

What are the Environmental Impacts of Privatizing Mexico's Oil Industry?

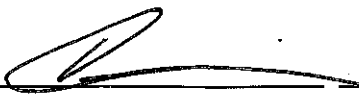
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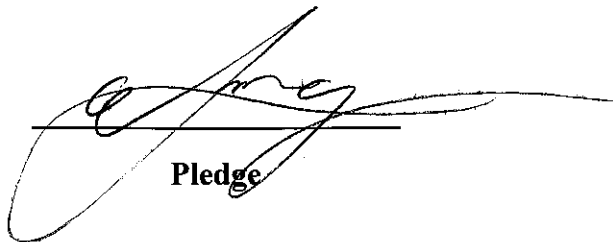

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Table of Contents

I. Acknowledgements	I
II. Abstract	II
III. Introduction	1
IV. Methods	8
A. Case Study - Ixtoc-I, Bay of Campeche, Mexico 1979	10
B. Case Study - Deepwater Horizon, Gulf of Mexico, United States, 2010	18
V. Discussion	26
VI. References	31

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Para Mamá Josefina y Papá Eduardo

To the Nicholas Academic Centers; Fernando, Rosa, Hugo, & Janae.

Thank you Professor Bethurem & Chris Allison

Did you hear about the rose that grew
from a crack in the concrete?
Proving nature's law is wrong it
learned to walk with out having feet.
Funny it seems, but by keeping its dreams,
it learned to breathe fresh air.
Long live the rose that grew from concrete
when no one else ever cared.

Long live

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Title: What are the Environmental Impacts of Privatizing Mexico's Oil Industry?

In 2013, the Mexican Government, under President Peña Nieto, approved energy reforms to increase economic output in the energy sectors. The denationalization of Mexico's state owned oil industry opened up the industry to private firms and investors worldwide. The reforms promised economic growth and access to deep offshore oil reserves in the Gulf of Mexico. However, offshore oil drilling has had catastrophic environmental effects throughout the world leaving behind damaged ecology and marine life. With the Gulf of Mexico being the main sight of drilling activity, the Gulf of Mexico and coastal communities are possibly facing environmental degradation and contamination. The goal of this paper is to evaluate the potential environmental impacts associated with increased offshore oil drilling in the Gulf of Mexico. In this study, I use a comparative case study approach to examine the impacts of two major offshore oil spills, the BP Deepwater Horizon in 2010 and the Ixtoc-I in 1979. Using documentary analysis of government documents and academic articles, I demonstrate the range of possible impacts linked to major oil spills in the Gulf of Mexico. My findings show that the ecological impacts of offshore oil spills are catastrophic to coastal communities and ecological biota and may be exacerbated if oil companies disregard protocol and safety. These findings and ecological impacts are also exacerbated by the fact that contingency technology has not improved as can be noted in both case studies.

Introduction:

Shortly after the culmination of the Mexican Revolution (1910-1920) freed Mexico from Spanish rule, the Mexican government exercised the powers granted by the newly created Mexican Constitution of 1917 to establish the rule of law, order and peace. Although Mexico's victory would lead the country to autonomy and democracy, British and U.S companies continued operating in Mexico during and after the revolution. Oil firms from these nations were particularly interested in Mexico's oil sector. Two of the most notable crude oil processors in Mexico at the time were the Mexican Eagle Company (a subsidiary of the Royal Dutch/Shell Company) as well as the Jersey Standard and Standard Oil Company of California (SOCAL – now Chevron)(Mexican Expropriation of Oil, 2017). The accord between private firms and the Mexican government allowed Mexico to become a prominent leader in the oil sector, second only to Saudi Arabia during the 1920's (Seelke, Villareal, Ratner & Brown, 2015). Although a major exporter, the Mexican oil workers were in constant conflict with the Mexican Eagle company over taxes and labor disputes. This dispute is relevant for it paved the way for Mexico to not only eventually free itself politically, but also economically, from foreign firms in the oil sector.

The first wave of protests over salary increases in the petroleum industry occurred in Tampico and Minatitlán in April 1915, followed by a second wave in 1916 and 1917 (Brown, 2004). Turmoil struck again on November 3, 1936 when the *Sindicato de Trabajadores Petroleros de la República Mexicana* (STPRM), the oil union, demanded a compensation package for oil workers due to previous failures to take care of oil workers financially (Archivo General De La Nacion, N.d). The Mexican Eagle company had maintained a record of

inadequate care and unfair treatment toward oil workers (Victor & Sheldahl-Thomason, 2017). Some of the demands by the STPRM included a \$2.3 million wage hike, guaranteed overtime pay, 18 paid holidays, 20 to 60 days paid vacation, health insurance, 25 days of severance pay for each year of service in the case of voluntary separation, 90 days of severance in the case of involuntary separation, housing benefits, and control over all hiring (Maurer, 2011). The company had stated in previous years, and all the way up to 1936, that it did not have the means to satisfy the demands. This led to an investigation by an independent committee, which revealed that the company had the financial means to satisfy the STPRM demands. The findings were supported by a 1928 financial newspaper from London stating on behalf of Royal Dutch Shell "Our Mexican subsidiary, Oil Company *El Aguila*, has obtained good returns during the last fiscal cycle" (Florescano, 1995).

On March 2, 1938 the Supreme Court of Mexico upheld a decision by the Federal Labor Board and ordered that the Mexican Eagle Company honor the demands of the oil workers and pay 7.3 million pesos towards benefits and wages (Gordon, 1940). Mexican Eagle reacted to the demands instead by closing 23 wells, moving oil stored in the fields to Tampico, a port city in the southeastern part of the state of Tamaulipas, Mexico, presumably for quick export, shutting down the Mata Redonda plant, and sending a letter to every employee stating that it would be unable to comply with the board's order (Brown, 1990). Facing imminent collapse of the oil industry, President Lazaro Cardenas intervened. In a bold attempt to regain peace and order, President Cardenas, on March 18, 1938, expropriated all foreign oil assets granted by Article 27 of the Mexican National Constitution thereby placing all hydrocarbons under command of the Mexican Federal Government. The expropriation of all sub-soil resources led to the creation of

PEMEX, *Petróleos Mexicanos*, or Mexican Petroleum, Mexico's first state owned oil company, which became a source of national pride, and a symbol of National sovereignty (Samples & Vittor, 2011).

Seventy-five years after the nationalization of crude in Mexico, PEMEX is struggling to counter declining oil production and reserves (Seelke et al., 2015) in a highly globalized market. Capitalizing on this throughout his candidacy for presidency in 2012, Enrique Peña Nieto promised energy reforms that would shift the playing field for Mexico economically and politically by opening doors for foreign investment in deep oil reserves in the Gulf of Mexico. After winning the election, his vision for a more developed petroleum industry was implemented on December 20, 2013, when President Enrique Peña Nieto ratified energy reforms ending the state monopoly on oil and gas production (International Energy Agency, 2017). Under these newly ratified reforms, Mexico was to remove "hydrocarbons from the list of strategic sectors that can only be developed by the government and allowed Pemex to form "profit-sharing" partnerships with international companies in exploration and production" (Seelke et al., 2015). On August 11, 2014, President Peña Nieto formally signed into law the proposed energy reforms of 2013 which included details on shares of oil exploration, tax process, and transportation methods (Seelke et al., 2015). The reform enabled major oil companies such as Royal Dutch Shell, British Petroleum and ExxonMobil, among others, to explore deep water oil fields in the Gulf of Mexico. President Peña Nieto's reforms might be regarded by his cabinet and himself as a strategic move, but there are citizens who claim that the intervention of private companies in Mexico dismantles the national identity (Blackmon, 2013). The reforms were met with resistance by political parties and citizens alike. The most outspoken critic of the reform, Andrés Manuel

López Obrador, leader of the leftist party known as, *Movimiento Regeneración Nacional*, or National Regeneration Movement, in an interview with Univision, stated (Lopez Obrador, Manual. Transcript from *Al Punto con Jorge Ramos*. 2013, August 13) In the interview, Obrador states [Translation]

“These are risks to the nation ... Peña Nieto has committed abroad to deliver the oil profits. That would be very serious because we have a budget due to oil. Of each Mexican peso of the national budget, 40 cents come from oil. If the oil income is given to individuals, nationals and especially foreigners, there would be no budget for public education, for health, and for the development of Mexico.” (Lopez Obrador, Manual. Transcript from *Al Punto con Jorge Ramos*. 2013, August 13)

A similar privatization case took place in Latin America in the early 1990's. In 1993 Argentina privatized YPF, *Yacimientos Petrolíferos Fiscales*, Fiscal Oilfields; shortly after, Argentina experienced a 70 percent increase in its oil production (Howell, 2007). Because privatization of YPF reduced the government's budget deficit, created room for an efficient oil market, and became a bedrock of financial stability, privatization of Argentina's oil market is a wonderful example of the benefits of petroleum privatization (Howell, 2007). From an economic standpoint, the transition to privatized oil could boost economic growth for a dwindling Mexican economy and an ineffective PEMEX. PEMEX oil production had begun a decade-long decline, falling by almost 1 million barrels per day by 2015 (Valenzuela, 2016). In addition to the lack of oil drilling technology and inability to invest funds into the deep offshore waters of the Gulf, PEMEX is plagued by corruption from the oil workers union (STPRM), heavy tax demands and illegal criminal tapings into oil pipelines all resulting in losses of millions of dollars (Seelke et al., 2015). For these reasons, Peña Nieto thought it beneficial to open its frontiers to foreign

companies practicing offshore oil drilling (Seelke et al., 2015; Vietor & Sheldahl-Thomason, 2017).

Offshore oil drilling may be a lucrative business for companies with the funds and technology, and may even benefit the overall Mexican economy, but the activity also potentially carries negative consequences. Offshore drilling has been known to be a risky and lengthy venture leaving oil residues and chemical dispersants that persist in the marine environment for many years (Kingston, 2002). Many of the private firms funneling money into Mexico have destroyed the ecology and communities of various countries and have done little to nothing in terms of remediation. For example, the Deepwater Horizon spill of 2010, although occurring on U.S waters, was one of the most catastrophic and haunting events in the history of oil drilling. Aside from resulting in a polluted and contaminated Gulf of Mexico, the oil spill also ruined Louisiana's coastal economy and ecology. BP, British Petroleum, responsible for the Deepwater Horizon spill, knew about a fault in the pipeline and did not act promptly; the result was 4.9 million barrels of oil—more than 200 million gallons—being spewed from the well, coating migratory birds, destroying pristine marshes, sullyng beaches, and inflicting incalculable damage to the ecosystem of the Gulf (Uhlmann, 2009). Another oil giant, Dutch Shell, has been responsible for environmental contamination in the country of Nigeria since the late 1930's (Agundu & Obaleke, 2004). According to the Nigerian Department of Petroleum Resources (DPR):

“between 1976 and 1996 a total of 4,647 incidents resulted in the spill of approximately 2,369,470 barrels of oil into the environment. Of this quantity, an estimated 1,820,410.5 barrels (77%) were lost to the environment. A total of 549,060 barrels of oil

representing 23.17% of the total oil spilt into the environment was recovered. The heaviest recorded spill so far occurred in 1979 and 1980 with a net volume of 694,117.13 barrels and 600,511.02 barrels respectively” (Nigerian Department of Petroleum Resources, N.d).

The irresponsibility of BP and Dutch Shell and their handling of environmental catastrophes casts worry and doubt about whether privatization is the right move for Mexico. The oil industry has also been known for financial corruption, environmental destabilization, and manipulation of government officials (Castaingts Teillery, 2009), effects that will be explained in the next section.

Although it is quite difficult to predict marine blowouts in offshore oil drilling, (blowouts are not very frequent), when they do happen, they often go on until relief wells can be drilled (Jernelöv, 2010). This can easily take months, and the amounts of oil discharged can become enormous during this time (Jernelöv, 2010). Not only is the oil spill detrimental to marine life, coastline and ocean water, but in this regard, can also be classified as state-corporate crime. Michalowski and Kramer (2006) define the concept as,

State-corporate crimes are illegal or socially injurious actions that result from a mutually reinforcing interaction between (1) policies and/or practices in pursuit of the goals of one or more institutions of political governance and (2) policies and/or practices in pursuit of the goals of one or more institutions of economic production and distribution.

Daly, (1999) states, “growth is uneconomic when it increases environmental and social costs by more than it increases production benefits.” Although Mexico’s economists predict a substantial monetary gain from the newly denationalized oil industry (Victor & Sheldahl-Thomason, 2017), the monetary gain could come at the cost of polluted waters, social-injustice, damaged ecology and irreparable damages to the environment. The ramifications of oil

spills affect all regardless of ethnicity, socioeconomic status, and arbitrary political barriers; and these effects last for years and are not easily erased from the memory of people nor from our history on this planet.

The purpose of this paper is to examine the possible environmental consequences that may come about as a result of privatizing offshore oil drilling in the Gulf of Mexico. Below, I examine two case studies, the Deepwater Horizon spill and the Ixtoc-I spill, in order to determine the possible environmental impacts of a future offshore spill in Mexican waters. With multiple oil companies being granted sites of potential oil reserves in the Gulf of Mexico, the possibility for offshore oil spills, equivalent to Ixtoc-I or Deepwater Horizon, are much more likely. I examine documents published by scientists, media, and government post offshore oil spills to outline the environmental impacts on surrounding ecology.

The environmental impacts of the Ixtoc-I and Deepwater Horizon oil spills can be used to inform the reader and the public, of potential impacts on the environment due to increased activity in the Gulf of Mexico.

Case Study Selection and Methods:

I examined two of the largest offshore oil spills to occur in the Gulf of Mexico. I examined the Ixtoc-I oil blowout of 1979 which occurred in the Bay of Campeche in Southern Mexico and the Deepwater Horizon oil spill of 2010 that occurred on U.S waters in the Gulf of Mexico. These two oil spills were chosen due to the proximity they have to coastal U.S and Mexican environments, and because they are similar in the fact that both incidents were a result of offshore oil exploration. Both are also sites of current and future oil development platforms as a result of the 2013 energy reforms in Mexico. Although the Deepwater Horizon occurred in U.S. waters, devoid from the Mexican energy reforms of 2013, for the purposes of this paper the location will be used to examine the impacts of oil.

Content analysis, document analysis of relevant peer reviewed journals, environmental assessments, and governmental documents was used to construct the case studies for both the Deepwater Horizon and Ixtoc-I spills. I chose to analyze these three sources of information to best articulate and outline potential implications for the offshore oil activities that are currently taking place in the Gulf of Mexico. I looked at the impacts caused by both spills the causes of both spills, and the cleanup process because the previous impacts upon the environment as a result of offshore oil drilling could be interpreted as precedent for impacts that may occur in case an oil blowout occurs in the Gulf of Mexico in the near future. The previous impacts also uncovered an unchanged remediation process which may serve industry leaders in the task of enhancing future remediation processes. The case studies provided information in regards to factors that contributed to the expansion of crude being distributed all over the Gulf. This is important to highlight in the event that a blowout does occur because knowing the behavior of

the environment is key to solving an oil spill in a timely fashion. If the information is applied to a scenario in which a blowout occurs, the potential impacts and consequences to neighboring coastlines may be prevented and/or reduced.

Each case study will have a brief introduction in regards to the oil spill and will transition to more detailed information relating to environmental impacts. The case studies will be divided into three sections. The first section will deal with oil behavior, the second with environmental impact, and the third with remediation. The section on oil behavior details the type of oil released, the estimated amount of oil released, and the surface distribution of the oil. The second section will outline and discuss the environmental impacts caused by the oil spills such as coastal areas affected, impacted flora, fauna and marine ecosystems, etc,. The third section will discuss contingency plans enacted to contain the oil, plug the well site and reverse the negative effects on the environment.

Case Study: Ixtoc I

Bay of Campeche, Mexico

1979

Introduction:

The Deepwater Horizon oil spill of 2010 is perhaps the most catastrophic oil spill of our time (National Commission on the BP Deepwater Horizon Oil Spill, 2011). However, the Deepwater Horizon oil spill is not the only oil spill of such magnitude. On June 3rd, 1979, in the southwestern Gulf of Mexico, the exploratory well, Ixtoc-I, exploded. The Ixtoc I Oil Spill in the Bay of Campeche of 1979 took 9 months to cap and is an example that Jernelöv (2010) states as to how difficult and risky offshore oil drilling is. In this incident alone, more than 3.4 millions of barrels of crude oil were liberated by the Ixtoc-I blowout into the Gulf of Mexico, for nearly 9 months (PC-EESC, 1980). The accident was further aggravated by the absence of a rapid response to control and mitigate the grave pollution affects on not only oceanic waters but also on the eventual transportation of oil mousse, sheen and tar balls toward the coastal zone by the prevailing surface circulation pattern in the area (Soto, Botello, Licea-Durán, Lizárraga-Partida, Yáñez-Arancibia, 2014).

As figure 1 illustrates, the southwestern Gulf of Mexico is composed of the Bay of Campeche and the Campeche Bank near the states of Tabasco, Campeche and Veracruz. PEMEX began the drilling of Ixtoc-I on the 10th of December of 1978, about 80 kms northwest of Ciudad del Carmen in the Bay of Campeche (Jernelöv & Lindén, 1981). The water depth of the drilling operation was 50 meters deep but according to Jernelöv (1981), drilling reached approximately

3600 meters below surface. The drilling operation continued into 1979 when the desired depth was reached (Jernelöv & Lindén, 1981). A crucial step of the oceanic drilling process is the inclusion of drilling mud. According to the National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling (2011):

“Drilling mud, which is used to lubricate and cool the drill bit during drilling, plays a critical role in controlling the hydrocarbon pressure in a well. The weight of the column of mud in a well exerts pressure that counterbalances the pressure in the hydrocarbon formation. If the mud weight is too low, fluids such as oil and gas can enter the well, causing what is known as a “kick.” But if the mud weight is too high, it can fracture the surrounding rock, potentially leading to “lost returns”—leakage of the mud into the formation. The rig crew therefore monitors and adjust the weight (density) of the drilling mud as the well is being drilled—one of many sensitive, technical tasks requiring special equipment and the interpretation of data from difficult drilling environments...Designed and used properly, drilling mud, cement and casing work together to enable the crew to control wellborn pressure. If they fail, the crew can, in an emergency, close powerful blowout-preventer valves that should seal off the well at the wellhead.”

On June 2nd, the absence of drilling mud in the drill site resulted in extremely high pressure. As noted earlier, drilling mud maintains the pressure in the drill site, however, when

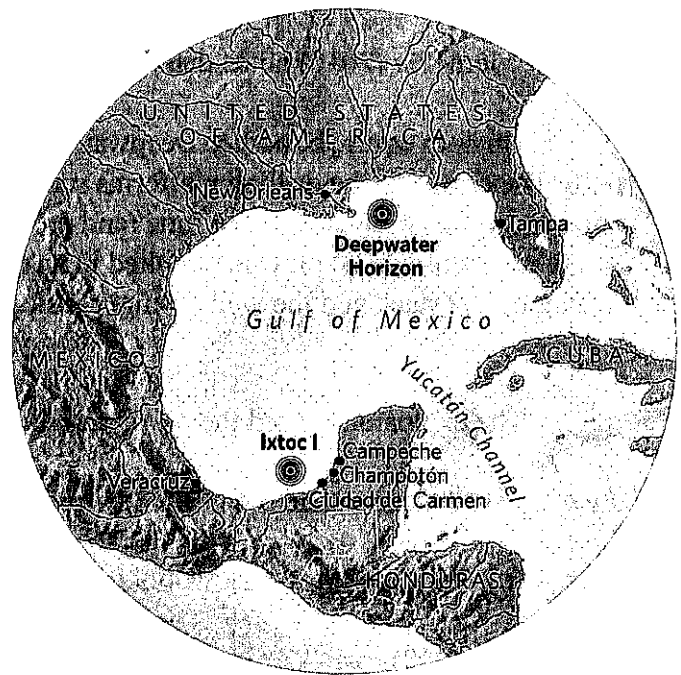


Figure 1. Ixtoc I proximity to neighboring Mexican States. Adapted from “Nature: The lost legacy of the last great oil spill,” by Mark Schroepe, 2010, retrieved from <https://www.nature.com/news/2010/100714/full/466304a.html>

drilling mud is absent, the end result is an exploding well site, and that is exactly what occurred in 1979 . Jernelöv (2010) notes that

“in both cases [Ixtoc-I & Deepwater Horizon], the pressure in the well was unusually high. The crews on the drilling platforms seem to have neglected warning signals to that effect and proceeded as usual. To save time (and money) they may even have skipped some of the safety procedures. The blowout resulted in an explosion and fire and the platform sank, damaging the stack and the well casing, causing the oil to gush into the sea from the bottom.”

The explosion caused the oil rig to fall under water on top of the oil well at 3:30 AM on June 3rd, 1979. More than 3.4 million barrels of crude oil [or 14,279,999,805 million US gal.] were released by the Ixtoc-I blowout into the Gulf of Mexico over a period of nearly 9 months (PC-EESC, 1980).

Oil Behavior

When assessing an oil spill, the most difficult task is calculating the amount of oil being released and the distance the oil will travel (Jernelöv, 2010). The Bay of Campeche was affected by the oil spill for a period of nine months. From the beginning to the end of this incident it was estimated by PEMEX that close to half a million tons of oil were spilled in 1979 (Jernelöv, 2010). Similarly, Jernelöv & Lindén (1981) note that the size of the Ixtoc oil spill may have been underreported in an attempt to ensure the safety and peace of mind of Mexican citizens. In other words, although many attempts were made to cap the well, every failed attempt was a reason for the Mexican government to report and underestimate on the amount of oil being spewed into the gulf.

An understanding of the type of oil released is always important for it allows the oil company to assess the impact on surrounding areas as well as maximize clean up efforts. In this case, the oil being released was light crude. Had the oil been a heavy mayan crude, the clean up efforts would have been much more difficult and the weathering of the oil wouldn't of been as rapid; heavier crude is usually more viscous (Jernelöv, 2010; Li, Cai, Lin, Chen, & Zhang, 2016). Weathering in this instance refers to "wear away or change the appearance or texture of (something) by long exposure to the atmosphere" (English Oxford Living Dictionaries, n.d). In this case, many factors had to do with the weathering and dissolution of the oil. Soto et al., (2014) state that

"part of the reason why oil was able to sink as quickly as it did is due in part to the consumption of oil by zooplankton, which attached itself to the emulsion of oil droplets in order to begin consuming the oil – and the excrement pellets produced by the zooplankton weighed down the oil, causing it to sink. The stratification of different waters caused the less dense oil droplets to sink faster, aiding to this process was sunlight that raised deposited oil on beach causing it to weather at a quicker pace."

Although natural factors allowed for dissolution of the oil, the oil slick was transported to the north and the west of the well from June until early September 1979 (Boehm & Fiest, 1982). Figure 2 illustrates the extent of the Ixtoc oil spill in comparison to the Deepwater Horizon Oil Spill of 2010.

Environmental Impact

The Ixtoc spill caused an immense amount of damage to offshore environments and coastal ecosystems (Soto et al., 2014). Soto et al., (2014) and Jernelöv (2010) state that the

effects of oil on ecosystems are as follows:

oil on birds feathers leads to the loss of insulation, which leads to hypothermia; oil droplets trap smaller marine creatures, leading to death; oil droplets get stuck on gills of fish causing sickness and death, which contributes to a loss of biodiversity and a loss of stock for fisherman; oil spills wipe out snails and algae grazers leading to an increase in growth of algae, resulting in massive amounts of algae that can disrupt marine life; oil destroys coral reefs

instantaneously, and the process to rebuild reefs is lengthy and uncertain; oil that makes it to the coast also kills mangroves. Neighboring communities that depend on shrimp suffered an economic impact as a

result of the spill. For example, this oil incident led to the decimation of three types of shrimp, which are important sources of revenue for Mexico: pink shrimp, *Penaeus duorarum*, the white shrimp, *Penaeus setiferus*, and the brown shrimp, *Penaeus aztecus* (Jernelöv & Lindén, 1981).

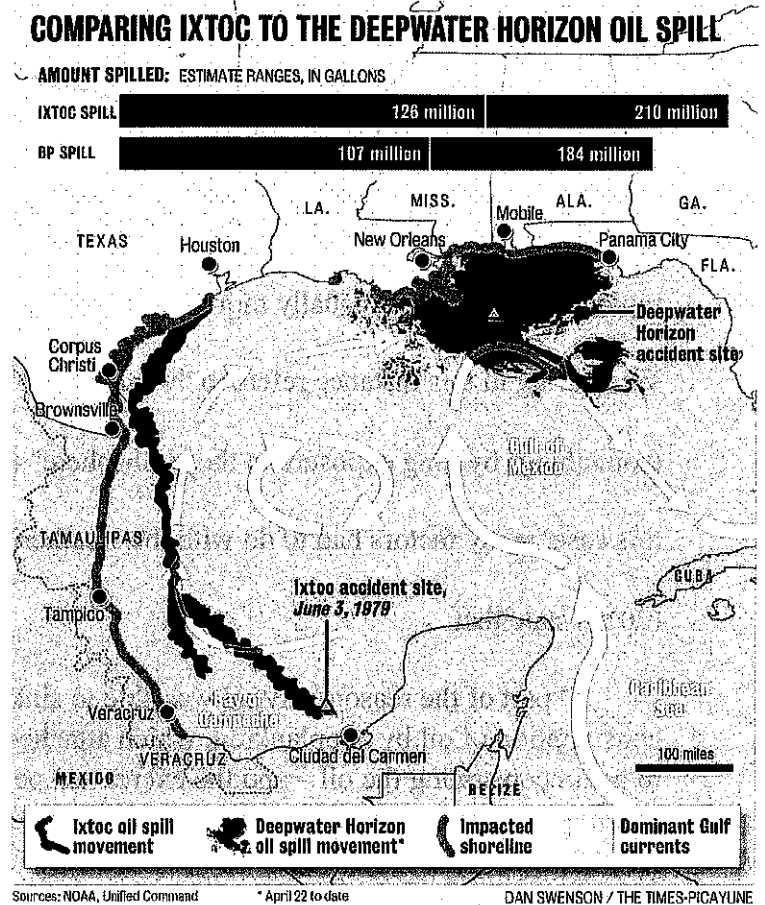


Figure 2. Ixtoc comparison to Deepwater Horizon Oil spill. Adapted from "NOLA: 1979's Ixtoc oil well blowout in Gulf of Mexico has startling parallels to current disaster," by Dan Swenson, 2010, retrieved from http://www.nola.com/news/gulf-oil-spill/index.ssf/2010/07/1979s_ixtoc_oil_well_blowout_i.html

Remediation

Soto et al., (2014) stated that the accident was further aggravated by the absence of a rapid response to control and mitigate the spread of the oil and the grave pollution effects not only in the waters of the gulf, but also to keep oil mousse, oil sheen, and tar balls from the coastal zone because of the prevailing surface water circulation pattern in the area. The lack of a concrete contingency plan in union with various external factors exacerbated the grave pollution effects not only in the Bay of Campeches oceanic waters but also other coastal environments due to the eventual transportation of oil mousse, sheen and tar balls... by the prevailing surface circulation pattern in the area (Soto et al., 2014) as seen in Figure 2. Many attempts were made by PEMEX to cease the flow of oil (Jernelöv and Lindén, 1981), but it was quite difficult due to the rig collapsing on the well itself (National Commission on the BP Deepwater Horizon Oil Spill, 2011). Although the well was not capped until nine months after the fact, several attempts were made to contain the oil within range of the epicenter, all of which failed. PEMEX handled the clean up of the oil by placing high sea booms, skimmers and absorbent devices to halt the spread of the crude (Jernelöv & Lindén, 1981). These approaches were partially useful, but not successful in actually containing the oil. Many external factors interrupted the success of the clean up such as wind, daylight and mechanical failure. Wind speed during fall and winter seasons caused bigger waves which exacerbated the issues of containment making it difficult for PEMEX to organize booms and barges. Poor nighttime visibility was another factor that made it much harder for clean up to occur. The visibility issue would make day operations the crucial point to contain as much as possible before sundown. In some instances, oil equipment also broke down, which halted the process of an already flawed remediation plan (Jernelöv & Lindén,

1981). For example, under wave heights of 3-4 meters tall, the equipment was rendered useless because booms and skimmers were not able to remain in place effectively (Jernelöv & Lindén, 1981). The waves also allowed the crude to ‘jump’ the booms and skimmers into open waters which would’ve made both these methods ineffective to some degree. With no real contingency plan and no preparation, the oil would travel as far as Texas, impacting beaches and ecology along the Texas coastline.

On June 9, PEMEX began to use planes and boats to spray oil dispersants on the spill site as part of the remediation plan.

According to Jernelöv

(1981), dispersants were initially sprayed 10-25 miles away from the coast, but during the fall,

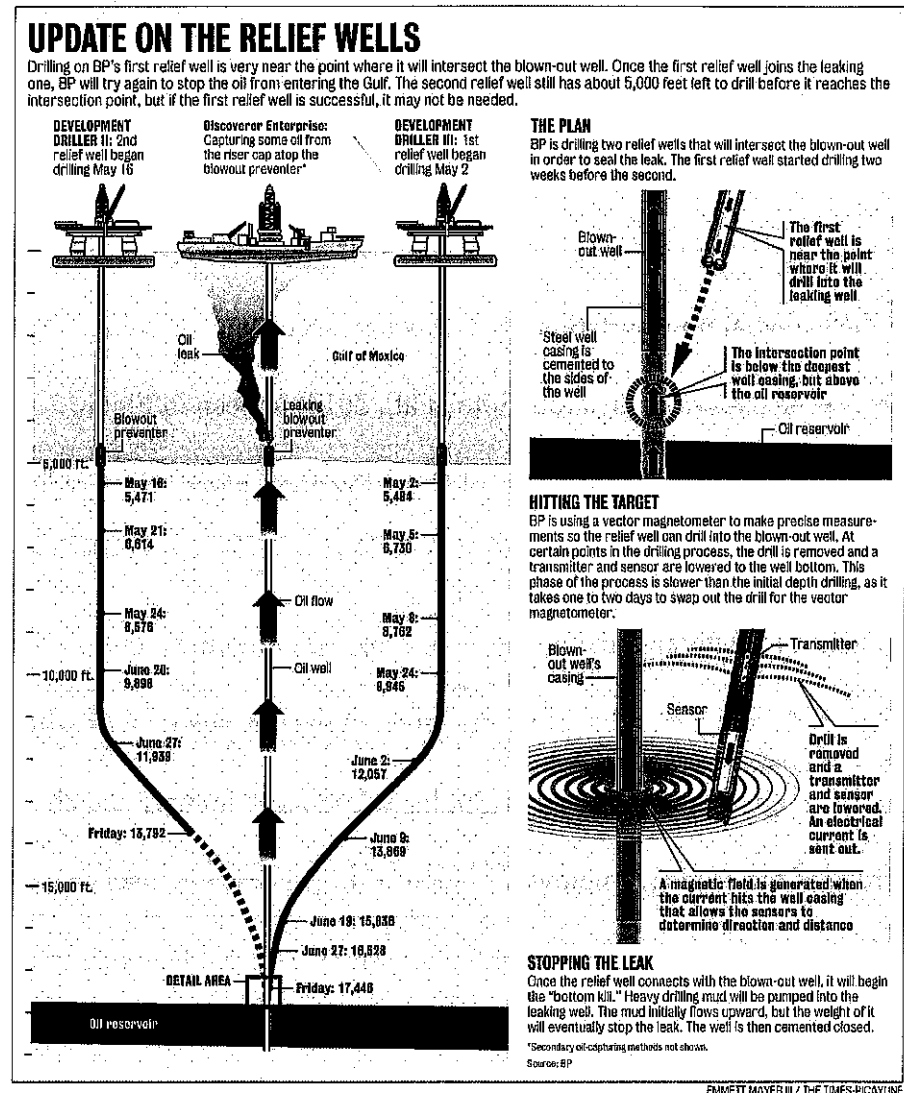


Figure 3. The basics of Relief Well Process. Adapted from “NOLA: How BP’s relief well will drill into the leaking well,” by Emmett Mayer III, 2010, retrieved from <http://www.nola.com/news/gulf-oil-spill/index.ssf/2010/07/>

between September and October, dispersants were sprayed near beaches. According to information received by PEMEX, at least 9000 metric tons were used, and, of this, at least 6750 metric tons were Corexit product (Jernelöv & Lindén, 1981). From day one of the explosion to the day of capping, the aforementioned methods became the sole solution for combatting the Ixtoc-I oil spill.

Jernelöv (2010) states that in deeper waters, blowouts are not very frequent, but when they happen, they often go on until relief wells can be drilled. In this case, two relief wells were eventually put into operation to plug the oil site. The drilling of Ixtoc relief well IA and IB began in June and the middle of July (Jernelöv & Lindén, 1981). On March 23, the pumping of mud into relief wells Ixtoc IA and IB capped the site ultimately ending one of the most catastrophic oil spills in history. Figure 3 depicts how a relief well operates to end the spill by diverting oil from the original damaged well. Although the Ixtoc-I spill occurred 39 years ago, impacts on the ecology and fisherman community require further study. Very limited amounts of information were ever published in regards to this spill which generates interest into the environmental impacts such as weathering of oil in the long term, mangrove impact and recovery, public health and economic impacts to name a few.

Case Study: Deepwater Horizon

Gulf of Mexico, United States

2010

Introduction

In 1979, the explosion of Ixtoc-I in the Bay of Campeche released 140 million gallons of oil in the Gulf of Mexico (which took five years to clear all the oil from the Texas beaches) (Smith, Smith & Ashcroft, 2010). The environmental impacts as stated in the previous section

depict the destruction that is propagated upon the environment when a disaster of this nature occurs. Although Ixtoc-I is faint in the memories of people, the image of disaster and destruction was portrayed once more

on April 20th, 2010.

Figure 4 portrays the burning and sinking of the British Petroleum

Deepwater Horizon oil



Figure 4. Deepwater Horizon Oil Rig under fire after explosion. Adapted from "The Washington Post: BP's big bill for the world's largest oil spill reaches \$61.6 billion," by U.S Coast Guard/Reuters, April 21, 2010, retrieved from https://www.washingtonpost.com/business/economy/bps-big-bill-for-the-worlds-largest-oil-spill-now-reaches-616-billion/2016/07/14/7248cdaa-49f0-11e6-acbc-4d4870a079da_story.html?hpid=hp_hp-top-table-main-bp-spill%3Ahomepage%2Fstory&hpid=hp_hp-top-table-main-bp-spill%3Ahomepage%2Fstory

platform off the Coast of Louisiana in the Gulf of Mexico.

On April 20th, 2010, the oil rig known as *Deepwater Horizon* exploded, initiating the discharge of over 800 million liters of oil, [or 211,337,741.49 gallons], into the Gulf of Mexico over approximately three months (Barron, 2012). At the time, the crew was completing the drilling of the exploratory Macondo well in water 5000 feet deep beneath the Gulf of Mexico, just 49 miles from the Louisiana coast (Summerhayes, 2011). The oil rig itself was “designed to operate in waters as deep as 8000 feet, and to drill down 30,000 feet (Coy & Reed, 2010). Before this incident, the rig was in the Gulf for several years at various oil fields prior to the April 20, 2010 accident. On that day, a methane bubble caused an explosion and a fire that burned for two days and sank the Deepwater Horizon (Smith, Smith & Ashcroft, 2010). The environmental impacts of this incident varied from region to region. For example, this incident affected the coastal wetlands of the Mississippi River Delta ecosystem, which constitute almost 40% of the coastal wetlands of the 48 conterminous United States (Mendelssohn, Andersen, Baltz, Caffey, Carman, Fleeger & Rozas, 2012); impacts from shoreline oiling and wildlife exposures and the results of coastal condition(s) (Barron, 2012); implications of the Gulf oil spill are immunotoxicity to aquatic invertebrates, fish, birds, and mammals (Barron, 2012); the white sandy beaches along Alabama’s Gulf coast were inundated with crude oil (Hayword, Clement & Valentine, 2011); and on commercial and recreational fishing, as well as mariculture (marine aquaculture) in the US Gulf area (Sumaila, Cisneros-Montemayor, Dyck, Huang, Cheung, Jacquet & Watson, (2012). Although, this incident did not run for a period of nine months such as the Ixtoc-I oil spill, for reasons still not clear, the blowout preventer (BOP) did not seal the wellhead as intended, and the well discharged to the Gulf for almost 86 days prior to being

capped and finally shut-in on July 15 (Griffiths, 2012).

Figure 5 illustrates the extent of the oil spill on coastal states.

Oil Behavior

An estimated 205 million gallons of crude oil were released into the environment (Blum, Bernik, Azwell, & Hoek, 2014), and

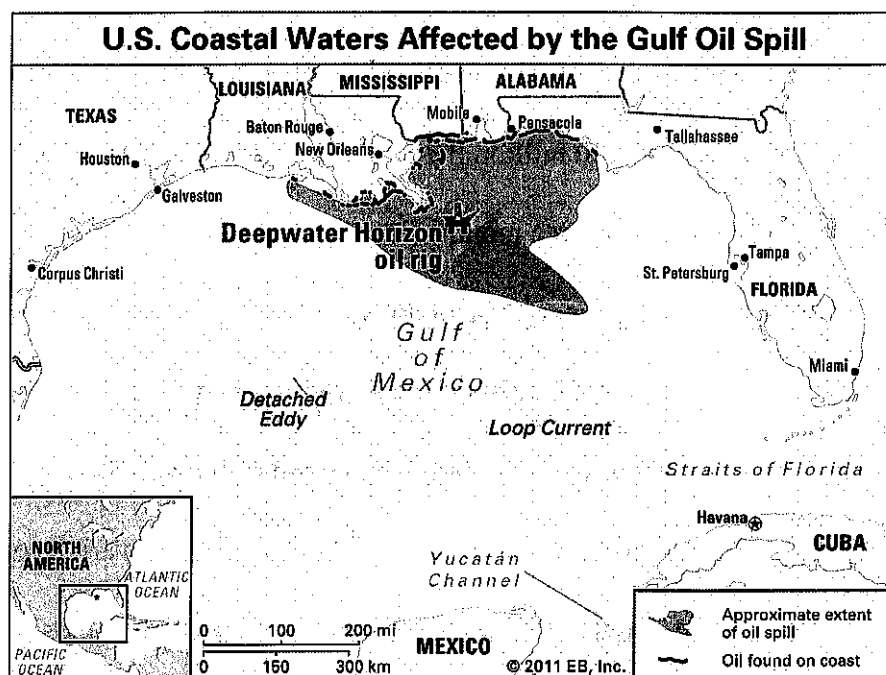


Figure 5. U.S Coastal Waters Affected by the Gulf Oil Spill. Adapted from “Gulf Ecological Monitoring and Modeling,” by Encyclopedia Britannica, 2011, retrieved from <http://www.ladcgemm.org/full-sized-map-2/>

upon surfacing, oil from the blown Macondo well was transported across the northern [Gulf of Mexico] (GoM), where it grounded on shorelines from Louisiana to Florida (Blum et al., 2014). Blum et al., (2014) also points out that “by the time the disabled well had been capped, oil had grounded on shorelines throughout the northern GoM, including sensitive wildlife refuges like the Chandeleur Islands in Breton Sound, and white sand beaches frequented by tourists in Florida, Alabama, and Mississippi.”

Environmental Impact

All oil spills documented throughout history leave behind a horrendous footprint of environmental disaster, ecological imbalance, and public health impacts (Li, Cai, Lin, Chen, &

Zhang, 2016;

Barron, 2012).

The oil released by the Macondo well site affected beaches, marine biota, fishery business, and coastal wetlands.

In the Report to

then President Obama, the National Commission on the BP spill (2011) stated that more than 650 miles of Gulf coastal habitats---- salt marsh, mudflat, mangroves, and sand beaches----were oiled, with more than 130 miles designated as moderately to heavily oiled. Figure 6 depicts the footprint of the oil, impacted shoreline, as well as impacted fauna and flora.

The coastal areas of the United States are also home to many species of birds, mammals, turtles and fish. The NOAA (N.d) (National Oceanic and Atmospheric Administration) lists 28 abundant marine mammals in the Gulf of Mexico with six of the whale species and the manatee...listed as endangered. To give a better idea of statistics, table 1 lists the following as a result of the oil spill (NOAA, N.d):

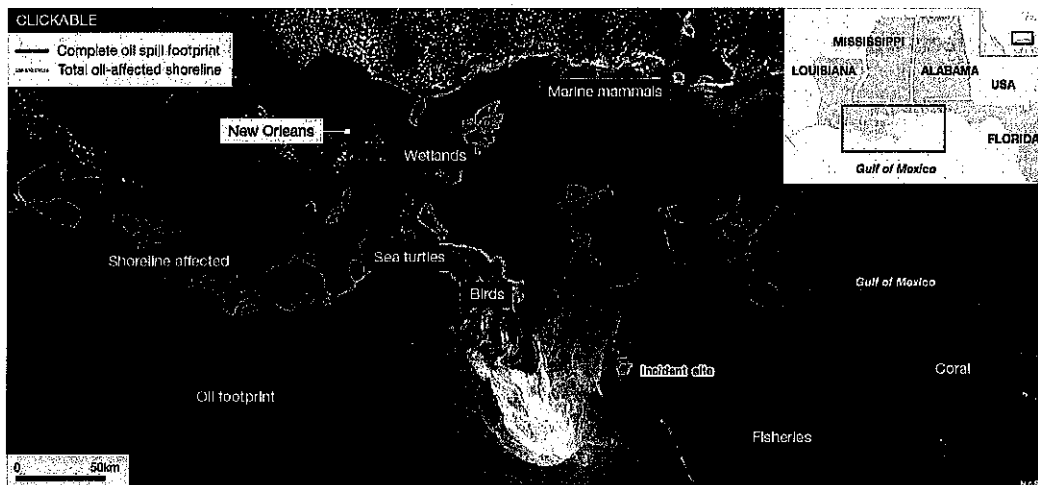


Figure 6: Oil extent & affected shorelines. Adapted from “BBC: BP oil spill: The environmental impact one year on,” by BBC, 2011, retrieved from <http://www.bbc.co.uk/news/science-environment-13123036>

Table 1: List of Impacts on Marine Wildlife as a result of the Deepwater Horizon Oil Spill 2010, NOAA, N.d

Fish	Red snapper, bluefin tuna, and spotted sea-trout are among species with known effects from the oil.	Shellfish in the Gulf affected by the oil spill included oysters, scallops, and several species of shrimp and crabs. Billions of shellfish were killed by oil that reached the shoreline,	Oyster reefs (aid in water filtration) were lost as a result of oil and may take years to recover.
Whales & Dolphins	Barataria Bay bottlenose dolphins were one of the most severely injured populations: 35 percent increase in death, a 46 percent increase in failed reproduction, and a 37 percent increase in adverse health effects compared with a healthy population.	Oil exposure resulted in up to an estimated 7 percent decline in the population of endangered sperm whales.	48 percent of the Bryde's whales population was impacted by the oil, resulting in up to an estimated 22 percent decline in population.
Turtles	4,900 and 7,600 large juvenile and adult sea turtles, and between 56,000 and 166,000 small juvenile sea turtles, were killed by the spill.	Nearly 35,000 hatchling sea turtles were also injured by response activities.	LEFT INTENTIONALLY BLANK
Birds	Bird species particularly affected. Ex: brown pelicans, diving ducks, wading birds, and piping plovers (a threatened species).	51,600 and 84,500 birds of at least 93 species died as a direct result of the spill. Ex: brown pelicans, laughing gulls, terns, skimmers, and northern gannets.	4,600 to 17,900 chicks died before they could fledge because their parents perished and did not return to the nest.

Remediation

BP moved towards its first attempt to kill the well completely through procedures called “The Top Kill” and “Junk Shot”... a top kill...involves pumping heavy drilling mud into the top of the well through the BOP’s (blowout preventer) choke and kill lines, at rates and pressures high enough to force escaping oil back down the well and into the reservoir. A junk shot complements a top kill. It involves pumping material (tire rubber and golf balls)... [which] impedes the flow of the oil and gas (National Commission on the BP Deepwater Horizon oil spill, 2011).

The National Contingency Plan (NCP) serves as the federal government blueprint for responding to oil spills in U.S federal waters. In accordance with the plan for coastal zones, the U.S. Coast Guard (USCG) was charged with overseeing the DWH oil spill (Blum et al., 2014). The same technology that has been employed in various other oil spills around the globe were also implemented in the Gulf. Such technology as containment and sorbent boom are often among the first response technologies deployed during offshore surface oil spills (Blum et al., 2014). During the DWH event, approximately 4.2 million feet of containment boom and approximately 9.1 million feet of sorbent boom were deployed—considered to be the largest deployment of boom in the history of spill response—to aid in skimming, *in situ* burning, and temporary shoreline protection (British Petroleum, 2010).

From April 20 to 26, BP and its contractors began the application of Corexit with an increase in dispersant from April 27 to May 3 (National Commission on the BP Deepwater Horizon Oil Spill, 2011). Although the technology for cleanup has improved over the last 30 years, cleanup does not necessarily mean complete removal of crude from the environment.

According to Jamail (2011), “there have been continued reports of oil flowing from Macondo (the oil well that caused the Horizon Oil Spill in 2010 in the Gulf of Mexico) in September 2011. During the 2010 oil spill, according to Bradshaw (2014), Chemical dispersants applied both at the surface and directly at the wellhead were the primary weapons to prevent the oil from reaching the shore. As the amount of toxic dispersants reached unprecedented levels, the Environmental Protection Agency (EPA) unsuccessfully tried to force BP to reduce its use of dispersants, but the US Coast Guard allowed the company to continue unabated (Bradshaw, 2014). Due in part to proprietary information, the ingredients of dispersants available for oil spill cleanup are not easily accessible and sometime unattainable. The National Commission on the BP Deepwater Horizon oil spill claims that from April 20 to 26, 14,654 gallons of Corexit were applied and from April 27 to May 3, 141,358 gallons were applied (National Commission on the BP Deepwater Horizon Oil Spill, 2011). However, it is important to note that BP may have underreported the amount of Corexit applied due to the toxicity and absence of information on the effects of Corexit. According to Blum et al., (2014)

“The total volume of chemical dispersant used in the GoM during the DWH event was approximately 1.8 million gallons. Dispersants were applied on the ocean surface by plane (“carpet bombing”) or boat. The first subsurface application of dispersants approved by the USEPA also was carried out during the DWH event. Approximately 800,000 gallons (44% of the total used) of dispersants were directly injected into oil flowing from the Macondo wellhead in an effort to prevent oil from reaching the surface near the incident site where crews were working to close the well.”

The application of dispersants is not always the most viable option for remediating spilled oil. Jernelöv (2010) states that the application of dispersants “helps to protect birds and beaches, but increases the harm to shrimp, squid, and small fishes.” In a recent study conducted

by Goodbody-Gringley et al., (2013) in regards to the impact of corexit on coral larvae, it was concluded that exposure of coral larvae to the dispersant Corexit® 9500 is toxic and will result in loss of coral recruitment. One report conducted a literature review of scientific research on the 57 chemical ingredients that were found in dispersants at the time of Deepwater Horizon. According to Earth Justice (2011), of the 57 ingredients, 5 chemicals are associated with cancer, 33 chemicals are associated with skin irritation ranging from rashes to burns, 33 chemicals are linked to eye irritation, 11 chemicals are suspected of potential respiratory toxins or irritants and 10 chemicals are suspected kidney toxins. Furthermore, there is also an array of potential effects on the marine environment. For example, 8 chemicals are suspected or known to be toxic to aquatic organisms, and 5 chemicals are suspected to have a moderate toxicity to fish (Justice, 2011).

According to the National Commission on the BP Deepwater Horizon oil spill (2011), BP had no available, tested technique to stop a deepwater blowout other than the lengthy process of drilling a relief well. The relief well that begun drilling in early May was completed in mid-September allowing cement to be pumped into the leaking well, ultimately sealing the reservoir and ending the Deepwater Horizon oil spill once and for all.

Discussion & Results

Based on the facts of both case studies, the environmental impacts due to offshore oil spills are clearly evident. Table 2 provides a compare and contrast table between Ixtoc-I & Deepwater Horizon. As evidenced, when an oil blowout occurs, the oil spews unto the environment until a relief well can be drilled. In the meantime while the oil is spewing, many attempts are made to halt the flow of the oil. In both the 1979 & 2010 events, the blowout preventer, which is a multi-ton stack of valves and pipes that sits atop deepwater wells to stop oil and gas from gushing upward in an accident, jammed (Hays, 2017). The impacts of the Ixtoc-I oil spill affected the shrimp business, coastal lines, set off ecological imbalances & spewed oil for a period of nine months. In the Deepwater Horizon oil spill, the coastal shores of Louisiana and Alabama were impacted, the seafood business was economically affected, public health became a major concern and ecological imbalances were noted. One topic of interest for further research is that as can be noted in both case studies, the same contingency plans were enacted; more research and more effective contingency plans for offshore spills, must be in place especially when it comes to the activities of the oil industry. In the 1979 oil spill, booms, burning of oil & dispersants were the techniques used to remediate the spill. The same approaches were used in the Deepwater Horizon oil spill of 2010. These incidents are thirty-one years apart yet the methods used were essentially the same. The impacts on the environment are not just caused by the oil itself, but also by the application of Corexit, which dissipates and is consumed by smaller marine organisms (Jernelöv, 2010); and which is considered a carcinogenic compound, as noted by an article by the Huffington Post “has been identified as one of the agents that caused liver, kidney, lung, nervous system, and blood disorders among cleanup crews in Alaska following the

Table 2: Comparison of Ixtoc-I & Deepwater Horizon Oil Spill

Information	Ixtoc-I	Deepwater Horizon
Year	June 3rd, 1979	April 20th, 2010
Location	Bay of Campeche, Mexico	Gulf of Mexico, U.S.A
Duration	9 Months	3 months
Oil Company	PEMEX	British Petroleum
Reason	absence of drilling mud in the drill site resulted in extremely high pressure	methane bubble caused an explosion and a fire that burned for two days and sank the Deepwater Horizon
Depth	3600 meters below surface	1500 meters
Barrels Spilt	3.4 million barrels of crude oil	4.9 million barrels of oil
Extent of Oil	North & West of the Well; Refer to Figure 2	650 miles of coastline; Refer to Figure 2
Contingency	sea booms, skimmers and absorbent devices, dispersants, relief well	containment and sorbent boom, skimming, <i>in situ</i> burning, and temporary shoreline protection, dispersant, relief well,
End of Spill	March 23rd, 1980	Mid-September, 2010

1989 Exxon Valdez spill” (N.a, Huffington Post, 2013).

Although the extraction and production technology employed by different private companies has improved (Slider & Ailworth, 2015), the remediation and technology methods employed to combat oil spills has not improved as can be evidenced through the examination of Ixtoc-I & Deepwater Horizon. Although there are preventive measures and contingency plans in place to combat oil spills, the threat of oil spills is more likely to occur with the increase of more oil extraction activities in the Gulf of Mexico. Numerous companies have taken advantage of Mexico's 2013 Energy Reform and have won bids of oil parcels in the Gulf of Mexico since its ratification into law in 2014. Big name oil giants such as British Petroleum, Shell, ConocoPhillips, Chevron, ExxonMobil, Norway's Statoil ASA, just to name a few, have invested in the deep oil reserves of the Gulf (Garcia, 2017; Whelan & Harrup, 2017). However, it is of noteworthy value to mention that besides the threat of oil spills, some of the companies investing and introducing new oil technology in the Gulf of Mexico carry with them a legacy of environmental neglect and contamination. British Petroleum's 2010 oil spill is an infamous example of environmental contamination and the detrimental effects of oil spills. Shell's environmental responsibility since the 1930's in Nigeria has given it a bad reputation amongst environmental scientists and communities throughout Nigeria. ExxonMobil and the ExxonValdez spill of 1989 is an infamous case releasing 11 million gallons of oil into the environment (Carson, Mitchell, Hanemann, Kopp, Presser & Ruud, 2003). Based off prior incidents regarding these oil companies, the Mexican government and Mexican people must be cautious of these oil giants because one slip up may have the potential to cause environmental destruction. The incidence of oil spills is not frequent, but when they occur the effects last decades. More research

is needed to assess the environmental legacy left by Ixtoc-I and although it has only been eight years since Deepwater Horizon, the environmental effects on marine life, coastal ecosystems, and public health have yet to surface over the long run. It is tough to predict when or where oil blowouts may occur but for the time being, Mexico, the U.S, private oil corporations and people will have to hope an incident of such magnitude does not occur.

Throughout the course of my research, I noticed that my findings on the Ixtoc-I oil spill were very limited. Jernelöv & Lindén (1981) stated that the Mexican government, at the time of the spill, selected what information to publish and who would release and do the publishing. The amount of information available made it somewhat difficult to find information relating to the incident and brought about doubt in regards to the validity of the information I used. As mentioned in the case study regarding Ixtoc-I, the Mexican government may have underreported and omitted information in an attempt to minimize the incident. Studies in regards to BP are still being conducted in terms of public health and ecological impacts. I chose not to address the public health issue for a number of reasons. First, little public health information is available in regards to the Ixtoc-I oil spill. The public health issue in regards to the Deepwater Horizon oil spill is a comp topic all on its own, and would've deviated from the original intent of this project; and given the timeline, would've been even lengthier.

At the time this study is being conducted, the Keystone oil pipeline that runs through South Dakota blew out resulting in 210,000 gallons of oil being spilt (Smith & Bosman, 2017). Although this is not relevant in location to the exploration of oil in Mexico, the impact and the opposition against the implementation of this pipeline were ignored. As mentioned earlier in the introduction portion of this paper, many Mexicans protested against the privatization of oil yet

the government went ahead and approved plans for the development of the offshore oil industry. And so there is a communal struggle here against big corporations, mainly geared against corporate greed, environmental degradation and societal toxins; by societal toxins I am referring to the stress and fear related to the abandonment of the voice of the people. Although the resistance against privatization is present, rarely is the movement acknowledged and looked upon as the correct measure to take in regards to environmental conservation. Through privatization and disregard of the peoples voice, days of peril and environmental uncertainty create a culture of increased environmental stewardship and of obligation to civil duty to fight against resource privatization. When moving forward with resource privatization and exploitation, two major perspectives are disregarded in an attempt to facilitate the process; history and the people. When history is disregarded, especially in the activity that has brought about so much environmental destruction through emissions and oil blowouts, we are silencing the voice of the past which preaches the truth for a more sustainable future. And when the voices of the people are heard but not taken into account, the risk factor for environmental impacts, especially in the oil industry, are dramatically increased.

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