which is generally transmitted through contact with feces or urine in contaminated water, food or soil.²⁷ The authors of the study also noted an increase in the number of stranded dolphins in the region, indicating that changes in their environment or exposures to contaminated water could be causing illness and subsequent death. These dolphins serve as sentinels for the risk of possible human exposures to dangerous bacteria such as *E. rhusiopathiae* by both recreational water users and through occupational health exposures.³⁰

Research into the extent of **chemical contamination** has been sporadic, however studies by local government agencies have reported high levels of metals, pesticides, herbicides, volatile organic carbons (VOCs), and semi-volatile organic compounds (SVOCs).^{13,20,31} Additionally, researchers have found highly concentrated toxicants such as acetone, methanol, xylene, plasticizers, hormones, and flame retardants.^{32,33} Another recent study by SDSU experts identified 392 organic chemical contaminants in the border water by applying a novel analytical approach, mass spectrometry based nontargeted analysis. Out of the 392 identified compounds, 224 appeared on a regulatory list, and 175 appeared in the U.S. Environmental Protection Agencies Toxic Substance Control Act. A substantial number of **contaminants of emerging concern** were detected in the water for the first time.³

Another developing threat recently found through the application of metagenomic analysis by SDSU researchers is the significantly elevated levels of microbes carrying antibiotic-resistant genes (ARG), including beta-lactamases (resistant to antibiotics including penicillin), and resistant strains of *E. coli* and *Legionella*, which are of considerable public health concern.^{23,34} This study also revealed the presence of microbial species that are not routinely monitored but are potential pathogens such as *Acrobacter cryaerophilus*, which can cause severe gastrointestinal illness, and was the most common species of bacteria found.³⁴⁻³⁷ Other pathogens that can cause significant illness were identified and included bacteria such as *Salmonella enterica*, *Vibrio parahaemolyticus*, *Streptococcus pneumoniae*, *Mycobacterium tuberculosis* and *Listeria monocytogenes*, parasites like *Trichomonas vaginalis*, and viruses such as HIV-1, Hepatitis B and C.²³ These findings indicate the **potential for community exposure to harmful pathogens including antibiotic resistant varieties** due to cross-border sewage contamination and illustrate the need for increased surveillance of a broader range of contaminants.

Air Contamination

Air contamination originating from nearby impaired water bodies and contaminated ocean water is a concern and is a pathway of exposure that has hardly been studied.^{15,16,38-41} A recent study examining air over the coastal waters near TJRE

documented airborne microbes and chemicals related to the sewage and runoff over the ocean.¹⁵ However, no studies have been conducted inside communities where people live, work and play. Contaminated air from the nearby Tijuana River outflows can possibly diffuse across the community of San Ysidro and Imperial Beach and enter homes, childcare centers, schools, and potentially **increase the health risks of local community members without any direct water contact**. Community concerns about strong odors and pollution within San Ysidro from the Tijuana River have been frequently reported.^{42,43} Air mass transport patterns that can potentially transfer pollutants to border communities are not well characterized. While long-range transport of persistent chemicals transferring from water to air has a strong theoretical basis^{18,44-46}, and is a well-known cause of global chemical contamination, pollution transfer to air basins inside communities next to or near impaired water bodies has not been thoroughly explored and poses a potentially serious health threat to already at-risk communities.^{40,47-49} This is an area of urgent need for increased monitoring and surveillance.

Soil Contamination

Analysis conducted on soil sediments in and around the Tijuana River and Estuary by the authors and others have detected over 170 organic chemicals and inorganic elements including toxic polycyclic aromatic hydrocarbons (PAHs), banned pesticides such as chlordane and DDT, polychlorinated biphenyls (PCBs), heavy metals, and phthalates.^{4,49-53} Many of the detected contaminants are a direct result of the transboundary sewage flows and are known to be **persistent, bio-accumulative, carcinogenic, toxic** and can be **resuspended in water and air** during weather events in both the wet and dry seasons, exposing nearby communities.^{4,53} San SDSU experts found significant levels of harmful chemical contaminants in the soil from Los Laureles-Goat Canyon, a sub watershed located within the Tijuana River Watershed. Arsenic and cadmium concentrations were higher than the EPA recommended levels (0.07 ppm for arsenic and 1.7 ppm for cadmium) in soil samples taken from Los Laureles Canyon and TJRE (Figure 3).⁵⁴ Bisphenol A (BPA) and triclosan were also high and comparable to concentrations found in sewage sludge and soils amended with sewage sludge.⁵⁴ The results of this study indicate that the heavy metals and organic contaminants in the soil are not just coming from solid waste disposal sources but are also from wastewater flows and pose a health risk to residents in the area. Exposure to these contaminants may come from ingestion, respiration or/and dermal contact and are known to have significant harmful effects on humans and wildlife.⁵⁵⁻⁵⁸

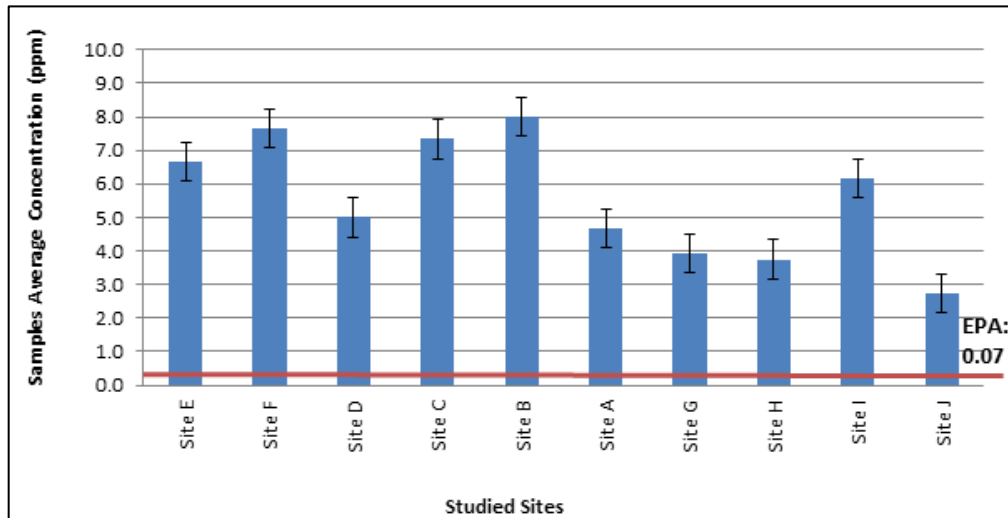


Figure 3. Average concentrations of arsenic found at study sites in Los Laureles Canyon and TJRE, A-F are sites in Mexico and G-J are sites in the U.S., n=22⁵⁴

Exposures Pathways and Risks

Dangerous pathogens and chemicals in contaminated waters pose a spectrum of short and long-term health risks, spanning gastrointestinal illnesses to neurological disorders.^{26,59} Sewage and runoff are reservoirs for diverse and prevalent pathogenic bacteria (including antibiotic resistant), viruses, harmful chemicals, and pollutants that can cause both acute and long-term health consequences, especially when being chronically exposed.^{34,60} Contaminated soils from years of transborder flows of polluted waters are laden with dangerous and toxic legacy chemicals, and when they enter the waterways or become airborne during dry weather seasons, they present major health concerns for residents and workers. Exposure pathways include contact/touching, leading to ingestion, either through contaminated soil, water or house dust, and this pathway may be especially significant for infants and toddlers. Inhalation is also a pathway of exposure, as these dangerous contaminants can also be airborne.^{15,40,61} Contaminated aerosols can be transported over land and deposited through various mechanisms, exposing residents and workers by inhalation.⁶¹



Figure 4. Photos taken of the TJRE during sampling events by SDSU researchers, courtesy of Dr. Kari Sant

Public Health Significance

Community concerns and the documented presence in the Tijuana River and Estuary of toxic chemicals and human and animal pathogens, especially antibiotic resistant pathogens, demands urgent attention. Monitoring for a wide suite of chemicals and microbes in water and air is necessary to characterize the risks and geographic extent of the contamination to our region. In addition, special populations within this area may be at heightened risk, including workers such as lifeguards, other outdoor workers and border patrol agents, pregnant women, with their increased risk from exposure to chemical and microbial pollutants, and children, who are both highly susceptible and at increased risk of exposures due to hand-to-mouth behaviors. The possibility for a **heightened incidence of illnesses** linked to the influx and constant exposure to wastewater into California communities along the U.S.-Mexico border should be investigated. New analytical tools (e.g. non-targeted analysis of chemicals and microbial genomes) that allow characterization of a wide range of chemical and microbial pollutants much beyond the contaminants currently measured should be used to help paint a better picture of the magnitude of the problem. Especially, **poorly understood pathways of exposure should be carefully and explicitly studied**, such as

exposures through breathing community air and through particulate matter and dust deposited on

surfaces touched by children. The potential for acute infectious diseases as well as long-term health impacts in both humans and animals necessitates comprehensive monitoring and more research. Health data collection for environmental epidemiology, a robust monitoring program assessing chemicals and pathogens correlated to toxicity and a broad suite of microbial risks should be considered. A multidisciplinary approach such as this is critical for understanding the current ecological and human health risks prevalent in the region and to determine best solutions for reducing the flow of sewage and improving public health.

Environmental Justice

The U.S. border communities of San Ysidro and Imperial Beach are located directly adjacent to the border and are both within the boundaries of the Tijuana River Watershed. Both cities are characterized as having a majority of residents who are resource limited and economically marginalized with an overall elevated risk of chronic diseases compared to surrounding cities in San Diego county.⁶² Increased exposure to soil, air and waterborne contaminants from the pollution in the region could be one potential factor for the increased risk of disease. Also, despite being on the coast, both cities are designated as being “park poor”.⁶³ By definition this means that there is less than three acres of green space per 1,000 residents, and there is inequitable access to these green spaces and their quality is subpar.⁶⁴ A qualitative study looking at community perceptions of their environment and the sewage contamination issues demonstrated that the majority of youth living in or near Imperial Beach are “disgusted” with the environmental issues and feel the beaches and water are unsafe.⁶⁵ This environmental injustice has created both real and perceived barriers for these communities to access outdoor spaces and healthy environments. These current environmental health challenges faced in the region may have lasting effects that will be difficult to mitigate if urgent action is not taken.

Next Steps

To better understand the human and environmental risks both short term and long term imposed by this public health crisis and environmental disaster, activities focused on **monitoring of environmental contaminants** and **investigating nearby community exposures and health effects** are urgently needed, especially exposures to at-risk individuals. Collaborations among healthcare professionals, public health departments, researchers, local organizations, and government agencies are necessary to ensure adequate data access and collection to provide evidence-based solutions and allocate appropriate resources. Investments by Congress and federal and state agencies are desperately needed to not only slow and prevent the ongoing and egregious contamination but to also assess the health and environmental harm that has occurred

as a result. Strategic planning amongst partners in both Mexico and the U.S. to prioritize infrastructure investments and find a reliable funding stream to implement improvements is of utmost urgency and should be prioritized to prevent further harm to the residents, visitors, workers and wildlife in our region.⁶⁶

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