THE TEXAS COAST AS GEOPOLITICAL TERRITORY

The Spatial Regime of Burning Fossil Fuels in Coastal Landscapes of Oil

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The Texas Coast is a symbol of the Industrial Age: on the one hand largely undeveloped and sparsely populated, on the other hand an icon of oil-based cities depending on the economic power of the petrochemical industry. The Gulf of Mexico as common ground between Mexico, Cuba, and the United States, is a geopolitical territory, producing, refining, and supplying the globe with oil and gas.

Coastal areas have always been in environmental danger zones due to storms, flooding and seismic activity. At the same time, strategic coastal locations allowed for early global cities to become trade-hubs connecting the world. River deltas and bays as fertile regions, with sometimes calculable environmental risks, have brought resource-based economic growth to cities and regions along the coast and in the hinterlands. Understanding water not as risk or boundary but as a connector of places and well of life accelerated the development of thriving settlements, towns and even mega-cities. More than ever before, architects need to leave the object scale behind and understand architectural creation as an integral part of the natural beyond the built environment. Land(scape) is the physical medium which ties architecture and nature together. This relationship between (architectural) object and ground must be renegotiated in times of (climate) change as the shifting edges between water and land alter the (sur)face of coastal territories. After mankind had started a process of altering the world's climate over the past two centuries, the ecological repercussions of industrialization have now begun to manifest physical impacts on the natural environment. These impacts impose new parameters for architecture on the scale of both buildings and cities, and also for the logistical infrastructure connecting them across the changing landscapes in different territories.

The Epoch of the Anthropocene, this time of human activity impacting global climate, creates a new narrative of how architects and designers approach context.[1] The ties between industrialization, capitalism, and globalization share a common denominator: fossil fuels. The burning of fossil fuels as a symbol of carbon emissions, across many economic sectors from transportation to agriculture, has become a spatial regime demanding transformations of the built environment. Summarized under the term "Post-Oil Environments", this paper acknowledges the changing environmental conditions as a direct result of burning fossil fuels. Post-Oil Environments describe the current transition-period away from carbon-dependency towards a collective ecological awareness of human-based climate change. They link climate change directly to the burning of fossil fuels rather than to the processes of industrialization and globalization, as these phenomena could have been powered by sustainable sources of energy that emit fewer greenhouse gases.[2]

The use of fossil fuels has not directly shaped the design of cities. Cars can be powered with alternative resources, heating and cooling systems can run on renewables, plastic can be replaced in many of its applications of every-day-life. Whether a car runs on an Otto-Motor or on an electrical engine, changes a city marginally. Yet, the use of gasoline as major energy source to power millions of cars worldwide, over decades, is putting lives and cities at risk. The dependencies on crude oil and its applications has been increasing over the past century and continues to grow. Even though Western democracies developed cities in different ways, the post-war economies on both sides of the Atlantic started to “tie the value of money to the movement of oil”[3] in the mid-20th century. This fact is significantly important, as urban morphologies, consumer-demand and wealth became connected to a commodity that, unlike land or water, cannot be used to sustain human life. Any type of natural resource harvesting leaves footprints on the planet. The drilling-oriented industry has shaped landscapes and altered coastlines to allow for heavy industry and major seaports. The question is no longer how the design of coastal cities, facing major storms and rising sea-levels, needs to evolve in response to the changing climate, but if cities along the coast should exist as a typology itself.

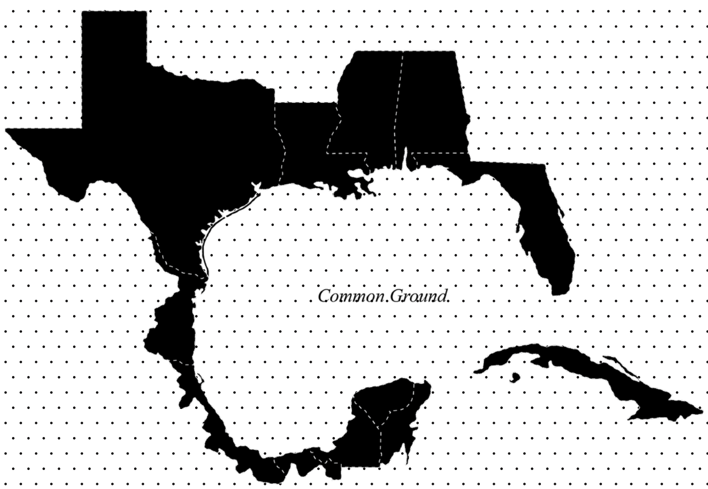
Over thousands of years, coastal cities were able to develop thriving economies, taking advantage of access to oceans connecting the world. Now, an enormous amount of time, labor, materials and money needs to be invested to develop infrastructural typologies of a kind and scale, unseen before, to protect what can (or cannot) be protected. Besides the risk of climate change, industrial production along coastlines has caused severe ecological hazards and, at times, disasters. Major spills, contaminated soil, or toxic drinking water has shaped (urban) landscapes and impacted fragile ecologies.

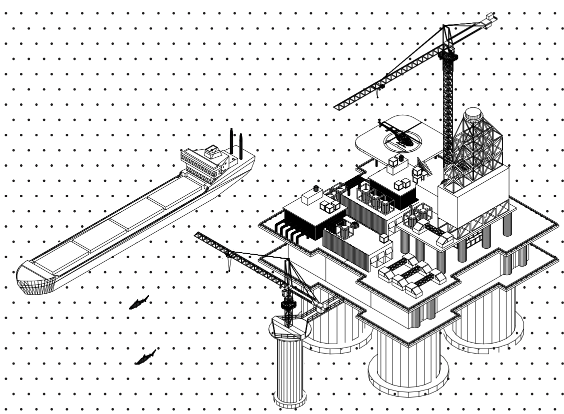
A prototypical territory of industrial production, heavily relying on the petrochemical industry, is the Gulf of Mexico and especially the Texas coast. An oil-producing, oil-refining, and oil-distributing territory, created by man-made power and a deregulated hunger for profit. As global economies shift towards the tertiary service sector, the late Texas oil-boom of 2016 once again shifts the regional economy along the coast towards secondary, if not primary, economic sectors, processing crude oil.

Extracting 294,257 BBL (barrels of oil) and 1,202,181 MCF (thousand cubic feet) of natural gas from 17,826 boreholes within the 19 counties along the Texas coast, this geopolitical territory exports over one million barrels of oil into the world, daily.[4] The power of oil has dictated the shape of coastal cities along the Gulf. As the oceans rise, the storms increase, and the temperature climbs, Texas needs to prepare for a post-oil future in a landscape soaked with petrochemicals.

Welcome to the Texas coast.

Figure 1. The graphic highlights the relationship between the Gulf of Mexico as a geographical location and the operations of oil within it.





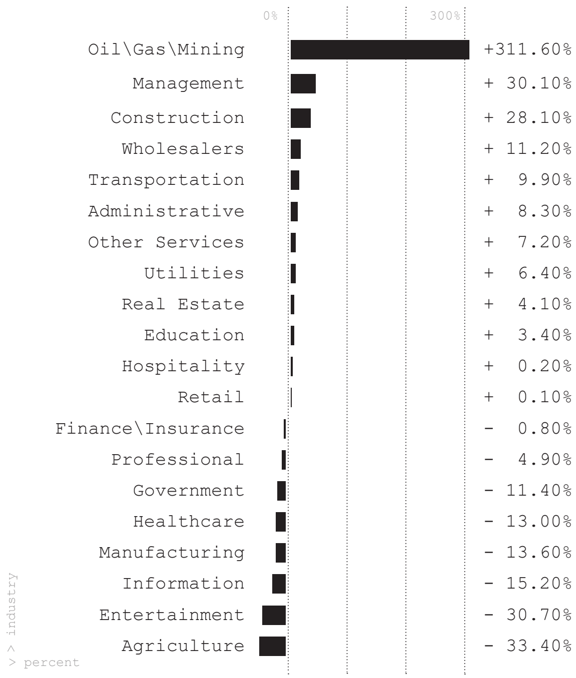


Figure 2. This chart shows the employment in various economic sectors in Texas relative to US average.

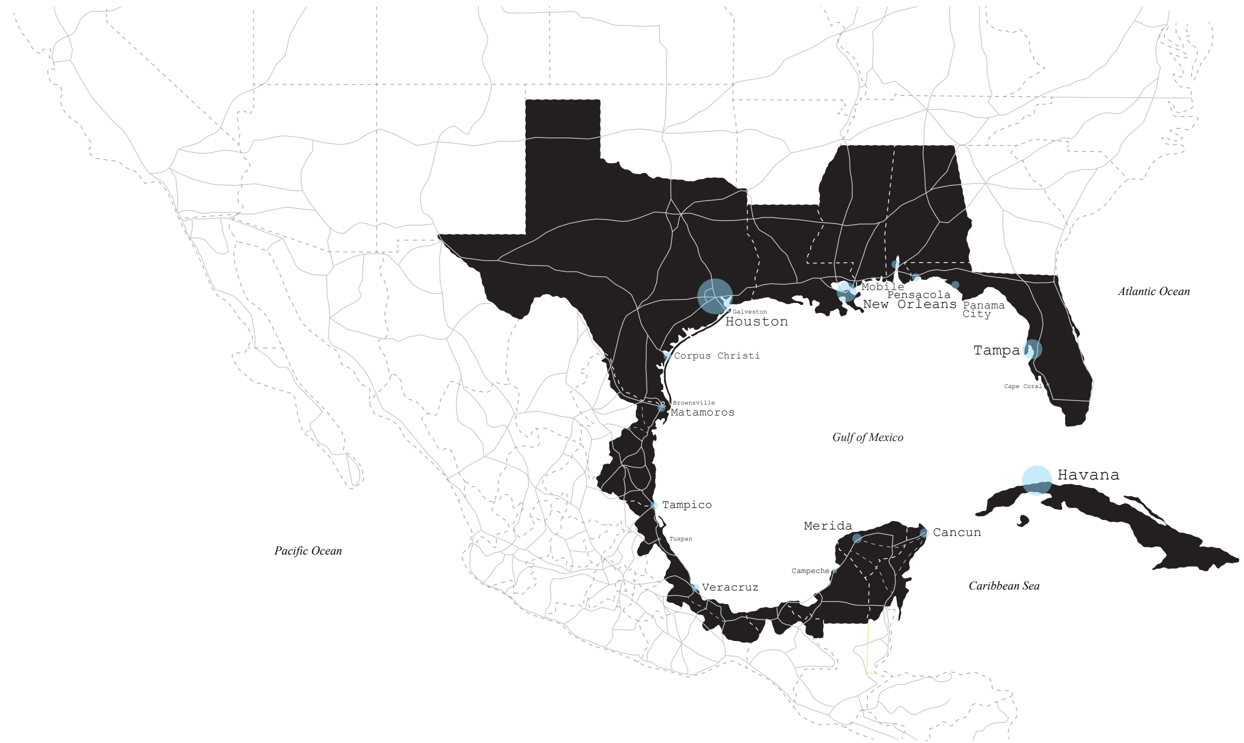


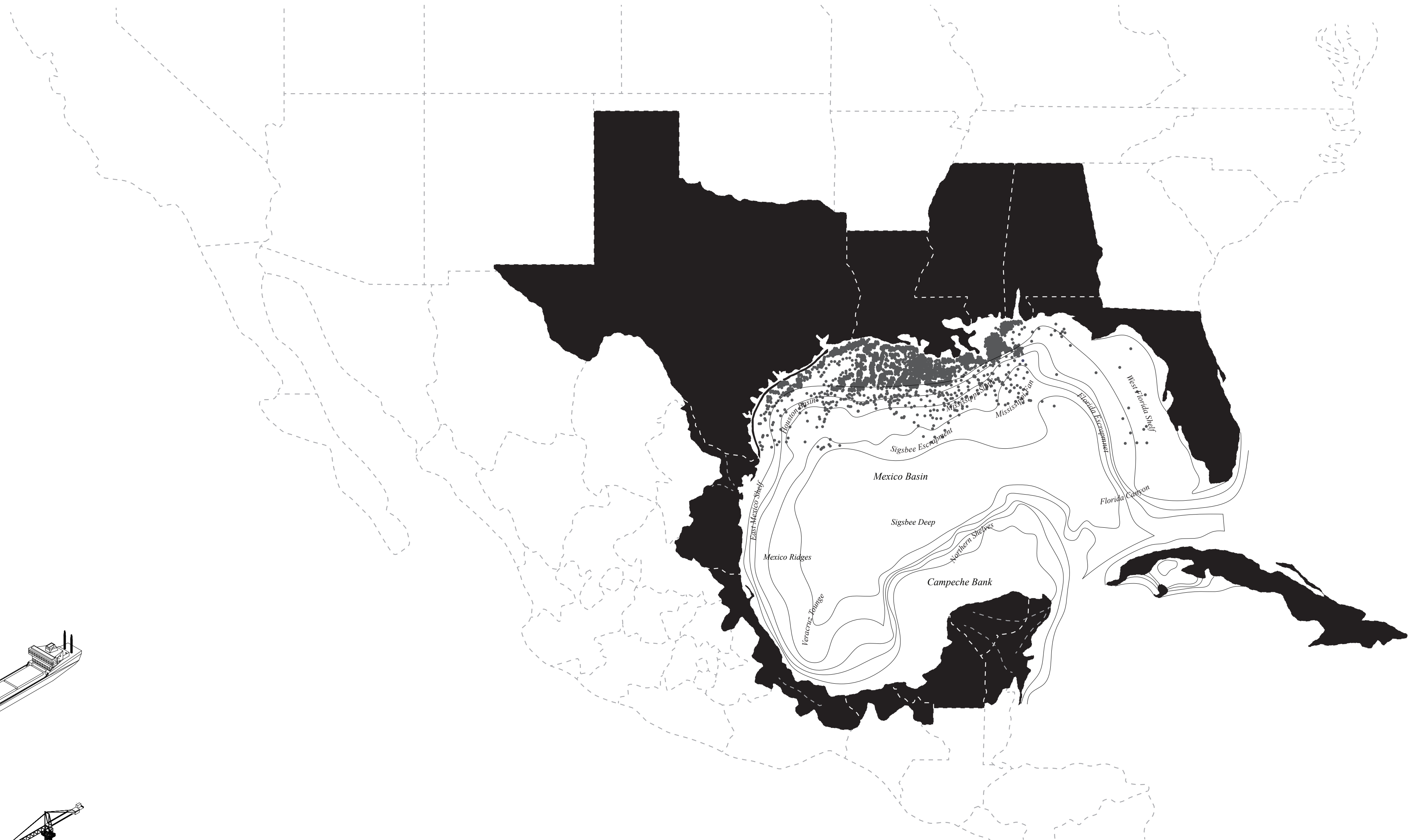
Figure 3. This map shows the largest cities along the Gulf of Mexico. The diameter of the circle indicates total urban population of the respective city.

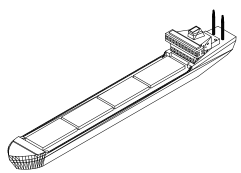
(SELF)DEFENDING GULF

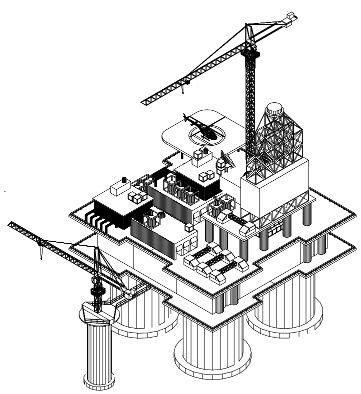
The Gulf of Mexico may be seen as common ground between Mexico, Cuba, and the United States. It connects three countries, three distinct political regimes, and three different cultures as they have evolved over time. Across political boundaries, the fragile ecosystems around the Gulf are facing similar threats both natural and man-made. Environmental threats like Hurricane Katrina in 2005 or Harvey in 2017 underline the potential risk this common ground and its coastal settlements are exposed to. Defined as a “large, productive, warm-water ecosystem”[5], the Gulf naturally protects the shorelines through salt marshes and mangroves nearly along the entire coasts of Mexico and Cuba and major parts of the US. In addition, large portions of the Texas Coast are sheltered by barrier islands. Thriving ecologies of corals, fish, and wetlands have been capable to adopt naturally to changing environmental conditions for thousands of years. The Gulf is a rich resource of life and of distinct species sharing a common habitat and provides access to both the inter-coastal waterway system, connecting the coast upstream all the way to Minneapolis, and also is a gateway to the world across the Atlantic or Pacific.[6] The geographical location created profitable conditions for settlement and trade within and beyond the Americas.

On the other hand, the Gulf of Mexico also is a gigantic industrial field. Deeply embedded into this large body of water, are roughly 52,000+ known boreholes, 5,800+ active leases, and 3,370+ oil and gas platforms pumping in Federal Waters of the United States only. Over the past decades, the oil industry in the Gulf has moved farther offshore, now drilling in deep (>305m, 1,000ft) and ultradeep water (>1,524 m, 5,000ft).[7] The harvesting of fish and hydrocarbons has significant impacts on the regional economies of the respective countries, states and cities along the shore. While Mexico produces three-quarters of its oil offshore in the Gulf, Cuba has temporarily stopped offshore drilling due to a lack of investors.[8]

Reaching back to the Maya Civilization from Yucatan to the Florida Peninsula, and to Cuba, the coastal territory around the Gulf has a long and culturally rich history. The South Texas Coast, located at Mexico’s frontier, was settled by Anglo-American traders in the 1830s, though the history goes back to Spanish







3,700+ permanent structures
in the US Federal Waters
of the Gulf of Mexico only

Figure 4. This map shows offshore oil platforms in the Gulf of Mexico. The dots indicate the locations of the platforms.

colonizers in the mid 18th century. Until today, the cities along the Texas coast are located at the estuaries of major rivers, which provide access to the hinterlands. Beaumont-Port Arthur to the north and Corpus Christi and Brownsville to the south, are the only larger cities along the sparsely populated Texas Coast, besides the metropolitan area of Houston-Galveston. The history of these cities shows the economic transformation from pre-industrial agriculture to a globally exporting petrochemical industry at the scale of other nations rather than other states within the US.

FROM COWBOYS TO OILMEN

The impacts of climate change on the Gulf of Mexico have become more visible in the past two decades. Human-based destruction of fauna and flora, off- and on-shore, has caused severe damage to the natural and built environment, locally, regionally, and globally.

After forty-five years, the US is now once again the biggest producer of crude oil. Among the 50 states, Texas has historically been a global player in the fossil fuel industry. If counted as a country, the State of Texas would rank as the third-largest oil producing country worldwide, after Russia and Saudi Arabia. While Texas is the biggest oil-producer in the US, it is also the biggest emitter of carbon dioxide. Relative to the US, the Texan economy employs

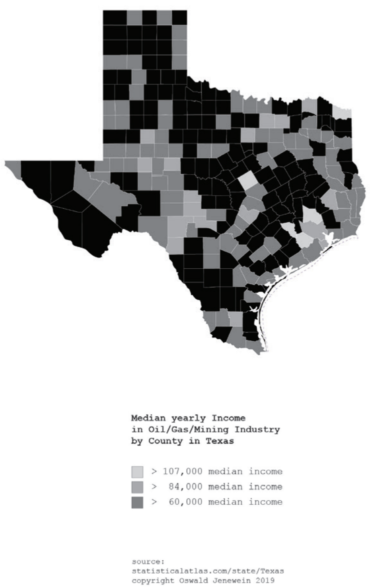


Figure 5. This map shows the median income in the oil/gas/mining industry in the respective counties of Texas.

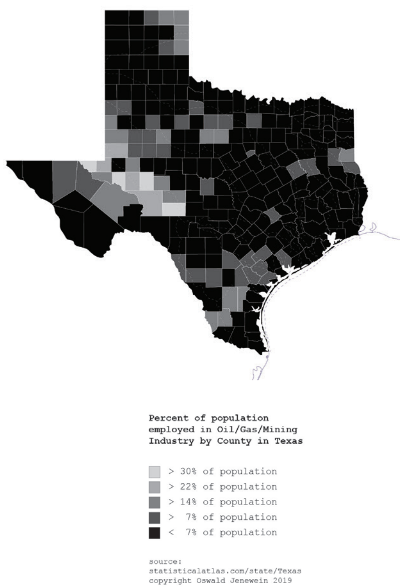


Figure 6. This map shows the percentage of population employed in the oil/gas/mining industry in the respective counties of Texas.

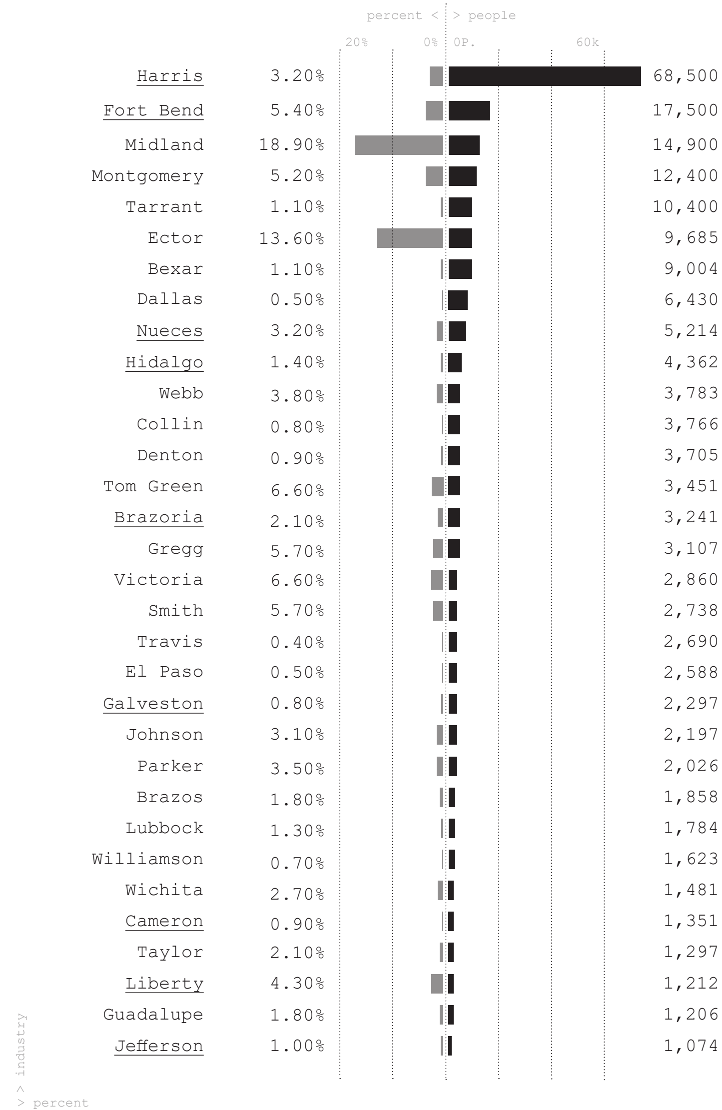


Figure 7. This chart shows the percentage of population employed in the oil/gas/mining industry in the respective counties of Texas.

+311 percent more people in the oil, gas, and mining industry than the average of all states combined.[9] This fact underlines how interwoven the Texas population and the petroleum sector are.

The Texas Gulf Coast is of particular economic importance for the petrochemical industry, although most of the oil production of the state takes place in the Permian Basin, around Midland in West Texas. It is the marina infrastructure that allows the Ports of Houston to rank second, the Port of Beaumont to rank fourth, and the Port of Corpus Christi to rank eighth largest in the US by total tonnage.[10] The dependencies of the cities along the coast on the fossil fuel industry have historically been a major premise for developing (urban) infrastructure between Texas' eastern and southern borders to Louisiana and Mexico.

The resource-extraction economy started to boom in east Texas around 1900, after the opening of the Spindletop oil field and the Houston Ship Channel about a decade later. Spindletop, a former salt dome near Beaumont, Texas, was one of the first major oil fields. Its symbolic nine-day gusher, supported the success of major corporations like Gulf Oil and Texaco. Dredging the Buffalo Bayou to allow for industrial activity, connected through the Houston Ship Channel to Galveston and the Gulf, was a major premise for the development of the thriving Port of Houston.[11] Similar engineering developments, dredging the Aransas Pass, enabled the Port of Corpus Christi to become a successful industry after its opening in 1926.

During the rise of Fascism and the collapse of European democracies between the world wars, petroleum was about to replace the international gold standard and became the largest commodity in world trade.[12] Within the following decades, the Texan population changed from a predominantly rural population of 80 percent at the beginning of the century, to about 80 percent urban population in the 1980s.[13] In 2017, a total of 6,815,035 people live in the counties along the Texas coast, including a population of 4,652,980 in Harris County around Houston, and 2,162,055 people distributed over the remaining 16 counties. These numbers highlight the fact, that the Texas coast is still 80 percent undeveloped. A little under a quarter of the Texan population lives along the coast while about 75 percent of the population lives within the Texas triangle, which describes the area between Dallas, San Antonio, and Houston. (While 25 percent of the Texas population lives in coastal counties, and 75 percent of the population lives within the Texas triangle, both of these numbers include Harris County as it is a coastal county and a part of the Texas triangle.)[14] Over the term of one century, Texas as a state of cotton and grain farmers, transitioned into the age of petrochemical industrialization, exporting oil and gas nationally and internationally. While the world started to connect the value of currencies to the movement of oil, Texas became a global petroleum super-power.

Located farther inland in a bay, all major Texan cities along the Gulf have the advantage of being waterfront yet not being fully exposed to coastal storms. Spanning from Sabine Lake to Upper and Lower Laguna Madre, the Bays of Galveston, Matagorda, San Antonio, Aransas, and Corpus Christi are home to the few larger cities along this mostly undeveloped coast.[15] Naturally protected by the barrier islands, from Galveston Island in the north, to Padre Island in the south, cities along the Texas Coast have struggled to find their identity. From

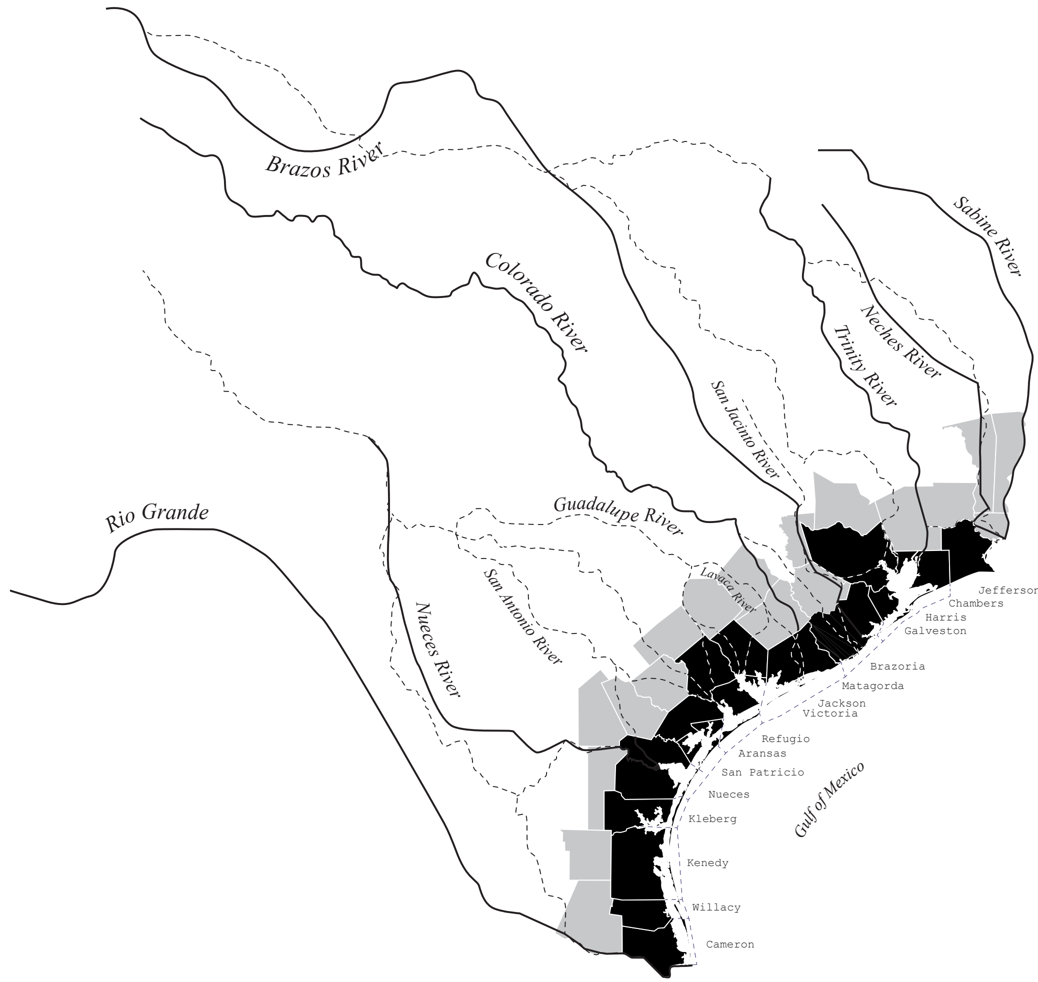


Figure 8. This map shows major rivers and plains in Texas alongside with coastal counties.

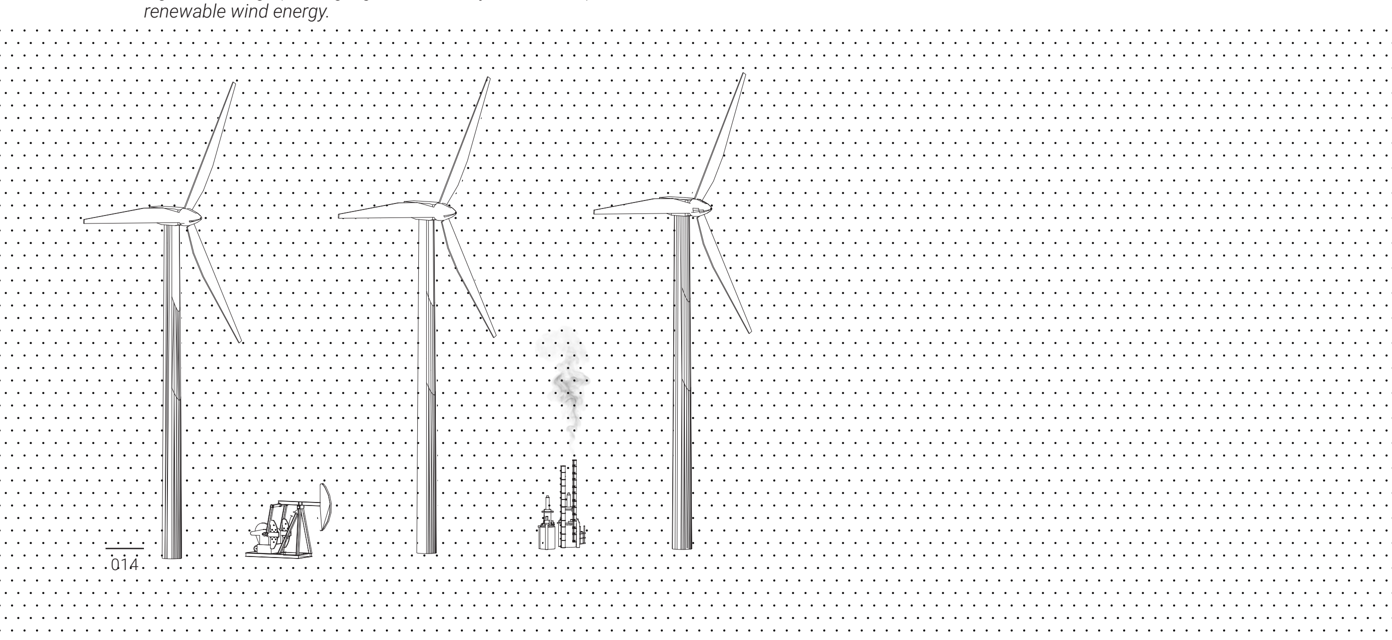
preservation areas like the Padre Island National Seashore, across thousands of square-miles of undeveloped marshlands, the Texas Coast would have potential for economic branches other than resource-extraction. The strategic geographic location was a factor to build and still maintain a variety of naval and air force bases. Within the twentieth century, Houston and Corpus Christi have also established major university campuses including top-tier educational facilities. Especially the south Texas coast has also become a respectable tourist destination, offering quiet beaches apart from the crowded tourist beaches in Florida or Cancun. The treasures of the Gulf coast are diverse and precious.

RESOURCE WONDERLAND

The Texas landscape is a fertile resource wonderland. The morphology of the coastal landscape, providing relatively protected areas for settlement within the Texas bays, also benefits from freshwater access. The water provided by rivers, bayous, creeks, and streams, supplies the coastal ecosystems along estuaries. The freshwater is enriched with carbon, nitrogen, and phosphorus, creating the habitat for microscopic plants and animals, which form the basis of the coastal food chain.[16] Wetlands, oyster reefs, and sea-grasses are home to unique species. Fisheries have historically been a major natural and economic asset way before the first boreholes punctured the sea floor of the Gulf. Harvesting the Texas land and water has provided economic wealth before and, hopefully, after oil.

Texas is the biggest oil-producer and the biggest emitter of carbon dioxide in the United States but it is also the number one producer of wind energy. Roughly 15 percent of electricity in Texas is produced by wind turbines, according to the Department of Energy. The flat, coastal landscape is an ideal laboratory for wind farms, producing carbon-free energy (not taking the construction process of the turbines itself into account). Besides wind farms in north and west Texas, coastal wind turbines produce about 12.5 percent of Texas' wind energy.[17] The transformation of energy sources towards sustainability has been ongoing and steadily increasing. In some parts of the state, the landscapes of oil and extraction, have started to extract another (re)source: data. In 2017, Amazon CEO Jeff Bezos announced the opening of a 253-megawatt Amazon Wind Farm in Scurry County, in West Texas. This agglomeration of 100 wind turbines produces energy for 90,000 single-family houses, theoretically.

Figure 9. This graphic highlights the new hybrid landscape of Texas: resource extraction vs. renewable wind energy.



Amazon is, alongside with Google, Facebook, and Microsoft, one of many companies which invests in wind farms, powering gigantic data centers around the world. In Texas, the Dallas-Fort Worth area has become a data-center-hub over the past years. In 2016, Facebook completed the construction of a one Billion Dollar data center in Fort Worth, also powered by wind.[18]

Wind power shifts the dependencies from oil slightly towards a renewable future, by adding variety to the energy industry. Yet, the Texas coast has also been a rich reservoir for lignite coal deposits from north-central Texas to the Rio Grande Valley at the border. Texas is the seventh largest producer of coal in the US, but the largest producer of lignite coal.[19] Along the Colorado River, the South Texas Nuclear Power Plant generates energy to supply Houston, Austin, and San Antonio. Located in the Matagorda Bay area, it is one of four nuclear plants in Texas. Wind, coal, and nuclear, each contribute a similar amount to the total energy production of the state, ranking third, fourth and fifth after oil and natural gas.[20]

Besides all the resources the state, and especially the coastal territory, provides nothing seems as powerful as Texas oil. The enormous hard infrastructure necessary to produce, refine, and distribute oil and natural gas, severely impacts other natural resources, both on- and offshore, and the potential environmental risk comparing wind turbines and refineries are incommensurable.

GLOBAL NETWORKS AND LOGISTICS LANDSCAPE

The significant geopolitical role of the Texas coast may easily be put into perspective, looking at the activity of the major seaports and airports. In addition, the thousands of miles of railroad tracks, alongside with the inter-coastal waterways, are connecting the Texas coast nationally and internationally, by land, sea, and air. Oil is constantly moving through Texas and beyond into the nation, and the world.

The gray infrastructure of the 19 Texas Gulf ports handled 563+ million tons of cargo and generated 367 billion Dollars in annual economic activity in 2015, according to the Texas Ports Association.[21] The spatial regime of logistical processes shaping the natural and built environment has a long history in human settlement. The Roman Empire expanded along their commercial roads, into landscapes encountered through a network of trade. Global logistics changed significantly in the twentieth century with the US Interstate and Civil Defense Highway system and the standardized shipping container. The concept of having a uniform container, easily adaptable to be transported on a track, train, or by ship, was a milestone in making global logistical processes possible. Cranes lifting these standardized vessels from one mode of transportation to another allowed for more efficiency in both time and manual labor.

Figure 10. Map Beaumont-Port Arthur

Figure 11. Map of Houston-Galveston.

Figure 12. Map of the Corpus Christi Bay area.

It became increasingly inexpensive to ship items from warehouses to ports and then around the world. This masterpiece of industrial design opened global markets to consumers, offering affordable goods to the public. The typology of a seaport expanded and transformed. Large storage facilities, warehouses, cranes, and security measures became quickly necessary. While the global shipping industry flourished, the US interstate system grew to allow for point-to-point delivery to remote areas and to connect the major seaports on the east and west coast.

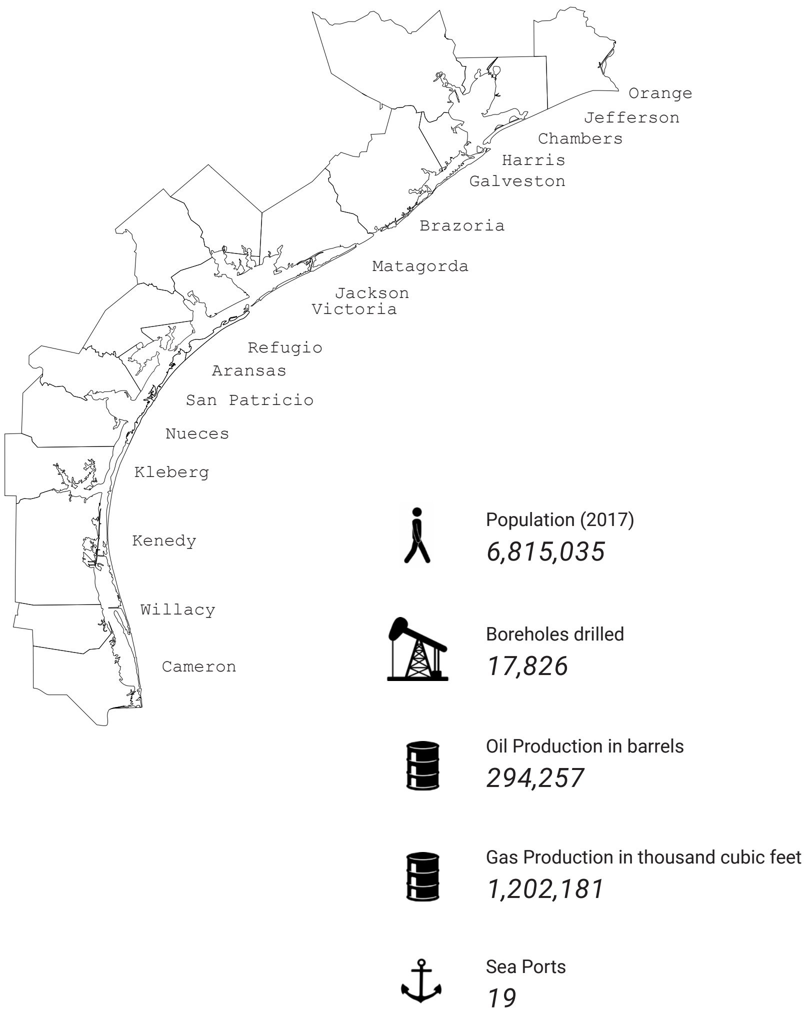


Figure 13. This diagram shows facts and figures on the daily operations of producing and refining oil and gas alongside with the total population in the coastal counties of Texas.

The increasing importance of shipping created the demand for designating more sea- and airports to foreign trade zones. “A foreign trade zone (FTZ) is an area designated by the federal government as outside of US Customs territory.”[22] Besides several inland FTZs around industrial airports, the ports of Houston, Galveston, Corpus Christi, Free Port, and Port Arthur are declared foreign trade zones. The success of most Texan ports is connected to the enormous amount of available land, making expansions, in the transition period from traditional city harbors to FTZs, possible.[23] As in many global ports, land needs to accommodate shipment, staging, and delivery of goods. However, Texan ports mainly focus on the petrochemical industry. From refineries under construction, to abandoned fields of corroding oil tanks, former wetlands are being destroyed. The global supply chain for crude oil and natural gas relies on Texas. Waldheim describes logistics landscapes under the realm of Post-Fordist Economies, as highly engineered and optimized spaces for accumulating and distributing goods. This might not represent the Texan reality of Post-Industrialization. Though, the global economy moves past production and towards services, Texan ports are growing in a traditional industrial way. The toxic brownfield has not become a remnant of a petrochemical past, it is very much the motor of growth in the neo-liberal resource landscape of Texas. As of January 2019, a total of 135 petroleum refineries are operated in the United States. From 2015-2019, four out of five newly constructed refineries were opened along the Texas coast.[24] The oil industry is growing, and it is growing in one of America’s petroleum heartlands: Texas. This late oil boom goes back to 2015, when the Obama administration lifted the US oil-export embargo from 1975. Ever since, the Texan ports have seen significant growth in producing, refining, and distributing oil and gas. Especially in south Texas, the Port of Corpus Christi increased its exports from 148,000 barrels per day in 2016 to over 700,000 barrels per day in December 2018.[25] This growth in the coast’s capacity to process oil is visible as both the natural and built environment have to react to these economic changes which again become a dominant spatial regime, shaping the coastal landscapes of Texas even more into landscapes of oil. These landscapes are transformed by private interests and private capital, leaving long-lasting impacts on the (urban) landscape. The regulations within foreign trade zones allow industrial development to be undertaken outside of city’s jurisdiction and make potential infrastructural synergies, like the use of cargo rail tracks for public transportation, a rare phenomenon. The benefits for the greater public realm based on the petroleum industry is often limited to blue-collar jobs in off- and onshore facilities. In addition, the environmental drawbacks striking through the coastal landscape of oil often outperform the economic benefits many times over.

(MECHANIC) LANDSCAPES OF OIL

The face of the Texas coast could not be more contrary: on the one hand, undeveloped, seemingly untouched landscape, a natural habitat for thousands of species. On the other hand, a symbol of the industrial age: a territory, where clusters of petrochemical facilities permanently changed the morphology of a place. What might look like a skyline of a mega-city from afar, are gigantic steel structures, perfectly engineered machines at the size of a small city. Permanently unaccessible to the public, surrounded by tall fences, and observed by hight-tech equipment, these industrial objects produce 24/7, while they are slowly corroding, cracking, and polluting the air and the ground.

The cities around and between the three Texan oil areas Beaumont, Houston, and Corpus Christi are "the products of hydrocarbon capitalism: a culture of automobility predicated on the availability of cheap gasoline to fuel the particular form of the internal combustion engine known as the car."[26] These cities are a product of the process of suburbanization mixed with and accelerated by fossil fuels. The shape of Texan cities is a consequence of burning this finite resource to commute, cool, heat, and to wrap goods. A concept, exported to the global market, ready to keep the world carbon-dependent.

The landscapes of oil are toxic. Besides the thousands of boreholes which puncture the earth's surface, corroding refineries pollute air, soil, and water using a mix of chemicals to process crude oil, gas, and coal. Refineries are major environmental polluters. Particulate matter, nitrogen oxides (NO_x), carbon monoxide (CO), hydrogen sulfide (H_2S), and sulfur dioxide (SO_2) are hazardous and toxic air pollutants. Many of these pollutants are known or suspected cancer-causing agents. Refineries are also major contributors to ground and surface water contamination. The use of deep-injection wells to dispose waste-water underground, is potentially contaminating drinking water. Soil contamination may occur during spills and other accidents in petroleum plants. Material collected and disposed in landfills may cause additional soil contamination off-site. Further, air and soil contamination may occur in the process of transporting crude oil before the refining processes, or while delivering the end product afterwards.[27] In the discourse of (landscape) architecture, brownfield contamination is important, as land ties the natural and built environment together. Approaching architecture through an ecological lens, demands holistic thinking. If industrial, or former industrial sites, contaminate the water supply or pollute the air within, or at the edge of a city, town, or settlement, this contamination becomes a spatial regime. Spatial, because these contaminations unleash a sequence of impacts in water supply and food chains. These impacts directly cause the natural and built environment, and its inhabitants, to suffer consequences, from health risks to property damage. Waste waters and runoffs into the Texas creeks, bayous, and rivers disturb the ecosystem. Fish and shrimps who live in, or farm animals who drink, water full of toxic by-products of petrochemical process, ultimately feed these toxins into the food chain.

Between the oil platforms and crude carriers off shore, tons of trash swims in the world's oceans. Especially plastics leave permanently negative impacts on the marine environment. Tracking the beaches of the five states on the US Gulf shores, on nine barrier islands from North Padre Island, Texas to Santa Rosa, Florida, scientists found ten times the amount of trash being washed onto the Texas coast than on the shores of any other state. Between 69-95 percent of this trash was plastics.[28] The components for plastic production are refined from crude oil. These oils are used as feedstock for petrochemical crackers that produce the basic building blocks for making plastics. Most of these materials are produced at crude oil and petroleum refineries, or are byproducts of natural gas processing.[29]

Plastic pollution in the marine environment of the Gulf of Mexico, pose chemical and physical threats to the ecosystem. Plastic particles can be found in coral reefs, beaches, rivers, estuaries, and even the deep sea.[30] The negative impact of microplastics on sea-life is evident, however, the internationally peer-reviewed expert panel reports by EFSA calculate, that "microplastics may have a negligible effect on the exposure to some pollutants and additives considering the total dietary exposure of humans."[31]

The built environment is embedded into the natural environment. Permanently. The complex logistical systems which ship goods to remote areas and provide fuel for transportation, heating, cooling, and energy production, are harming the environment and everyone within that environment, severely. Though some impacts may do less damage than others, the long-time impacts on the food-chain cannot be fully investigated just yet.
Certainly, the impacts on fauna and flora have been devastating. Besides air, water, soil contamination and oil-based plastic in seafood, petrochemicals are also part of modern agricultural processing, especially in fertilizer production. In many ways, fossil fuels have become part of the water we drink, the food we eat, and the air we breathe. Alongside with these pollutions, spills and accidents are a major threat to ecosystems on land and water.

SILENT SPILL

The danger of petroleum facilities drilling for, or refining, crude oil on land, contaminating grounds, air, and water, is evident. While the environmental impact of offshore drilling sites might often be as severe, leaks and spills are often not detected right away, given the remote location outside of human settlements.

Exposed to the extreme environment offshore, the thousands of oil platforms in the Gulf of Mexico have to withstand wind and waves. The steel structures within this humid and salty environment are aging, corroding, and not always able to handle the forces of nature. In 2004, category three Hurricane Ivan damaged and sank the Taylor Energy Mississippi Canyon 20 drilling platform, 12 miles off the coast of Louisiana. While the Taylor Energy Company estimated that three to five gallons per day have been leaking into the Gulf, the scientists from the National Centers for Coastal Ocean Science have calculated that up to 500 times this amount was released into the marine environment. The calculations of the research teams estimate between nine and 108 barrels (378 to 4,536 gallons) were spilling into the Gulf per day.[32] The remnants of this platform have been leaking for over 14 years, making this oil spill the worst environmental offshore disaster in history. The extreme discrepancy between the estimated gallons spilling into the Gulf daily, provided by the operator, versus the actual figures provided by a collaboration of various research centers, over a time period of 14+ years, shows how silent spills may have poisoned the Gulf in the past beyond the known catastrophes.

Perhaps the most publicly known oil disaster in the Gulf is the Deepwater

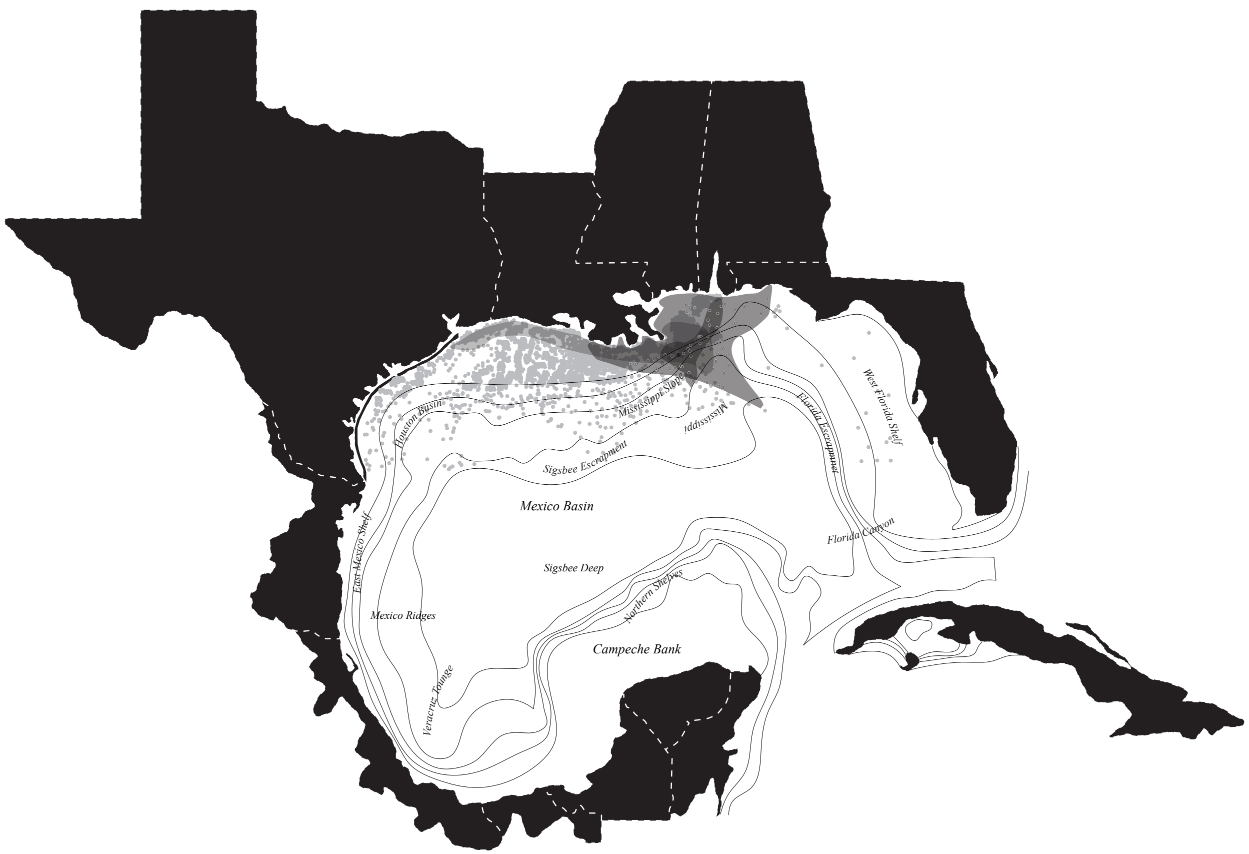


Figure 14. This map shows the impacted water surface after the Deepwater Horizon Oil Spill in the Gulf of Mexico.

Horizon spill. An explosion sank this oil rig operated by British Petroleum and killed eleven people on April 20, 2010. Underwater cameras showed, that oil and gas were leaking into the deep sea roughly 1,500 meters below sea level of the Gulf. This permanently dark underwater environment, 42 miles off the coast of Louisiana, set extremely difficult conditions for the process of capping the boreholes. Over 87 days, an estimated 3.19 million barrels leaked into the Gulf, impacting 1,300 miles of shoreline in five states. Marine life has been exposed to oil and gas by inhalation, aspiration, ingesting contaminated sediment, water, or prey, or by absorbing contaminants through their skin. Beyond these catastrophic events, their impact on human life, and the marine environment, the use of highly toxic dispersant added another layer of ecological hazard to this disaster.

Corexit 9500A and Corexit 9527A had been used as dispersant and were sprayed onto the Gulf's surface in the aftermath of the Deepwater Horizon spill. Corexit contains the toxin "2-Butoxyethanol which may cause injury to red blood cells, kidney or the liver with repeated or excessive exposure", according to the manufacturer's safety data sheet. About one million gallons of dispersant were applied to the impacted water surface through airplanes, and an additional 771,000 gallons were directly pumped into the water. Besides the risks for humans, other species like fish, corals, sea turtles, and birds have been severely impacted by the use of these toxins. Though other countries prohibit the use of Corexit, the Environmental Protection Agency EPA allows the use of Corexit 9500 and 9527. However, BP used a more toxic and less effective dispersant, produced by a manufacturer working in joint venture with the Exxon Chemical Company. While the EPA was aware of the use of unauthorized dispersant, they did not intervene in the first 30 days after the explosion, silently allowing these toxins to be spread. After the first month, EPA required BP to use a less toxic and more efficient dispersant. While BP kept using Corexit 9500A and Corexit 9527A, less dispersant was applied in response to the EPA's request.[33] This example of post-disaster management highlights the difficult relationship between governmental authorities and private cooperations in the drilling industry. The list of spills on the world's oceans and lands is long and seems to get even longer, even faster. Toxic chemicals used in various industrial processes may impact the environment. Water collects and distributes toxic materials. It transports fertilizers used in agricultural processes, all the way into the Gulf of Mexico and beyond.

Besides these major ecological disasters in the Gulf, many smaller accidents, causing spills, happen every year. The latest oil spill occurred in May 2019, in the Houston Ship Channel. It caused more than two million gallons of reformate, an oil-refining byproduct, to contaminate the water.[34] In the daily operations of petroleum processing, oil and gas get pumped into pipelines and trucks, to then be stored in fields of oil tanks, to then get processed in treatment plants, to finally get shipped around the world. The landscapes of oil are marked by these logistical operations. Fauna and flora suffer the consequences often more so, than people inhabiting the built environment, in which these processes occur.

EXTREME ENVIRONMENTS

Besides man-made disasters, the Texas coast is, like most coastal areas, an environmental danger zone. Threats to the built environment also occur naturally, and many times unpredictably.

Statistically, hurricanes occur every six years, measured in fifty-mile segments, along the Texas coast. Since 1829, the longest time period without a hurricane striking Texas, was a ten-year period, from 1989 to 1999, while in 1886, Texas was hit by four hurricanes in one year. While extreme wind speeds may be life-threatening, they definitely cause severe damages on the built environment. Even more dangerous than wind, are the heavy rainfalls tropical storms, cyclones, and hurricanes bring, flooding cites and lands. Making landfall as a category four storm on August 25, 2017 in Rockport, Texas, Hurricane Harvey brought devastating impacts. After meandering above Victoria, Harvey moved farther north bringing 50+ inches of rainfall to Houston. Harvey was the sixth major storm hitting Texas in the new millennial, yet has also been the most deadly storm in Texas history taking 108 lives, followed by Hurricane Ike in 2008 (84 deaths), and Rita in 2005 (59 deaths).[35]

Harvey damaged approximately 345,000 housing units in the Houston area, yet one of the most devastating impacts on both the natural and built environment, was done by hazardous spills and toxic releases as storm-water flooded the petrochemical sites around Galveston and Trinity Bay. Explosions and fires released toxic pollutants into the air leading to severe health problems in the days after Harvey.[36] NASA, local to the Houston area, prepared airplanes with high-tech equipment to monitor the toxic air pollutants aiming to warn citizens about potential health risks. Texas authorities and the EPA “stopped the NASA scientists from doing so, arguing that the air pollution data collection would cause “confusion” and might “overlap” with their own analysis.”[37] Yet another example of conflicts between private and collective interests.

(Petro)chemical industries are an enormous ecological risk, especially during natural disasters like hurricanes, tropical storms, and the flooding, as the toxic materials spill into the natural and built environment.

> *“Some 500 chemical plants, 10 refineries and more than 6,670 miles of intertwined oil, gas and chemical pipelines line the nation’s largest energy corridor. Nearly half a billion gallons of industrial wastewater mixed with storm water surged out of just one chemical plant in Baytown, east of Houston on the upper shores of Galveston Bay. Benzene, vinyl chloride, butadiene and other known human carcinogens were among the dozens of tons of industrial toxic substances released into surrounding neighborhoods and waterways following Harvey’s torrential rains.”*[38]

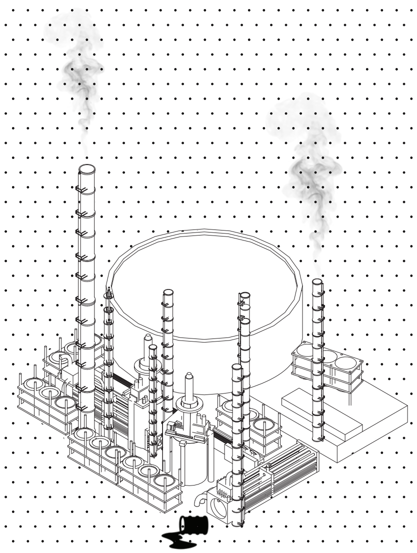
The post-disaster recovery began quickly after Hurricane Harvey. Thousands of volunteers working with the red cross offered immediate help providing medical assistance, food, water, and shelter. In fact though, day one after a hurricane, is only an undefined number of days away form the next disastrous storm and unpredictable floods. While the reconstruction of private and public infrastructure starts, the measures to protect the built environment with coastal engineering projects of an unseen scale, are treating the symptoms rather than the cause of these disasters: human-based climate change.

COASTLINE MORPHOLOGY

The hydrocarbon economy of Texas is embedded into the regime of western capitalism, in a conservative, neo-liberal state, with a long history of politicians who are declared climate change deniers. Parts of local, regional, and federal governments, supporting their campaign donors from the petroleum industry, have an interest to downplay the ecological impact of petrochemicals as the dependencies of Texan cities on oil are not just strong but growing.

Climate change highlights the paradoxic territory of the Texas coast. While global warming is fueled by the burning of fossil fuels, the repercussions of

Figure 15. Graphic shows an oil refinery: these industrial typologies pollute air, soil, and water as they process petrochemicals for a variety of uses in every-day life.



these burning processes now start to manifest physical impacts on the natural and built environment. The Texas coast is charging the disasters which leave its landscapes devastated.

Natural beaches have been exposed to the forces of nature since the formation of land. They have always been able to adapt to changing (natural) conditions. Huge storms might change the size or location of a beach but they will ultimately regenerate themselves naturally. Coastal engineers aiming to protect the built environment along the shorelines of the world, created huge problems for local ecosystems, often preventing natural regeneration processes after storms. Flexibility is crucial for the survival of a beach. Going back to 3500 BC, and perhaps even before that, mankind practiced coastal engineering on the shores of the Mediterranean Sea, the Red Sea, and the Persian Gulf. In the history of world trade across the oceans, navigation channels and harbors, and impressive pre-industrial constructions of wave shelters have been added into the coastal landscapes. The knowledge gathered in early civilizations from the Phoenicians, Greeks, Egyptians, and Romans was based on sophisticated construction methods, using cement to harden underwater structures. Even the dredging of ports and channels allowed for areas in the hinterlands, or upstream a river, to become accessible to Roman fleets.[39]

The concept of coastal areas as tourist destination also has its origins way before the French Revolution. Pompeii, Italy, for instance, served as a holiday location during volcanic eruptions of the Vesuvius going back to 30 BC. Along the shore of New Jersey, the development of a tourist-oriented industry already started in the early nineteenth century, at a time, when the Texas coast had barely been settled. To ensure the protection of waterfront developments, either soft or hard stabilization concepts are applied to keep shorelines in place. Soft stabilization or beach replenishment utilizes natural materials from other areas, often close to the existing beach: sand may be transferred from another beach or from lower or upper beach areas. Hard stabilization involves the construction of gray infrastructure, built objects permanently put into the coastal landscape, such as a seawall, groin, or offshore breakwater. These engineered constructions aim to prevent beach erosion, and/or to trap and accumulate sand to ensure the stability of a beach.

Hard infrastructure is associated with negative impacts of marine ecologies. The impacts include the erosion of adjacent beaches, increasing the height of surf-zone waves, reduction of water quality, turtle and bird nesting, or even the loss of well-functioning ecosystems.

Seawalls, groins, jetties, and other hard infrastructural typologies have been constructed along the Gulf of Mexico and the Texas coast ever since the 19th century. On September 8, 1900, a major category four storm on the Saffir-Simpson Hurricane Wind Scale hit the low-lying barrier island Galveston, located two miles off the shore of Texas City in the Houston area. At the time, Galveston was a Texan boom-town with thriving economy and tourism counting 40,000 inhabitants. The storm surge of approximately 15 feet damaged 3,500+ buildings and took well over 6,000 lives.[40] A board of engineers proposed the construction of a curved-faced concrete seawall rising 17 feet above mean low tide and stretching over 3 miles along the shore of Galveston Island. Behind the seawall, a 100-foot wide embankment was built alongside with the gigantic undertaking of extensive grade raising throughout the city. Completed in 1911, the elevation of major parts of the city was raised by 17 feet: a height-difference so extreme, that ground floors were transformed into basements while second floors became the new ground-floors.[41] The 1900 storm of Galveston permanently impacted the development of the cities along the Texas coast. This severe storm brought attention to the risk of human settlements along the shore of Texas. With the dredging and deepening of the Houston Ship Channel in 1909 and its opening in 1914, Houston was able to benefit from its geographical location farther inland and slightly more protected from major storms. Houston replaced Galveston as fastest growing port city of Texas.[42]

Similar developments took place in the other major port areas of Texas and beyond. The Gulf Intercoastal Waterway, a man-made canal, was constructed over decades and now connects ports over 1,300 miles along the Gulf shore from Brownsville, Texas to St. Marks, Florida. The Texas part of the Intercoastal Waterway spans 423 miles, handles over 50 percent of the United States' water traffic, and more than 90 million tons of cargo per year. As part of the Gulf Intercoastal Waterway, the Sabine–Neches Waterway connects Port Arthur and Beaumont to the Gulf since 1912.[43] Completed in 1936, the Brazos Island Channel and Port Isabel Channel was dredged to connect the Port of Brownsville and the Rio Grande Valley to the Gulf of Mexico.[44]

Perhaps the oldest ship channel of Texas is Aransas Pass in the Corpus Christi area. Located between Mustang Island and St. Joseph Island, this channel goes back to 1528 and has been deepened gradually over centuries. In the mid-eighteenth century, Texas legislature had authorized to dredge a seven-mile long deepwater entrance at Aransas Pass. Over years, efforts to stop the erosion of the channel failed. Dikes, revetments, sand fences, jetties, brush and stone mattresses, and tree plantings could not deliver the expected outcome of a permanently stabilized channel. It was not until 1885 until two jetties, a breakwater, and a mattress revetment finally allowed for permanent deepwater access through Aransas Pass.[45] Following a hurricane in 1919, the 12,000-foot-long seawall of Corpus Christi was built alongside with the downtown marina. Opened in 1923, the deep-water Port of Corpus Christi was connected to the Gulf by extending the Aransas Pass ship channel, through Laguna Madre and Corpus Christi Bay.

Over the past decades, the hurricane defense systems and flood protection systems along the Gulf shore have been maintained and expanded. These gigantic concrete monuments of the Anthropecene, aiming to keep the shores in place, have fulfilled their engineering task to a certain extend. However, unpredictable storms and even more so, extreme flooding, show the limits of coastal engineering in the age of global warming. The harmful impact of hard infrastructure along coast, beaches, and wetlands, has rather contributed to, than mitigated the natural forces which threaten the built environment.

BRIDGING OIL AND WATER

Disastrous storms like Hurricane Harvey, Irma or Maria, all happening in 2017, are examples of high-intensity storms, charged by global warming, due to the increased temperature of the Atlantic Ocean. In the aftermath of Hurricane Katrina in 2005, 14 billion Dollars have been spent to build a 1.8-mile-long seawall across Lake Borgne, off the shore of New Orleans, to protect the city from storm surges as high as 26 feet. An even bigger investment is the "Ike Dike" proposal off the shore of Galveston. The proposal includes a 70-mile-long system of levees and sea gates to protect the Houston-Galveston area for estimated costs of 36 Billion Dollars.[46] Enormous infrastructural projects have been, and will be necessary to protect coastal cities from natural disasters.

The petrochemical industry along the Texas coast is a major source of carbon emissions, of contaminating and polluting air, soil, and water. Yet, these facilities, located in Foreign Trade Zones are usually fenced, high security entities, not accessible for the public. A view of a refinery or the fields of oil tanks often is only possible from afar. The closest look into a refinery is usually provided when driving over a bridge. Suddenly, the city and its civil infrastructure, disappear in the rear mirror, and while the horizon appears ahead, stretching through the wide and open lands of Texas, one might get a glimpse into the world of industrial petroleum engineering along rivers, shores, ship channels.

Due to the increased oil production and export of crude oil and natural gas, Texan ports are growing. These growth processes demand infrastructural adaptations. While more land is sealed, covered with concrete, and while more toxic byproducts are being pumped into the earth, the reality of contemporary deep-sea ports is to provide access to bigger barges and ships carrying more barrels around the globe. The new era of VLCCs, Very Large Crude Carriers, and ULCCs, Ultra Large Crude Carriers, are a challenge for the natural and built environment. Bridges as an infrastructural typology play a key role in the three major port regions of Texas: Beaumont-Port Arthur, Houston-Galveston, and Corpus Christi. While the Rainbow Bridge in Port Arthur, opened in 1938, still remains to be the tallest bridge in Texas, the new Houston Ship Channel Bridge, as well as the new Harbor Bridge in Corpus Christi, are currently under construction. Both of these projects are directly linked to the petrochemical activity in the respective areas.

Billions have been and are being invested into large infrastructural projects which connect cities across industrial fields on land and water. The adaptation of urban infrastructure to accommodate the new era of crude carriers and vessels, will allow for a further expansion of petrochemical facilitates and cargo activity in Texas. These infrastructural investments, often financed by federal or state funds, are part of city planning for the hydrocarbon economy. While smart concepts on urban watersheds and storm protection often seem absent, projects to ensure further growth of Texas oil seem on the rise.
Again.

CONCLUSION: A POST-OIL GLIMPSE AT THE TEXAS COAST

The dialog between architecture and the (cultural) environment is manifested through the physical relationship to the ground. As rising sea-levels, storms and changing ecological conditions shift the edges of water and land, of habitable surface, architecture needs to (re)negotiate the relationship between object (building) and datum (land or water). Land as an entity, has the power to articulate authority, it provides resources and grounds architecture, metaphorically and literally, by tying environment and architectural creation together.

The physical analysis of a place starts with the very surface, the basis of architectural creation: land. Architecture as a phenomenological discipline must include the natural beyond the built environment and more: "drifting clouds, night and day, as well as feelings" according to Christian Norberg-Schulz.[47] The relationship between building and land demands to be renegotiated in a time, where changing weather patterns shift the edges of land and water and hence change the foundation of physical creation.

As history has shown, large-scale problems demand collective effort to be solved. Architecture as a tool of shaping the physical background of every-day-life asks for a complex set of parameters to be addressed at a collective scale. Parameters that directly impact the design of architectural objects, the relationships between these objects, and the relationship between objects and the whole, reach from material and immaterial site conditions to cultural impacts embedded into a specific context.

In 2016, the Department of Housing and Urban Development granted 48 million Dollars to the relocation of the citizens of Isle De Jean Charles, Louisiana. The people living on the island, situated on the Gulf Coast of the Mississippi Delta, are the first "Climate Refugees" of the United States. It is the first of probably many resettlement undertakings to come along the shores. Rising sea-levels will impact smaller cities, towns and dwellings the most, as these communities often lack the economic power to protect themselves through infrastructural mega-projects. The construction of man-made ship channels, waterways, deep-sea ports has mixed salty Gulf waters with the freshwater of the rivers, creeks, and bayous along the shore. The sensitive ecosystems have been able to adapt to changing natural conditions for thousands of years, yet, the impact of human activity on the local, regional, and global environment have been too severe for natural adaptation in many cases.

This Epoch of the Anthropecene, the impact of human activity on the climate, is visible. The Texas coast and its petrochemical industry have generated a new landscape: a landscape of oil and water. While water used to be a premise for settlement all over the world, it became a resource, equally crucial for petrochemical processing as for their distribution around the globe. The geopolitical impact of Texas oil, logistically distributed though the Texas coast, is huge. With well over one million barrels of oil products exported per day, Texas now produces more oil than Iran or Iraq.[48] This late oil-boom, following new legislature in 2015, is a fundamental parameter in the (re)formation and (re)industrialization of Texas' coastal landscape.

While Texas' coastal cities have been growing slowly or even shrinking over the past thirty years, oil has once again become a motor for growth. Unsustainable growth, as the history of industrial cities which failed to diversify their economic dependencies, have shown. While first access to water and fertile land was essential to human settlements, it soon became commodities, like salt, silver, gold and ultimately fossil fuels, which ensured economic growth over a certain period of time. Cities like Detroit demonstrate, how urban environments need to adapt to a changing economy to be successful – or risk failure. American industrial cities lack a variety of different economic branches across all salary ranges and become vulnerable socioeconomic entities.

As the global trends towards a Post-Industrial service-oriented society create new opportunities in how we might think and rethink settlement strategies and the development of cities, the reality along the Texas coast is different: the new Texan realities are old. They are shaped by global cooperations, extracting precious recourses faster, and of quantity, unseen before. The coastal landscapes of Texas are still largely undeveloped. Even though wind-farms have become a new type of coastal energy, shaping the landscape in addition to refineries and oil derricks, the long-term impact of burning a dark liquid, is going to be one of the most influential physical parameters to rethink where to build, rebuild or relocate human settlements.

The Texas coast as geopolitical territory, will remain to be a petroleum super-power for decades to come. It will also remain to be at the forefront of suffering the consequences of global warming fueled by oil. After this late oil boom, a variety of Texan coastal cities are at risk of becoming the Detroits of tomorrow: former industrial cities which will have failed to adapt to economic and cultural shifts and most importantly to (climate) change.

ENDNOTES

1 "Anthropocene" as define by Paul Crutzen; see article "The Anthropocene epoch. Have we entered a new phase of planetary history?" www.theguardian.com. (accessed 07/03/2019)

2 Jenewein, O., Post-Oil Envrionments; https://www.postoilenvironments.com/. (accessed 02/20/2019)

3 Mitchell, T., Carbon Democracy: Political Power in the Age of Oil. London; New York;: Verso Books, 2011, p. 109-112.

4 http://www.texas-drilling.com/ (accessed 08/02/2019)

5 Love, M., Baldera, A., Yeung, C., & Robbins, C. The Gulf of Mexico Ecosystem. A Coastal & Marine Atlas. New Orleans, LA: Ocean Conservancy, Gulf Restoration Center, 2013. p. 1-5

6 ibid., p. 17-20

7 ibid., p. 134-137

8 Marc, F., After offshore oil failure, Cuba shifts energy focus. Reuters online, https://www.reuters.com/article/us-cuba-energy/after-offshore-oil-failure-cuba-shifts-energy-focus-idUSKBN0GB1QN20140811. (accessed 04/03/2019)

9 Egan, M., Article "America is now the world's largest oil producer"; https://money.cnn.com/2018/09/12/investing/us-oil-production-russia-saudi-arabia/index.html. (accessed 03/07/2019)

10 See data on statista.com: "Leading ports in the United States in 2016, by tonnage; https://www.statista.com/statistics/184865/25-leading-us-ports-by-short-tons-2009. (accessed 04/14/2019)

11 Misrach, R., Orff, K., Petrochemical America. 1st ed. New York: Aperture, 2012. , p. 119-126.

12 Mitchell, T., Carbon Democracy: Political Power in the Age of Oil. London; New York; Verso Books, 2011, p. 109-112.

13 Lessoff, A. Where Texas Meets the Sea: Corpus Christi & its History. First ed. Vol number 21; Austin, TX: University of Texas Press, 2015., p. 19-37.

14 See Texas State Archives https://www.tsl.texas.gov/ref/abouttx/population.html. (accessed 08/02/2019)

15 Blackburn, J., A Texan Plan for the Texas Coast, First edn, College Station, TX: Texas A & M University Press, 2017, p. p. 54-73

16 ibid. p. 18-21

17 Druzin, R., While offshore wind gets developed, Texas will likely stay onshore; https://www.houstonchronicle.com/business/energy/article/While-offshore-wind-gets-developed-Texas-will-13015718.php. (accessed 05/20/2019)

18 Burrington, I. A Benediction for the Amazon Wind Farm Texas. Machine Land-

scapes: Architecture of the Post-Anthropocene. London, UK: Paul Sayer, 2019, p. 66-73
19 US Energy Information Administration; https://www.eia.gov/state/analysis.php?sid=TX. (accessed 05/01/2019)
20 US Energy Information Admisnistration, https://www.eia.gov/state/?sid=TX. (accessed on 05/10/2019)
21 Texas Department for Transportation; https://www.txdot.gov/inside-txdot/division/maritime/ports.html. (accessed 03/28/2019)
22 International Trade Administraion; https://www.trade.gov/enforcement/ftz. (accessed 04/25/2019)
23 Waldheim, C., Landscape as Urbanism: A General Theory. Princeton, NJ: Princeton University Press, 2016, p. 69-85
24 US Energy Information Admisnistration; https://www.eia.gov/tools/faqs/faq.php?id=29&t=6. (accessed 03/17/2019)
25 Port of Corpus Christi; https://portofcc.com/outbound-crude-oil/. (accessed 04/03/2019)
26 Mostafavi, M., Gareth D., and Harvard University. Graduate School of Design. Ecological Urbanism. Baden, Switzerland: Lars Müller, 2010., p. 450-455.
27 Hazardous Substance Research Centers/South & Southwest Outreach Program; https://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.files/fileID/14522. (accessed 05/09/2019)
28 Wessel, C., Swanson, K., Weatherall, T., Cebrian, J. Accumulation and distribution of marine debris on barrier islands across the northern Gulf of Mexico. Marine Pollution Bulletin, 2019; 139: 14 DOI:
29 US Energy Information Admisnistration; https://www.eia.gov/tools/faqs/faq.php?id=34&t=6. (accessed 02/20/2019)
30 Environmental Protection Agency. Toxicological Threats of Plastic. https://www.epa.gov/trash-free-waters/toxicological-threats-plastic. (accessed 07/12/2019)
31 Antão Barboza, L., Vethaak, A., D., Lavorante, B., Lundebye, A., Guilhermino, L., Marine microplastic debris: An emerging issue for food security, food safety and human health. Marine Pollution Bulletin, Volume 133, August 2018, p. 336-348
32 National Centers for Coastal Ocean Science; accessed on 06/07/2019, https://coastalscience.noaa.gov/news/mc20report/
33 Center for Biological Diversity; https://www.biologicaldiversity.org/programs/public_lands/energy/dirty_energy_development/oil_and_gas/gulf_oil_spill/dispersants.html. (accessed 04/21/2019)
34 Dropkin, A., What We Know About the Galveston Bay Oil Spill; https://stateimpact.npr.org/texas/tag/galveston-bay-oil-spill/. (accessed 02/19/2019)
35 Roth, D., Texas Hurricane History; https://www.weather.gov/media/lch/events/txhurricanehistory.pdf. (accessed 02/19/2019)
36 AIA Houston; https://aiahouston.org/v/site-page/Houston-2020-Visions/Harvey-and-the-Aftermath/9e/. (accessed 03/22/2019)
37 Union of Concerned Scientists; https://www.ucsusa.org/center-science-and-democracy/attacks-on-science/epa-blocks-nasa-monitoring-air-pollution-levels. (accessed 02/25/2019)
38 Sierra Club; https://www.sierraclub.org/compass/2018/04/toxic-aftermath-hurricane-harvey-covered-texas. (accessed 04/19/2019)
39 Pilkey, O. H., Cooper, J. The Last Beach. Durham and London, UK: Duke University Press, 2014. p. 40-46
40 National Ocean Service. https://oceanservice.noaa.gov/news/features/sep13/galveston.html. (accessed 07/12/2019)
41 Pilkey, O. H., Cooper, J. The Last Beach. Durham and London, UK: Duke University Press, 2014. p. 53-55
42 American Society of Civil Engineers. https://www.asce.org/project/houston-ship-channel. (accessed 07/12/2019)
43 Texas Department of Transportation. https://www.txdot.gov/inside-txdot/division/transportation-planning/waterway.html. (accessed 04/16/2019)
44 Port of Brownsville. https://www.portofbrownsville.com/about/history. (accessed 06/21/2019)
45 Texas State Historical Association. https://tshaonline.org/handbook/online/articles/rra03. (accessed 03/03/2019)
46 Houston Chronicle. https://www.houstonchronicle.com/news/houston-texas/houston/article/Ike-Dike-concept-raises-more-questions-than-it-13378121.php, (accessed 04/08/2019)
47 Norberg-Schulz, C. 1980, Genius Loci: Towards a Phenomenology of Architecture. New York: Rizzoli, p. 6-10
48 https://money.cnn.com/2018/08/23/investing/oil-exports-texas-houston/index.html. (accessed 04/03/2019)

CAPTIONS

Figure 1. The graphic highlights the relationship between the Gulf of Mexico as a geographical location and the operations of oil within it.
Graphic was generated using https://3dwarehouse.sketchup.com/?hl=en. (accessed 04/21/2019)

Figure 2. This chart shows the employment in various economic sectors in Texas relative to US average.
https://statisticalatlas.com/state/Texas/Industries#figure/county. (accessed 02/25/2019)

Figure 3. This map shows the largest cities along the Gulf of Mexico. The diameter of the circle indicates total urban population of the respective city.
https://statisticalatlas.com/state/Texas/. (accessed 03/02/2019)

Figure 4. This map shows offshore oil platforms in the Gulf of Mexico. The dots indicate the locations of the platforms.
Love, M., Baldera, A., Yeung, C., & Robbins, C. The Gulf of Mexico Ecosystem. A Coastal & Marine Atlas. New Orleans, LA: Ocean Conservancy, Gulf Restoration Center

Figure 5. This map shows the median income in the oil/gas/mining industry in the respective counties of Texas.
https://statisticalatlas.com/state/Texas/Industries#figure/county. (accessed 02/25/2019)

Figure 6. This map shows the percentage of population employed in the oil/gas/mining industry in the respective counties of Texas.
https://statisticalatlas.com/state/Texas/Industries#figure/county. (accessed 03/04/2019)

Figure 7. This chart shows the percentage of population employed in the oil/gas/mining industry in the respective counties of Texas.
https://statisticalatlas.com/state/Texas/Industries#figure/county. (accessed 02/25/2019)

Figure 8. This map shows major rivers and plains in Texas alongside with coastal counties.
Map generated using https://www.openstreetmap.org/#map=5/38.007/-95.844. (accessed 07/25/2019)

Figure 9. This graphic highlights the new hybrid landscape of Texas: resource extraction vs. renewable wind energy.
Graphic was generated using https://3dwarehouse.sketchup.com/?hl=en. (accessed 07/17/2019)

Figure 10. Map Beaumont-Port Arthur .
Map generated using https://www.openstreetmap.org/#map=5/38.007/-95.844. (accessed 05/25/2019)

Figure 11. Map of Houston-Galveston.
Map generated using https://www.openstreetmap.org/#map=5/38.007/-95.844. (accessed 05/25/2019)

Figure 12. Map of the Corpus Christi Bay area.
Map generated using https://www.openstreetmap.org/#map=5/38.007/-95.844. (accessed 05/25/2019)

Figure 13. This diagram shows facts and figures on the daily operations of producing and refining oil and gas alongside with the total population in the coastal counties of Texas.
http://www.texas-drilling.com/, https://www.tsl.texas.gov/ref/abouttx/population.html. (accessed 08/02/2019)

Figure 14. This map shows the impacted water surface after the Deepwater Horizon Oil Spill in the Gulf of Mexico.
Love, M., Baldera, A., Yeung, C., & Robbins, C. The Gulf of Mexico Ecosystem. A Coastal & Marine Atlas. New Orleans, LA: Ocean Conservancy, Gulf Restoration Center

Figure 15. Graphic shows an oil refinery: these industrial typologies pollute air, soil, and water as they process petrochemicals for a variety of uses in every-day life.
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