



Pipeline Logic and Culpability: Establishing a Continuum of Harm for Sacrifice Zones

Ned Randolph*

Tulane University, Baton Rouge, LA, United States

This article builds on the concept of Energy Sacrifice Zones, which has been used as a heuristic for areas negatively impacted by environmental degradation and/or pollution that harms nearby residents for broader economic gains elsewhere. Environmental justice scholars have since the 1980s identified urban “fence-line” communities as Sacrifice Zones, such as those along the industrialized Mississippi River corridor downstream of Baton Rouge, La., where public health and property values are impacted by plant emissions. More recent scholarship has identified analogous dispossession in coastal Louisiana, where indigenous and communities of color suffer environmental degradation and land loss from oil industry practices. Coastal oil and gas operations have left behind thousands of miles of pipelines, canals and subsiding oil fields that have accelerated marsh desiccation and land loss. This article argues that both inland and coastal areas of Louisiana are being sacrificed by the fossil fuel industry on a *continuum of harm* along pipelines from wellheads to inland plants. Oil wells, refineries, and petrochemical plants exist as nodes along a single line of production and manufactured demand for petroleum-based products, which also litter waterways and oceans. Such a continuum establishes a single Sacrifice Zone that conjoins multiple sites. Harmed communities need not be adjacent to one another to be considered logically contiguous and, therefore, subject to consideration of collective harm as long as they are linked by the material infrastructure that connects fossil fuel extraction, production and distribution. This zone of harm, once established, could be used to inform decision makers with more accurate and complex pictures of social and public health costs of industrial emissions and practices, particularly when considering proposals for plant expansions or new facilities. They may also be used to determine legal culpability in restitution claims by communities bearing the burden of the carbon economy.

Keywords: extraction, environmental justice (EJ), fossil fuels and carbon emissions, sacrifice zones, social justice

INTRODUCTION: ECOLOGIES OF POWER

Due to the seminal work by environmental justice advocates Robert Bullard and Beverly Wright, the concept of the Sacrifice Zone has gained currency as a framing device for industrial sites situated in poor, often minority neighborhoods (1986). One of the most important indicators of an individual’s health is one’s ZIP code. Residents in areas that become Sacrifice Zones are disproportionately burdened with toxic chemical releases, presumably so that other Americans can benefit from low-cost goods produced by these plants. It is the intent of this article to extend the concept of Sacrifice

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Brazil
Nathan Jessee,
Tulane University, United States

***Correspondence:**

Ned Randolph
tnedrandolph@gmail.com

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Zones geographically to connect non-contiguous areas that are impacted by a linked system of fossil fuel extraction and secondary industrial consumption. The article uses as a case study the south Louisiana region, which consists of a densely-clustered industrial river corridor, thousands of miles of pipeline infrastructure through coastal marshes, and intense land loss.

The article will demonstrate that disparate locations both offshore and inland are entrapped by a single system of fossil fuel extraction and production, and therefore, should be coupled together when designating areas as Sacrifice Zones. Such a framing device based on *pipeline culpability* may be used in a number of ways to articulate and quantify the collective harm done to communities who live in the destructive shadow of the fossil fuel industry. Coastal and inland fence-line communities may find mutual social and political solidarity to rebuff industry expansions and practices, which in the aggregate can be demonstrated to be more costly than representations by industry advocates about economic benefits and job opportunities that such facilities supposedly offer lower income communities. As global warming depresses the industry's image and bolsters more sustainable energy alternatives, the oil and gas industry is reportedly looking to shore up product demand through downstream, value-added production in petrochemicals (CIEL 2017). This directly affects Louisiana, where at least seven new petrochemical facilities and expansions have been approved here since 2015. Five more major projects are awaiting approval from the Louisiana Department of Environmental Quality, which has a reputation for rubber stamping industry actions (Together BR 2018).

The oil and gas and petrochemical industries have powerful actors in their corner to protect their interests. They are often awarded long term industrial tax breaks that starve local communities of important revenue sources for public services while forcing them to bear the burden of plant emissions (Staff Editorial, 2018, Staff Editorial, 2019, Staff Editorial, 2020; Together Baton Rouge 2018). Legislative bills are regularly introduced to shield industry operators from regulatory oversight and culpability. And the state's Department of Environmental Quality, charged with regulating one of the busiest clusters of industrial activity in the world, is perennially underfunded and reliant on 1990s technology, anarchic methodology and self-reporting by the plant operators themselves (Jacobs 2021). This leaves practical oversight to community members who document noxious smells and toxic releases through EPA-approved "grab air" bucket kits distributed by nonprofits, such as the Louisiana Bucket Brigade. Coastal communities, meanwhile, face their own industry threats from the labyrinth of aging pipeline infrastructure that crisscrosses coastal marshes and leads to massive land erosion and dispossession (Maldonado, 2018; Randolph 2018; Day et al., 2020).

But a renewed sense of energy has taken hold among impacted residents who are publicly and forcefully protesting plans by companies with powerful backers to build or expand operations that are supported by the state legislature, governor and local newspapers (Staff Editorial,

2019). A framework of pipeline culpability may offer a tool for impacted communities to rebuff such moves. Allied together, they may further impress upon policy makers the aggregate harm caused by the industry's ecology of production. Both coastal and inland fence-line communities are ensnared by a fossil fuel industry that is highly supported and subsidized by tax-abatements, zoning ordinances, and industry-friendly laws—to say nothing of the massive federal subsidy in the form of flood control.¹ Both coastal and inland fence line communities also happen to be predominantly African American, Latinx, Indigenous and low-income White communities with little access to financial and political resources. They instead live in areas that are sacrificed, as if nodes on a single Energy Sacrifice Zone continuum.

While this framework may seem abstract, conceptual frameworks are critical for activating public interest and scrutiny about an industry that benefits from concealment in many ways. Impacted communities must use every available conceptual tool to illustrate what industry insiders do not always want to reveal. The U.S. pipeline system includes 207,000 miles of mainly subterranean interstate and intrastate pipelines that carry crude, natural gas and petroleum products beneath the ground of 300 million American consumers. Another 300,000 miles of transmission pipelines transport natural gas over long distances from wellhead to storage and onto plants (AFPM 2018). Their enclosed delivery conceals them from public consciousness. Sometimes we experience them as part of a kind of esthetic of technical sublime. Petrochemical companies light up the nighttime Mississippi River corridor like futuristic lunar colonies. The writer John McPhee once noted that Louisiana's industrial plants on the Mississippi "made the river glow like a worm" (McPhee 1987).

Meanwhile, the enclosed capture and distribution of liquid hydrocarbons precludes opportunities for democratic action by workers and affected residents, according to scholar Timothy Mitchell. Their networks of production are less visible than earlier forms of labor-intensive energy extraction such as coal mining. Instead of manual production and railway transportation that historically enabled chokepoints for labor solidarity actions by striking coal miners, liquid hydrocarbons utilize pumping stations and pipelines for transport from extraction sites to processing destinations (Mitchell 2009). Pumping stations rarely go on strike. Without public scrutiny on channels of distribution, pipelines function without much attention. They become naturalized into landscapes.

What is required, then, is a framework that illuminates the net harm rendered by this assemblage. Such a framework would expand the geographic boundaries of the zone itself.

¹In 2018, the Louisiana Legislature made trespassing on or near oil and gas pipelines felonies punishable for up to 5 years in prison and/or \$1,000 fine. Yet state law allows pipeline companies wide discretion to seize or "expropriate" private land by eminent domain.

I argue that such zones need not be adjacent to one another to be considered logically contiguous and, therefore, connected by the infrastructure of fossil fuel extraction, production and distribution. This zone of harm, once established, could be used to inform decision makers with a more accurate and complex picture of social and public health costs of current and future industrial projects associated with fossil fuel and petrochemical production as well as to determine legal culpability in restitution claims by communities bearing the burden of the carbon economy.

The following sections of the article will provide some historic background to the definition and use of Sacrifice Zones as a discursive frame by actors to illustrate the relationship between land-use decisions and environmental racism, as well as by authorities as a necessary sacrifice for the public good. The article will build a conceptual framework for pipeline culpability by showing the tight coupling between the oil and gas extractive industry and downstream, value added refinement and petrochemical production. The article then applies this framework to the state of Louisiana as a case study, focusing on the harm that extraction and production practices have had on coastal indigenous residents in Louisiana and then on inland residents within the Mississippi corridor, dubiously known as “Cancer Alley.” It examines some modes of resistance that community residents have taken and concludes with the need to bolster community resistance with a conceptual framework that can bring multiple communities into solidarity alliance (Figure 1).

DEFINING SACRIFICE ZONES

Here, I discuss the proposed theoretical framework and history of the Sacrifice Zone. I use the term *continuum of culpability*

rather than ecology to underscore the continuity of the infrastructure and associated business and political networks among the practices of extraction, conveyance and inland production. Refinement and petrochemical processing once belonged to single, vertically integrated companies that drew liquid hydrocarbons from the ground and moved them to refineries and petrochemical operations. Inland plants that manufactured petroleum-based products created a secondary market for oil and natural gas, which added value to the supply chain. Today, these functions may be undertaken by separate entities, but they operate within a tight, vertically-integrated market with revolving boards of directors, lobbyists, supportive law makers business councils, and trade groups such as the U.S. Chamber of Commerce and American Petroleum Institute that fund deceptive marketing campaigns through proxy organizations. I have chosen to focus specifically on Louisiana to illustrate this tight industrial continuum, but such a framework may also be expanded to inter-regional and international constellations of symbiotic operations. As a heuristic, the term “Sacrifice Zone” has been used by a number of actors, activists, scientists, and even government officials to index areas and communities that have been permanently sacrificed for ostensibly greater causes (Bullard 2011; Holifield and Day 2017; Lerner 2019). The phrase tacitly acknowledges that harm visited upon some communities benefits others (Bullard et al., 2007; Maldonado 2018; Lerner 2019).

Popularized as a Cold War reference, Sacrifice Zones were designated by the government as areas made uninhabitable by military use. The nuclear arms race between the United States and Soviet Union left large areas in both nations contaminated with radioactivity. Due to the sheer number of areas and expense of soil remediation, many of these polluted, irradiated areas were abandoned, fenced off, and posted with



FIGURE 1 | Warning signs like this one near Pointe-au-Chien in Terrebonne Parish dot the coast. Credit: Kerry Maloney.

warning signs. “The areas contained within these fences began to be known by engineers working within the department as “Sacrifice Zones” (Lerner 2019). While government officials have conceded that the production of nuclear weapons caused citizens to “make health and economic sacrifices on the altar of national security,” analogous sacrifices by other groups were long ignored. The health of a much larger host of low-income and minority Americans is regularly sacrificed to chemical contamination by private industrial plants. The contemporary deployment of Sacrifice Zones attempts to dramatize the fact that “low-income and minority populations, living adjacent to heavy industry and military bases are required to make disproportionate health and economic sacrifices that more affluent people can avoid” (Lerner 2019). Proposals to locate a new industrial facility adjacent to residential areas are often sold to a community in terms of the jobs it will create. This tradeoff may be viewed as a kind of “economic blackmail” foisted upon hardscrabble neighborhoods with otherwise little employment opportunities (Lerner 2005: 3). Areas that become Sacrifice Zones are typically zoned as residential/industrial, which is “a particularly pernicious type of zoning ordinance,” where industrial facilities and residential homes stand side by side without adequate buffer zones (Lerner 2019). Negative health impacts predictably follow. “Residents along fence lines with heavy industry often experience elevated rates of respiratory disease, cancer, reproductive disorders, birth defects, learning disabilities, psychiatric disorders, eye problems, headaches, nose bleeds, skin rashes, and early death” (2019:6). Air pollution is compounded with “the stress and tension of noise and squalor” (Bullard and Wright 1986). This pattern of disproportionate exposure constitutes environmental racism—a pattern articulated in 1979 with *Bean v. Southwestern Waste Management*, which was the first lawsuit to use civil rights law to challenge environmental racism (Bullard 2011).

Heavy industry depresses property values, and what was sold as an economic booster becomes an economic drag. Residents become entrapped with added economic hurdles of poor real estate equity in undesirable areas, which real estate and land use professionals call “Locally Unwanted Land Uses” or LULUs. Study after study over the past 2 decades affirm that minority communities face an uneven pollution burden compared to White counterparts, even those with lower incomes. Researchers from the University of Colorado Boulder reported in 2008 that African Americans with household incomes between \$50,000 and \$60,000 live in neighborhoods that are, on average, more polluted than the White households that with \$10,000 less in annual earnings (Downey and Hawkins 2008). African Americans are much more likely to live near toxic pollution and are exposed to 38 percent more air pollution than White Americans (Fleischman and Franklin 2017). Likewise, in neighborhoods with “clustered facilities,” people of color make up 69 percent of nearby residents. Such disparities were repeated in nine of ten U.S. EPA regions and 40 of 44 states with hazardous waste (Bullard et al., 2007). Fines levied on polluting industries are also unequally portioned. An

examination of 1,100 Superfund sites reveals that the average fine imposed on polluters in White areas was 506 percent higher than the average fine imposed in minority communities (Lerner 2019). Meanwhile, White residents experience a “pollution advantage” by exporting air pollution created in the goods they consume, according to a 2019 study in the *Proceedings of the National Academies of Sciences*. Whites are exposed to 17 percent less air pollution caused by the goods and services they consume, while Blacks and Hispanics bear a “pollution burden” of 56 percent and 63 percent excess exposure, respectively (Tessum et al., 2019).

With the addition of Geographic Information System (GIS) tools, researchers can identify demographic areas by race and income to further correlate that race is more subjected to environmental justice issues than poverty (Perera and Lam 2013). Such GIS mapping studies find pollution discrepancies based on race, income, and education up and down the Mississippi River corridor. For example, in the heavily industrialized St. James Parish in Cancer Alley (counties in Louisiana are referred to as parishes), a GIS study found that polluting industries were located in areas with the highest percentages of African Americans, the lowest average household income, and the most residents without a high-school diploma. Meanwhile, the residents employed by the plants tended to live the furthest away, were wealthier, better educated, and more likely to be White (Blodgett 2006).

While recent tools have given social scientists and community activists the ability to quantify harm visited upon minority neighborhoods, activists of color have been publicly resisting such patterns of oppression and poison across the United States since the 1960s, from California grape-pickers organized by Cesar Chavez to black students in Houston protesting the location of a city dump (Miller and Maxwell, 2017). “This is not the racism of epithets . . . rather it is more subtle but equally powerful and repellent racism of neglect. Much environmental racism is latent, covert—and overwhelming” (2017: 17). Today, many grassroots community leaders and environmental justice actions are led by women of color and retired persons. In other words, grandmothers are performing the work that government regulators should be doing (Bullard 2011). They often face punitive resistance by powerful state actors, including felony trespassing laws that make it a felony to protest near “critical infrastructures” such as petrochemical facilities or pipelines on land seized by fossil fuel companies under eminent domain (Thibaut 2018; Sneath 2020a).

THE SACRIFICIAL FRAME

Sacrificial frames can also be deployed by policy makers as a rationale to support heavy industry in impacted areas. In a study on shale fracking in Wisconsin, geographers Holifield and Day suggest that the frame of Sacrifice Zones indexes a rationale to justify the exploitation of areas in order to secure other common goods or “scales of security” such as energy independence

(2017). It appears to be deployed by a multitude of actors to imply and rationalize harm. For example, the exploitation of shale gas deposits in Wisconsin has been justified as a means to attain national energy security, while promoting economic security for depressed rural areas, job security for local households, and protection from global climate change (2017: 271) (**Figure 2**).

Here in Louisiana, authorities often invoke a sacrificial frame when it comes to the environmental costs of oil and gas extraction in the context of the state's coastal restoration narrative. Presentations by the Coastal Protection and Restoration Authority (CPRA), which oversees the Louisiana's \$50 billion, 50-years Master Plan for a Sustainable Coast, tout the state's contribution to the nation's energy needs as a frame to underscore the importance of maintaining its "Working Coast" (Randolph 2018). In this way, the state's wetland loss, which is exacerbated by oil and gas extraction, is framed as an unavoidable sacrifice. In exchange, the state receives federal royalty collections on oil and gas drilling in federal waters, which are dedicated to funding the Master Plan. Prior to 2005, the state received practically nothing in royalties from deep-sea wells that carried liquid hydrocarbons from federal waters onshore through Louisiana's vast pipeline infrastructure. After Hurricane Katrina, then-U.S. Sen. Mary Landrieu, D-La. garnered support from sympathetic members of Congress to pass the Gulf of Mexico Energy Security Act, known as GOMESA, which significantly increased Louisiana's federal royalty share on drilling in the Outer Continental Shelf (Randolph 2020). She articulated her efforts through the frame of sacrifice. "These areas and their fragile environments in Louisiana were sacrificed long ago for the benefit of industry investment and development. I intend to ensure that these areas will be ignored no longer" (Theriot 2017: 187).

When Louisiana received a major haul from GOMESA in \$87 million on oil royalties in 2018, state officials applauded the money as a recognition of the sacrifices the state had made for the nation's energy security. Sen. John Kennedy, R-La. wrote, "This money will help us restore our beautiful coast so that we can continue to provide oil, natural gas and seafood to the rest of the nation" (2018). Through the discursive frame of sacrifice, fossil fuel production is "Green-washed" as supporting Louisiana's coastal restoration efforts (Miller and Maxwell, 2017; Randolph 2018). In fact, the industry is repositioned as a critical asset and victim of coastal erosion and sea-level rise, despite its culpability for environmental damages.

The Case of Louisiana: From the Coast to Cancer Alley

Oil and gas industry practices of cutting canals, drilling wells, and laying pipelines cause irreparable harm to the coastal landscape. Notwithstanding greenhouse gas emissions, fossil fuel industry practices are cited in scientific literature as major contributors to Louisiana coastal land loss, which has totaled of 2,000 total square miles since 1930 (Baustian and Turner 2006; Morton, Bernier, and Barras 2006; Morton et al., 2010; Houck 2015; Couvillion et al., 2017; Theriot 2017; Turner 2018; Day et al., 2020). Pipeline and navigation canals cause a number of compounding effects. Ponding caused by spoil banks of canal ridges disrupts sedimentation and drainage, which impairs marsh vegetation needed to retain coastal mud and sediment (Turner and McClenachan 2018). Canals also channel salt-water into brackish estuaries. Spoilage of the brackish ecology accelerates the loss of marshland and bayous to open water, which threatens international migratory flyways and seafood and marine estuary nurseries. Coastal erosion also denudes storm protection for



FIGURE 2 | Louisiana has lost 2,000 square miles of coastal wetlands since 1930. Credit: Kerry Maloney.

coastal urban centers like New Orleans and smaller coastal communities. A traumatic storm event is then compounded by the loss of generational livelihoods, flooding to homes and businesses, and unaffordable insurance. That's in addition to leaks, accidents, blowouts, and spills from thousands of miles of aging subterranean pipeline infrastructure.

Louisiana far out spills every state in the nation, magnifying exposure of co-pollutants to marginalized communities (Meiners 2019). And at least 30 facilities in Louisiana marshes contain the most toxic chemicals allowable by the E.P.A., which makes them particularly dangerous during hurricanes. Harmful “spot plant flaring” legally releases tons of pollutants during emergency shutdowns, magnifying exposure of the toxic payloads inside plants are structurally at risk from storm damage, often unbeknownst to nearby residents (Bracket 2020; Sneath 2020b). Louisiana, additionally, has a problem of abandoned oil wells (Meiners 2019). A 2014 state auditor's report found that within state boundaries, there were nearly 58,000 neglected oil wells that were either abandoned or unregulated. So many, in fact, that the state cannot afford to plug them. Industry lobbyists perversely argue that the growing number of designated “orphaned” wells abandoned by out of compliance owners are too expensive to properly plug without maintaining the industry, whose taxes fund the orphan well program (Schleifstein 2020). When Hurricane Laura crashed through southwest Louisiana in the Fall 2020, it struck 480 “orphaned” wells that left behind miles of observable oil sheen throughout the marshes (Dermansky 2020). The 4,300 official “orphaned” oil wells alone would take \$180 million and 20 years to plug (Schleifstein 2020).

Communities of color that live in increasing precarious areas are forced to reckon with these hazards that result in loss of health and livelihoods, disrupted generational connections, and coerced relocation (Maldonado 2018).² They are part of the violence that structures the social hierarchies of a place. Such oppression is even more perverse when those responsible for landscape degradation create a predatory relationship with victims of such practices. People with the least resources and legal knowledge to resist are burdened with presenting a cogent case of harm against powerful actors with the backing of state regulatory apparatus; a particular challenge when environmental degradation appears naturalized in the form of floods and storms, or as invisible toxins in the air and water. Such embedded, imbricated effects can be easily obfuscated (Figure 3).

Rather than a technical dilemma, environmental displacement is inherently social and racial, argues anthropologist Julie Maldonado. For example, offshore oil and gas extraction in coastal Louisiana has disproportionately impacted indigenous communities, who have borne the brunt of colonial, statist policy over generations (Maldonado 2014, 2018; Bisschop, Strobl, and Viollaz 2018). Maldonado characterizes the environmental impact of degraded areas—where the culpable actions have

degraded the landscape—as tacit persecution. Recent press has highlighted the plight of coastal indigenous tribes in Louisiana. One tribe in particular has been held up as a harbinger for the challenge of relocation. Members of the state recognized Ilse de Jean Charles band of Biloxi-Chitimacha-Choctaw reside at a particularly vulnerable location that was left outside of the “Morganza to the Gulf” levee system when the U.S. Army Corps of Engineers (USACE) determined in 1998 that its protection was cost-prohibitive (Maldonado 2018; Alaska 2020).

The Challenge of Resettlement

The island has been inhabited by indigenous peoples since the early 1800s. Today, encircled by a small ring levee and connected by an easily flooded, two-lane road, the island has lost 98 percent of its landmass since 1955. Prodigious dredging by oil companies to lay pipelines, mark boundaries, and open navigation canals to oil platforms has torn apart the brackish estuaries. Saltwater intrusion and ponding effects that followed have killed the flora and destroyed tree roots that hold the land together. “Without tree roots, the surrounding land sinks, which makes it difficult for Tribes to grow their traditional fruits and vegetables and harvest medicinal plants” (Alaska 2020: 19). Meanwhile, dredging around the island has never been remediated. In the 1970s, the tribal residents successfully fought an attempt by the Louisiana Land and Exploration Company to dredge and dynamite through its burial mounds. The company never refilled the cut leading to the cemetery or other canals that surround the burial mounds (2020). In another incident, an oil company in 1992 sued eight tribal members of nearby Pointe-au-Chien who were fishing in their ancestral fishing grounds . . . for trespass and damage to the property” (2020: 16). Meanwhile, wetland loss exposes the island to offshore storms that are growing more intense. “Rising sea level and increasingly intense hurricanes exacerbate these issues” (2020: 16) (Figure 4).

For 2 decades, the Isle de Jean Charles Tribe has been working on a resettlement plan that would also reunite members who have forced to leave the island over the years. Hurricane Lili in 2002 forced over 50 families to leave from severe flooding and damage, for example (Camardelle 2020). Since 2010, the Tribe has been working with a technical team on climate adaption and community planning to write a resettlement plan. In 2014, the Tribe along with its nonprofit partner, the Lowland Center, entered into an application with the Louisiana Office of Community Development (OCD) for a National Disaster Resilience Competition that called for innovative community responses to the devastating effects of climate change (Ilse de Jean Charles; OCD 2015).

Louisiana received a \$92.6 million grant in January of 2016, which included \$48.3 million for resettling Ilse de Jean Charles. The grant was the first federally funded initiative for voluntary community resettlement (Simms et al., 2021). In laudatory language, the award would “provide a safe resettlement for members of the Isle de Jean Charles tribe who are descendants of the historic Biloxi, Chitimacha, and Choctaw tribes through “blood lineage and cultural heritage” (Lowland 2016; EESI 2016; Ilse de Jean Charles Tribe, 2021). However, what followed illustrates the vast challenges of managed retreat, particularly concerning indigenous communities (Maldonado 2014; 2018). A climate of distrust pervades interactions between state actors and indigenous

²Populations surrounding facilities with enough toxic storage onsite to warrant risk management plans are 11 percent more likely to be communities of color, 10 percent more likely to be low income, and 3 percent more likely to be linguistically isolated, according to the EPA.

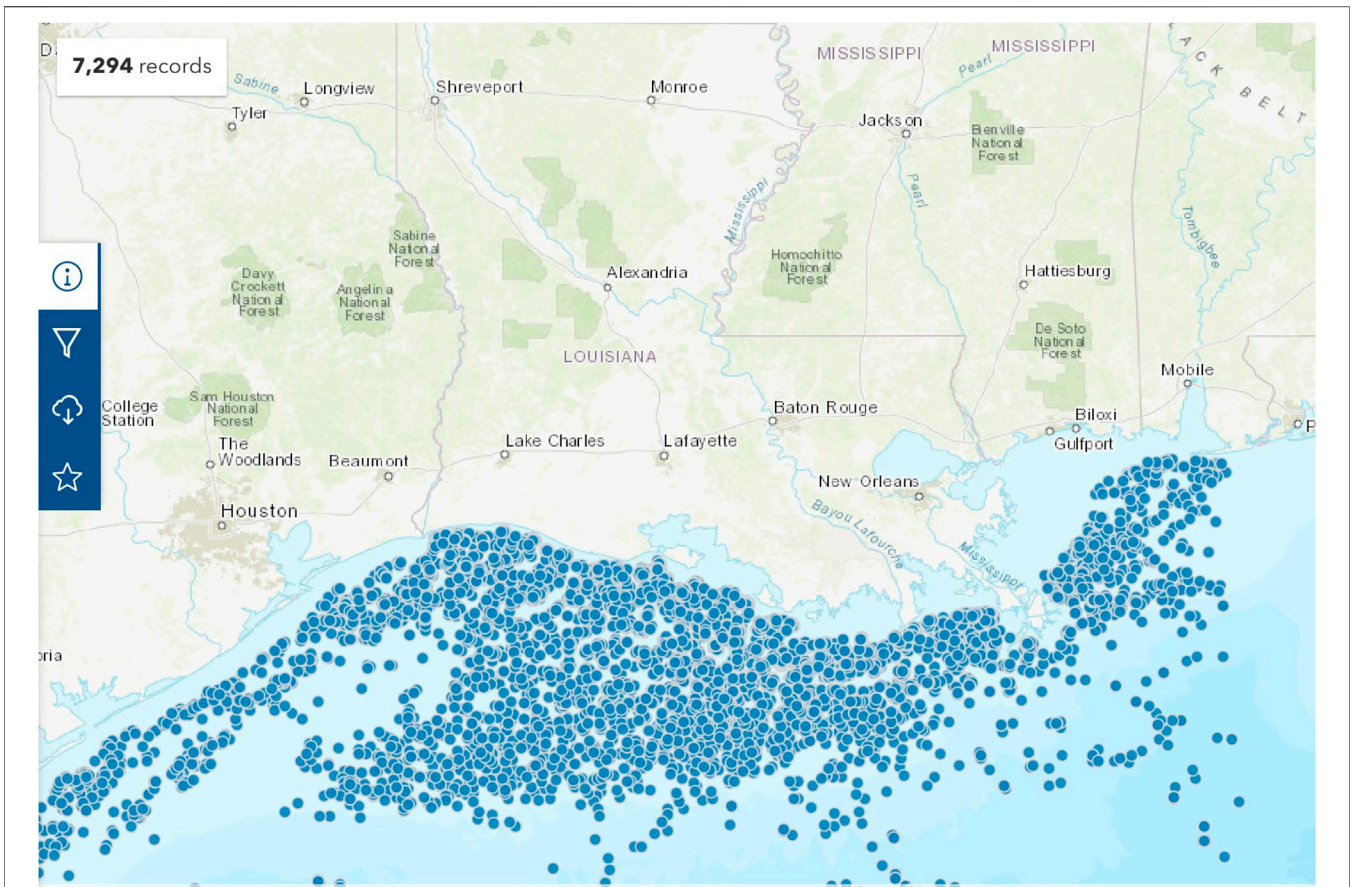


FIGURE 3 | Offshore oil and gas platforms off the coast of Louisiana and East Texas. Credit: Energy Information Administration (EIS) U.S. Energy Atlas.

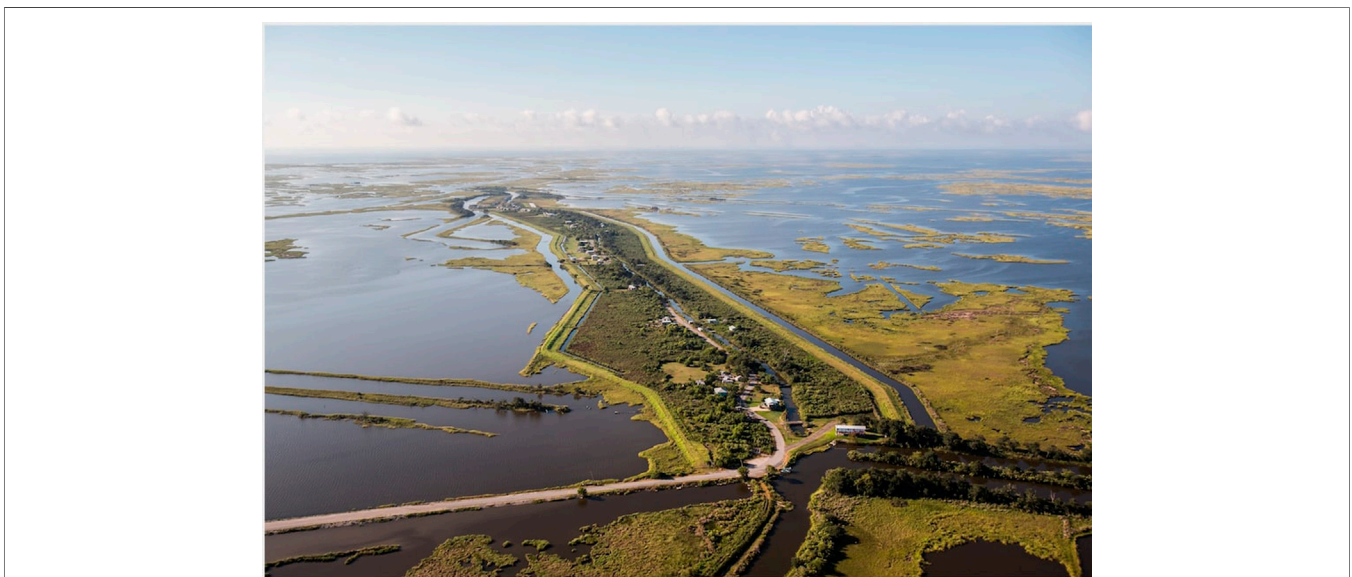


FIGURE 4 | Isle de Jean Charles, home to a Louisiana indigenous community, has lost 98 percent of its land mass since 1955. Credit: Kerry Maloney.

communities, which reflects a history of land prospecting, theft, rural gentrification and the thwarted attempts to resettle island residents (Simms et al., 2021). All of which can derail even goodwill attempts—as happened in Louisiana. “The current distrust, steeped in the deep memory of land stolen and promises broken, appeared in the rumors and misinformation that led to the creation of powerful competing narratives about the (HUD) grant” (Simms et al., 2021: 5). While the initial grant application and award announcements by federal and state agencies referred specifically to tribal affiliation with Isle de Jean Charles band of Biloxi-Chitimacha-Choctaw, the terms of the grant began to change as others came forward. The Louisiana OCD later said referring to a single tribe rather on the island was a mistake (Alaska 2020: Appendix F). Shortly after the grant announcement, the OCD was approached by leadership from the state-recognized United Houma Nation asserting that some of its members also resided on the island (2020: Appendix F). In March 2016, OCD released a fact sheet for the award, which asserted that “tribal affiliation” would not be a part of the resettlement plan (Alaska 2020). Frustrated, in October 2018 the Isle de Jean Charles Tribal Council wrote to the Director of Office of Block Grant Assistance at HUD to recommend that the grant funds be returned to the National Disaster Resilience Competition grant committee (Alaska 2020: 52–53). Tribal members were also informed through the 2018 Permanent Relocation & Homeownership Assistance Program they would have to relinquish their island properties if they resettled (Alaska 2020). That requirement has been modified to allow residents to maintain their island properties for part-time use as long as the no new construction takes place and no extensive repairs to storm damage are undertaken (Alaska 2020: Appendix G). Isle de Jean Charles members were also disheartened to learn that funded resettlement would not extend to members who left the island prior to Hurricane Isaac in 2012, dashing hopes for reunification (Alaska 2020).

After learning about residents of the island who identify with the United Houma Nation, the state OCD conducted an island inventory, noting that some residents maintain Isle de Jean Charles Tribal membership, while others maintain United Houma Nation membership and at least two residents are unsure about their affiliation. The OCD wrote that it discovered on the island a “diverse community of sometimes competing tribal interests” (Amendment, 2019: 4). The OCD formed a steering committee, which included five island residents, representatives from both the Isle de Jean Charles Tribe and United Houma Nation tribal councils, a representative from Terrebonne Parish government, and a representative from the Governor’s Office of Indian Affairs.

On February 21, 2019, the OCD presented its new plans before the Houma-Terrebonne Parish Planning Commission. Several chiefs of state coastal tribes objected. The Pointe-au-Chien Indian Tribe sent a public comment letter in response, noting that the changes minimize both the existence and leadership of the Isle de Jean Charles Tribe and other coastal tribes. (Alaska 2020: 55–56). The OCD responded in May 2019 that the state cannot legally acknowledge the tribes as sovereign because they are not federally recognized

by the Bureau of Indian Affairs (Alaska 2020: 56–61). Attempting to contextualize changes to the resettlement plan, the state said it had already presented a framework for community resettlement for threatened areas, and was looking for a specific resettlement project to propose. The Isle de Jean Charles Tribe, also known as the Isle de Charles Band of Biloxi-Chitimacha Confederation of Muskogees (BCCM), had been working on such a plan for some time. “Concurrently, tribal leadership of BCCM provided the state with a basic narrative.” The narrative, said OCD, was that the island was synonymous with Isle de Jean Charles Tribe. In following the Tribe’s narrative as presented, resettling the tribe would represent an ideal example of the community resettlement concept outlined in the state’s Phase I submission. “Having no reason to question this description of Isle de Jean Charles at the time, the state described in its Phase II submission the resettlement project accordingly” (Alaska, 2020: Amendment F).

Three years after the grant announcement, the state submitted an amended resettlement plan, which HUD approved in August 2019, to offer resettlement to anyone who resided on the island after 2012. “Regardless of which tribe residents and former residents identify with, the resettlement is, by federal law and the state’s desire, not tied to any particular tribe, race or belief system,” the amended plan said (Amendment, 2019). In response, the Isle de Jean Charles Tribe charged that the state violated its right to self-determination. The Tribe joined with three other Louisiana coastal tribes and the Native Village of Kivalina of Alaska in a complaint, dated January 15, 2020, to the United Nations claiming human rights violations “as a consequence of the U.S. government’s failure to protect, promote and fulfill each Tribe’s right to self-determination to protect Tribal members from climate impacts” (Alaska 2020: 3). In the complaint, Isle de Jean Charles Tribe said the Louisiana Office of Community Development substantially changed the resettlement plan without consulting Tribal leadership, and in some cases, took major action without notifying the Tribe (Alaska 2020).

The OCD in 2020 moved forward with the amended plan, using \$12 million of the HUD grant to purchase a former 515-acre sugar farm 40 miles north of the island. Construction is scheduled to be completed by the end of 2022 (Simms et al., 2021). The Isle de Jean Charles Tribe said it learned of the purchase through a press release. The Tribe said it had officially withdrawn from the settlement plans (Alaska 2020). Frankly, the resettlement process was much more complex than originally expected, noted the U.S. General Accounting Office. “Tribal leaders from both of the state-recognized tribes have expressed concern that the process does not meet the unique needs of tribal residents.” Some tribal residents have chosen not to relocate, and will remain vulnerable to coastal erosion and storm surge, increasing the likelihood that they will be impacted by a disaster event (GAO 2020).

The difficulty of resettlement, a disruptive process in its own right, is illustrative of the immense sociological challenge that coastal land loss presents to governing structures. Not only does sea-level rise threaten key ecological and economic resources, but the social impact of people forced to relocate as well as

communities that might absorb them presents an array of opinions about what self-sufficiency and/or restitution should comprise (Laska et al., 2005; Maldonado 2018; Hemmerling et al., 2020; Simms et al., 2021).

The Case of Louisiana: An Inland Secondary Market

The pipeline infrastructure that causes so much coastal destruction carries billions of barrels of oil and trillions of cubic feet of natural gas (produced onshore and offshore) across Louisiana's tidal marshlands through an intricate and aging network of pipelines. Pipelines carry gas and petroleum feedstock to refineries and petrochemical plants dotted along the 85-mile Mississippi River industrial corridor, where inland "fence-line" communities live on the front-lines of direct industrial exposure (Bullard and Wright 1986; Bullard 2011; Lerner 2019). This massive secondary market was drawn to the region by inexpensive oil and natural gas, unlimited supplies of water in the Mississippi River, inexpensive labor, loose regulatory oversight and massive tax breaks (McMichael 1961; Peterson 2000; Allen 2001; Leber 2020). In general terms, petrochemicals are chemicals derived from "substances or materials manufactured from a component of crude oil or natural gas" (McMichael 1961: 24). Starting in the 1950s, oil refineries began to "mine" their process streams for compounds to make higher value products. Shell in Emeryville, Calif., and Standard Oil of New Jersey began studying derivatives of their raw materials. By the mid-1950s American Cyanamid had expanded its operations into Louisiana followed by Monsanto to produce fertilizer and ammonia (Peterson 2000: 10). From 1956 to 1955, approximately, \$600 million was invested in new and expanding petrochemical plants in Louisiana (McMichael 1961). "From 1964 to 1968 ... petrochemical growth in Louisiana outpaced all other states, including Texas" (Allen 2001: 178; Scott, 2005). Companies like Union Carbide and Dow Chemical Co. relocated there. Refineries such as Shell Petroleum Company generated chemical sister plants for secondary markets for newly-discovered products like antifreeze, tires, plastic food containers trash bags, laundry detergent (Lerner 2005: 24). In the late 1960s, demand for fertilizers surged. Louisiana became a favorite spot for new ammonia plants, again predicated on the availability of cheap oil and gas feedstock (Peterson 2000: 10). The plastic boom followed with dozens of plants manufacturing Polyvinyl Chloride (PVC), Polypropylene, synthetic rubber, Polystyrene, Melamine Crystal, Isocyanates for Urethanes (Peterson 2000). "The petrochemical plants have to a large extent located where they may obtain the refinery off gases which formerly were burned as fuel or flare gas," Robert Nance McMichael, wrote in his 1961 dissertation entitled *Plant Location Factors in the Petrochemical Industry in Louisiana* (EPA, 2021). "It has been estimated that approximately 50 percent of the petrochemical raw materials are by-products of refining

operations. It would be expected, then, that petrochemical plants would be most common where the greatest concentration of refineries are found" (40) (Figure 5).

With the passage of the 1966 Federal Water Quality Act, companies began factoring pollution into their costs. Rivers with a high discharge rate like the Mississippi River made an ideal location in light of coming regulations (Allen, 2001: 179). Even more chemical plants and refineries began dotting the landscape of former plantation lands, where multiple generations of descendants of slaves and sharecroppers lived (Williams 2018). "A number of these plants bought their riverfront property from former white plantation owners who then moved, leaving their poorer and minority neighbors behind" (Allen 2001). "Enabled by state zoning, a wave of chemical plants dropped on African American communities like a bomb" (Houck 2019: 472).

Infrastructural pipelines and petrochemical plants did not spontaneously appear at the doorsteps of poor, largely African American communities. Rather, they are part of a historic continuum. Scholars have noted the historic and geographic connections between the slave plantation and chemical regime (Green 2015; Garrigus and Hall 1994; Steve Lerner 2005; 2019). Yet more research is needed to carefully map these relationships. The economies of scale of sugar plantations required large plots of land with proximity to the river. In Cancer Alley, this arrangement is quite stark. "They had by no means moved to the nuisance. Following the Civil War their towns arose next to the old plantations, and the industry that followed later simply introduced another plantation culture of its own, low wages, minimal employment and the profits going as far away as Germany and Japan" (Houck 2019: 459) Names such as the Diamond Plantation, Trepagnier and Good Hope Plantations became ideal sites in the 20th century for bringing oil ashore for storage and refining. "This exchange of land use—'from plantation to plant'—has exposed local residents, many of whom descend from slaves, to the life-limiting and protracted threat of harmful pollution" (Davies 2019: 9). Some of the industrial operators restored the ornate antebellum homes. Famous plantations such as Ashland-Belle Helene, Destrehan, San Francisco and Aillet House were purchased by Shell Chemical Amoco, Marathon Oil and Dow Chemical (Peterson 2000: 8). Restoration efforts are aided by historic preservation grants, which are not afforded to proximal historic areas associated with communities of color. Such practices, note scholars, preserve the esthetics of White Supremacy.

Nearly 200 years ago, the same area was the epicenter of the largest slave rebellion in U.S. history. Conditions were particularly harsh as river parish slaves cleared swamps, built levees and worked the fields. African slaves ran indigo processing facilities and, later, sugar mills. Slaves were lost to disease or suffered injuries in the fields and sugarhouses during grinding season. (Hall, 1992; Seck 2014; CEI 2020). Geographically, Louisiana was used as a threatened destination by masters whose slaves were not obedient. They could be sold 'down the river.' One of the legacies of

such operations in today’s Cancer Alley is a community called Freetown in St. James Parish. Situated on the site of the former Pedescleaux-Landry Sugar Plantation, Freetown just decades ago was a bucolic agricultural community. It was founded by former slaves during Reconstruction in 1872. Many of the existing residents have lineage to this era, well before the petrochemical plants began moving in next door (Davies 2019). The degradation of Freetown happened relatively slowly, which according to Rob Nixon constitutes the slow violence of pollution, which strands a community in a place and strips it of the characteristics that made it livable (Davies 2019).

Today, there are 156 industrial chemical plants and refineries in Cancer Alley. This massive “oil assemblage” of plants produces everything from insecticides, and fertilizers to jet fuel and neoprene rubber. The corridor also hosts the world’s largest manufacturer of Styrofoam (Baurick and Younes 2019; Tristan et al., 2019). Louisiana is the second highest top producer of U.S.

petrochemicals in an area much more condensed than the top producer, Texas. While the petrochemical corridor is touted by advocates as an important source for thousands of manufacturing jobs, its other moniker speaks to the terrible health outcomes and environmental racism that befalls on fence line communities, which are exposed to the nation’s highest concentrations of chemicals linked to cancers and other respiratory and prenatal illnesses.

The production of known carcinogens is well documented, but there is less precision about quantifying harm to residents. State regulators often downplay health claims, citing the Louisiana Tumor Registry that shows nominal elevations of documented cancer rates. Critics say the registry casts too wide a geographical net and fails to account for higher incidences of cancer closer to plants. The registry also fails to document the constellation of illnesses other than cancer, such as respiratory diseases, skin irritations, mental impacts and prenatal miscarriages.

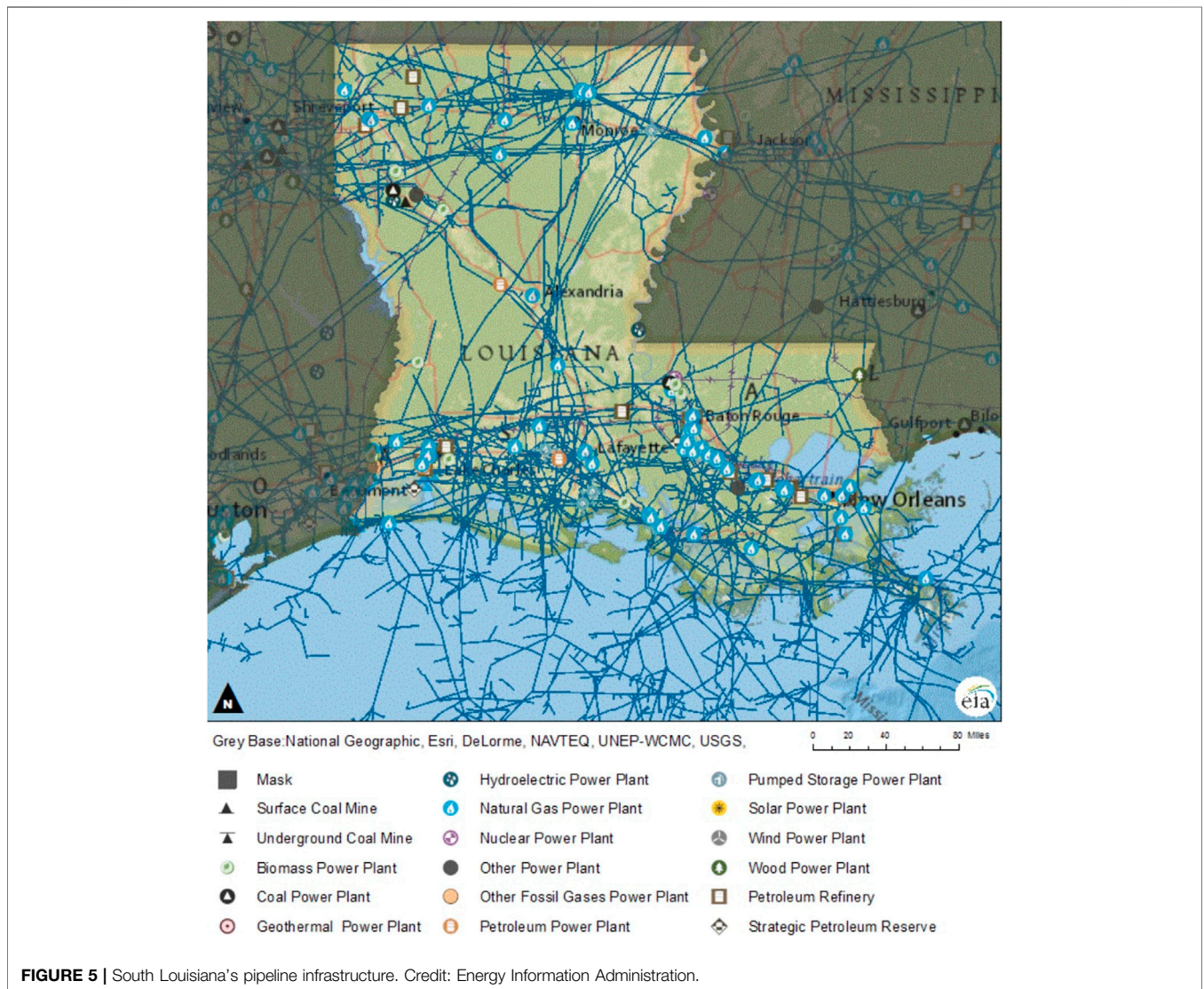


FIGURE 5 | South Louisiana’s pipeline infrastructure. Credit: Energy Information Administration.

This leaves impacted neighbors to offer anecdotal accounts to rebut official estimates. “Proof of causation in the case of cancer or any other suspected environmentally-related disease is difficult to produce,” writes Barbara Allen (2001: 193). Such a study would need to analyze not only those living in the proximity of plants, but also adjust for those who also drink, smoke, or have a genetic disposition to cancer. Length and concentration of exposure would have to be factored in, plus many other factors. “The beneficiary of this inaction is the chemical industry, which can unequivocally state that there is no proof of their pollution harms neighboring residents” (2001: 193).

There is also little granular air monitoring by federal or state agencies. Instead, the EPA models a “Risk-Screening Environmental Indicator” database to identify potential high-pollution areas. A 2020 investigation analyzed the EPA’s database and found that the seven Louisiana parishes along the Mississippi River Corridor from Baton Rouge to New Orleans contain 200 plants that emit toxic chemicals at a high enough level that they must report their emissions to the government (Baurick and Younes 2019).

Louisiana has the highest toxic air emissions per square mile of any state, based on data gathered by the U.S. Environmental Protection Agency’s 2018 Toxics Release Inventory. The state in 2018 averaged 1,239 pounds of toxic air releases per square mile, well ahead of runner-up Ohio with 899 pounds per square mile (Jacobs, 2021; Schleifstein, 2021). The chemical industry in Louisiana annually generates the equivalent of 16,000 pounds of hazardous waste for every resident of Louisiana, which is more than 12 percent of all hazardous waste in the United States. It also imports waste from other areas. “The region now has dozens of hazardous-waste incinerators and chemical landfills that line the river, many of them exempt from federal hazardous-waste disposal regulations” (Allen 2001: 180). That includes radioactive material.

In the next section I will examine conditions in three parishes in Cancer Alley where plant expansions are pending. This is not, however, an exhaustive account.

Inside Cancer Alley: The Case of St. James Parish

In the single community of Convent, a small town on the Mississippi River in St. James Parish between Baton Rouge and New Orleans, 11 chemical plants lay within a few miles of the town which is 80 percent African American with a 40 percent poverty rate. When the Japanese plastics manufacturer Shintech proposed a new facility there in 1995, the area’s emissions already amounted to 250,000 pounds of toxic air per mile—which was 658 times the national average. The Director of Tulane Environmental Law Clinic wrote that a person who spent a half day in Convent would be exposed to as much toxic air pollution as the average American breathes in a year. Between 1994 and 1997, there were 141 emergency toxic releases reported (three per month) in the Convent area, which forced school closures

and residents to shelter in place (Houck 2019). Nonetheless, Shintech was awarded the project.

Currently, there are proposals to build or expand three plants in St. James Parish, where 14 percent of the land is owned by chemical companies and over 40 percent of the parish is wetlands. In 2014, the parish passed its first land-use ordinance, which quietly rezoned to a large portions of its predominantly black 5th District from residential to residential/industrial. Meanwhile, two chemical companies—Petroplex and Wolverine—were around the same time barred from building new facilities across the river in the predominantly White 3rd District. Clyde Cooper is the 5th District Council member. “It’s a decision based on ‘We don’t want it in the white area but we don’t mind it being in the black area’” (Kardas-Nelson 2019). Several of St. James’s Parish Council members, including the president, are current or former employees of the petrochemical industry. Data collected there shows that residents have been exposed to emissions that can reach 765 times the levels considered safe by the EPA (Kardas-Nelson, 2019).

Inside Cancer Alley: The Case of St. John the Baptist Parish

In 2018, the EPA reported that St. John the Baptist Parish had one of the highest cancer risks in the nation from the “likely carcinogens” Chloroprene and Ethylene Oxide.³ Not incidental, the Denka Performance Elastomer plant the town of La Place in St. John the Baptist Parish is the only site in the nation that emits Chloroprene, which is used to produce the synthetic rubber Neoprene (EPA). In 2020, the EPA’s Office of Inspector General identified La Place along with three other sites in Cancer Alley among the top 24 of the highest risk areas that needed to be urgently alerted about health hazards of nearby Ethylene Oxide-emitting facilities, which the EPA in 2016 determined to be 30 times more carcinogenic to adults than its prior estimates. The 2020 report entitled: “Management Alert: Prompt Action Needed to Inform Residents Living Near Ethylene Oxide-Emitting Facilities About Health Concerns and Actions to Address Those Concerns.” (O’Donnell 2020). At the time of the report, none of the communities had been contacted by federal regulators. Around the same time the EPA was temporarily relaxing regulatory reporting requirements for plants in Cancer Alley in response to COVID-19, which was also killing residents due to pre-morbidities associated with respiratory problems and race (EPA 2020; Terrell and James 2020).

³In May 2021, the EPA Inspector General announced that the agency should conduct new risk reviews for sites that emit Chloroprene and Ethylene Oxide in order to protect the health of communities that face “unacceptable health risks” from exposure.

Inside Cancer Alley: The Case of Iberville Parish

In the town of Plaquemine in Iberville Parish, which is on the west side of the Mississippi River across from Baton Rouge, the second Shintech plant, which makes ethylene, was in 2019 greenlighted for a \$1.5 billion, 300-acre expansion, which would intensify pollution in an area where an EPA model estimates the toxic levels of cancer-causing chemicals to be double the already high Iberville Parish average. (Baurick and Younes 2019). “Plants like Shintech contribute to those high levels. In the nearby community of Bayou Goula, when Shintech expands, the toxic air levels are expected to worsen by up to 16 percent” (Younes 2019). Also in Iberville Parish, the predominantly African-American community of St. Gabriel has one petrochemical plant for every 656 residents. There are 30 large petrochemical plants within 10 miles of St. Gabriel. Thirteen are within a 3-mile radius. “A mile outside of town is the world’s largest manufacturer of polystyrene, commonly known as Styrofoam” (Baurick and Younes 2019). Exposure to cancer-causing emissions within the two-mile radius of those plants is 800 times higher than an average, according to the EPA’s National Air Toxics Assessment, which was published in December 2015. Other census tracts near the plant had risks of exposure to cancer-causing emissions that are over 200, 300, and 400 times higher than national average (EPA 2015; Lerner 2017). Just next door in Ascension Parish, Louisiana Gov. John Bel Edwards announced his support for a new plant by Mitsubishi Chemical Corporation, which is considering building a large Methyl Methacrylate chemical plant, subsidized by \$4 million in state tax incentives (Perilloux 2020).

Inadequate Regulation

While they bear the brunt of pollution, these communities likewise suffer from inadequate protections from Louisiana Department of Environmental Quality (DEQ), which is

charged with regulating the plants. The enforcement agency only considers the effects of individual chemicals emitted by plants, instead of considering the holistic impact of their combined effects. Nor does not conduct or mandate regular air monitoring (Baurick and Younes 2019; Terrell and James 2020). “Instead, Louisiana depends on information from the plants to estimate that ambient standards are met and are not violated by one or more sources” (Flatt 2007). Louisiana also does not require plants do their own risk analysis. And Louisiana’s choice of a residual risk level is 100-times greater than the more accepted standard of excess cancer deaths of one in one million (2007).

In January of 2021, the Louisiana Legislative Auditor issued a scathing report of the inadequate enforcement practices by DEQ. The auditor’s report found that it took nearly 20 months for DEQ to issue enforcement actions after a plant operator failed to properly report emission violations. “Auditors also found it could take as long as 9 years from the time a company was cited for violating emission standards before it was ordered to pay a fine or had a settlement approved requiring the company to pay for a mitigation project.” (Schleifstein, 2021). That means the plant could excessively pollute for more than a decade before being forced to stop. The enforcement agency also doesn’t adequately track the penalties it has assessed or whether penalties were even paid. Plant reports are mailed to DEQ and then manually scanned into the agency’s database, which the audit says results in unreliable reporting on when and whether the reports were received (Jacobs 2021).

In effect, any earnest attempt to correlate hazards with emissions and its impact on communities are left to the residents themselves. Residents with deep intergenerational ties who wish to exercise local land-use sovereignty find themselves up against legal resources of multi-billion corporations as well as the willful state complicity and often punitive laws. One of the legal strategies by communities to fight petrochemical expansions has been to highlight that these



FIGURE 6 | Community members have used multiple tactics and civil resistance to call attention to chemical pollution. Pictured here in a 2018 march against the construction of the Bayou Bridge Pipeline. Credit: Marc Pagani for the Louisiana Bucket Brigade.

plants are churning out single-use plastic products that end up polluting streams and waterways. Their production also contributes to greenhouse gases, as Louisiana already ranks among the top three states in the nation of per capita energy consumption because of its petrochemical and oil and gas industries (EIA 2018). Affected communities have employed different tactics and strategies to win legal settlements and educate and mobilize residents. Some have successfully blocked or delayed new permit approvals. Residents like Sharon Lavigne of Rise St. James joined with several environmental groups in a lawsuit against the U.S. Army Corps of Engineers in January 2020 to stop construction of a Taiwan-based plastics company, Formosa Petrochemical, to build a \$9.4 billion Ethylene Oxide and Benzene plant the Fifth District of St. James. According to its air permit application, Formosa would be one of the single largest emitters of Ethylene Oxide and Benzene (both carcinogens) in the state (Kardas-Nelson 2019). Rise St. James alleges that the Army Corps of Engineers failed to disclose the environmental damage and public health risks of the plastics facility under the National Environmental Policy Act. Rise St. James cited a number of environmental factors: loss of wetlands in construction, pollution of single-use plastics, and toxic emissions. They also allege that the Corps failed to adequately consider the harm to slave burial grounds on the site, which is a violation of the National Historic Preservation Act: “(T)he Plastics Facility is sited on two 19th century sugarcane plantations, which include two cemeteries that contain the remains of enslaved people” (CEI 2020; Rise St. James et al., 2020). The Corps announced on Nov. 14, 2020 that it would reevaluate its wetlands permit for Formosa Plastics. On Nov. 18, 2020 a state judge sent air permits for Formosa’s project back to DEQ, directing the agency to take a closer look at how the plastics facility’s emissions will impact the predominantly Black community living nearby (D. Mitchell 2020). Yet there are billions of dollars proposed projects along the river corridor still coming (Baurick and Younes 2019; Staff Editorial, 2019; Perilloux 2020) (Figure 6).

Conclusion: Surprising Challenges and Opportunities

In “Carbon Democracy,” Mitchell posits that the oil industry is particularly unique in the history of energy because it exists as part of a vast “technical zone” that relies on a set of coordinated yet dispersed “regulations, calculative arrangements, infrastructures and technical procedures” that allows its flows to be governable and predictable (2009: 409). It requires, in essence, a production of scarcity, which is maintained through national economic and legal policy and geo political arrangements with producers and buyers—which today must also reckon with a glut of capacity from gas fracking and consumer backlash. The industry is over-supplied and financially leveraged as demand falls because of macro-level global downturns, international concerns on global warming, and falling costs of sustainable energy alternatives. As a result, the oil industry is reliant on increasing a secondary plastics market to

maintain demand and justify future activity. Planning documentation indicates that fossil fuel producers see their future in increased plastics production to offset global downturn fossil fuels. As a whole, the oil and gas industry aims to increase plastic feedstock production by at least 33 percent by 2025 (CIEL 2017).

This secondary market of petrochemicals is part of a logical and physical continuum of the domestic oil and natural gas industry, which includes physical pipelines and “midstream infrastructure” of petrochemical plants and other channels of distribution. Other ancillary subsidies include regulatory rollbacks, tax incentives, disregard of public health assessments, and even laws penalizing trespassers protesting plant expansions. The symbiosis between fossil fuel extraction and inland refining and petrochemical manufacturing is supported by material pipelines as well as enabling logics of manufactured scarcity from increased secondary market demand, complicit regulators, and marginalized communities. There must be an extended connection between points of culpability to link the origin and destination sites. I therefore suggest that any restitution or protests of resistance can be enriched by connecting impacted communities along the pipeline to create an expanded Sacrifice Zone. This framework can make visible the true ecologies of production, harm and sacrifice from the coast to Cancer Alley or even from continental gas fracking sites whose pipelines connect to plants in Cancer Alley. By designating these multiple sites as singular Sacrifice Zones, local communities can organize in larger blocs as they attempt to seek some kind of restitution from fossil fuel actors and state regulators. Through a larger alliance of solitary, the hope is that affected communities can better determine the fate of their immediate environment; and perhaps win legal restitution to decide whether to accept potential property buyouts or remain in place, while demanding more stringent regulatory attention to their toxic exposure.

As we move forward in thinking about strategies to respond to a changing climate, and possible terms of mitigation, restitution, resettlement or adaption, it’s imperative to remember that the harm of a changing climate presents tremendous social challenges to population groups that are linked in surprising ways. Climate studies and its wide implications for not only technical challenges, but one that is immensely social and political. Solutions and responses will undoubtedly require social alliances to foster robust resilience and new imaginings of possibility for impacted communities.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding author.

AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and has approved it for publication.

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