The Real and Potential Health, Safety, and Environmental Issues from the 2010 BP Gulf of Mexico Oil Spill

Dale O. Ritzel, Ph.D., Dhitinut Ratnapradipa, Ph.D., Maria Alexandrova, M.D.

ABSTRACT

The April 20, 2010 Gulf of Mexico Oil spill created enormous challenges for public health and environmental health authorities. This paper examines those challenges and offers short-term and long-term views on the resultant effects of the spill.

Umwelt und Gesundheit Online, 2011; 4, 52-60.

Introduction

An explosion on the British Petroleum (BP) operated Deepwater Horizon oil rig killed eleven crew members on April 20, 2010 sparking the greatest environmental disaster in United States history. In combination with the Texas City Refinery Explosion and the Prudohoe Bay Oil Spill, this marked the third serious incident involving BP in the United States in five years (U.S. Department of the Interior, 2010). The Deepwater Horizon Oil Spill is also referred to as the BP oil spill, the Gulf of Mexico oil spill, the BP oil disaster, or the Macondo blowout (Paulnock, 2010).

Scientific estimates put the amount of oil being discharged from the broken well at above 1,470,000 US gallons per day! There are over 400 different species of animals living in the area affected by the spill. Approximately 464 sea turtles and 60 dolphins were found dead within the spill area (NOAA) (U.S. Department of the Interior, 2010).

BP operated oil skimmers and other cleanup tools to try to remove oil from the water and Louisiana began building oil containment beams to halt the spread of oil. On July 15, 2010 BP successfully stopped the flow of oil from the wellhead, after spilling 190 million gallons of oil into the gulf over a period of 3 months (U.S. Department of the Interior, 2010).

Deepwater Horizon Drilling Rig

The *Deepwater Horizon* was a 9-year-old semi-submersible mobile offshore drilling unit a massive floating, dynamically positioned drilling rig that could operate in waters up to 8000 feet (2,400 m) deep and drill down to 30,000 feet (9,100 m). It was owned by Transocean, operated under the Marshallese flag of convenience and was under lease to BP from March 2008 to September 2013. At the time of the explosion, it was drilling an exploratory well at a water depth of approximately 5000 feet (1500 m) in the Macondo Prospect, located in the Mississippi Canyon Block 252 of the Gulf of Mexico.

Deepwater Horizon Explosion

During March and early April, several platform workers and supervisors expressed concerns with well control. "BP executives either ignored these concerns or failed to take action quickly enough to avoid accidents. This negligence has led the U.S. Government to name BP the responsible party, and since have committed to hold the company accountable for all cleanup costs and other damages." (Roiz, 2010). At approximately 9:45 PM on April 21, 2010 methane gas from the well, under high pressure, shot all the way up and out of the drill column, expanded onto the platform, and exploded. Eleven workers were never found despite a three-day Coast Guard search operation, and are presumed to have died in the explosion. Efforts by ships failed and deepwater horizon sank on April 22, 2010 (U.S. Department of the Interior, 2010).

Volume and Extent of Oil Spill

About 36 hours after the explosion an oil leak was discovered on the afternoon of April 22, 2010 when a large oil slick began to spread at the former rig site. According to the Flow Rate Technical Group the leak amounted to about 4.9 million barrels (205.8 million gallons) of oil exceeding the 1989 *Exxon Valdez* oil spill as the largest ever to originate in U.S.-controlled waters and the 1979 Ixtoc I oil spill as the largest spill in the Gulf of Mexico (U.S. Department of the Interior, 2010).

Oil Sightings and Underwater Plume

Oil began washing up on the beaches of Gulf Islands National Seashore on June 1. By June 4, the oil spill had landed on 125 miles (201 km) of

Louisiana's coast, had washed up along Mississippi and Alabama barrier islands. On June 9, oil sludge began entering the Intracoastal Waterway through Perdido Pass (U.S. Department of the Interior, 2010).

On June 23, 2010 oil appeared on Pensacola Beach . By June 27, tar balls reached Gulf Park, the first appearance of oil in Mississippi. Early in July, tar balls reached Grand Isle which took effort of 800 volunteers were cleaning them up. On August 19, scientists reported conclusive evidence of a deep plume 22 miles (35 km) long (U.S. Department of the Interior, 2010).

Overview of Worker Events and the Cleanup

We decided to access local and news resources to determine what was occurring with the oil cleanup and potential concerns/problems with the oil cleanup workers. The results are presented by date for parts of May, June, and July.

May 4, 2010. The Louisiana Environmental Action Network (LEAN) and the Lower Mississippi Riverkeeper (LMRK) received and began distributing protective gear to the fishermen to utilize during cleanup activities. The protective gear consisted of half face respirators with organic vapor cartridges, goggles, gloves and sleeve protectors. LEAN and LMRK have continued to provide protective gear to fishermen and individuals going into the polluted areas (LEAN, 2010; Orr, 2010).

LEAN has gone to court and engaged the Occupational Safety and Health Administration (OSHA) in attempts to have the health and safety of the fishermen workers protected and to have BP provide proper training and protective gear to the fishermen (LEAN, 2010; Orr, 2010).

To offset the loss of livelihood, BP was encouraged to hire local fishermen, who have first-hand knowledge of the wetlands, marshes and water bodies. The fishermen were hired to install booms and absorbent pads to protect the coastal areas and estuaries and to participate in the crude oil cleanup activities. (LEAN, 2010; Orr, 2010).

May 25, 2010. OSHA's Assistant Secretary David Michaels ... asked that Admiral Allen stress to BP that their failure to address the issues in the memo raises serious concerns about the safety and health of the workers involved in the cleanup. "LEAN and LMRK have been working to protect the health of the fishermen who are working to address the crude oil disaster in the Gulf of Mexico and the estuaries and wetlands in the coastal areas" (Orr, 2010). BP has continued to fail to provide adequate protective gear and respirators to fishermen working in close proximity to the spilled crude oil and dispersants. The workers are afraid to complain, for fear they will lose their cleanup jobs, their only source of livelihood. BP has threatened to fire fishermen attempting to utilize respirators provided by LEAN, LMRK and other organizations (LEAN, 2010).

According to OSHA the "systems that BP currently has in place, particularly those related to worker safety and health training, protective equipment, and site monitoring, are not adequate for the current situation or the projected increase in cleanup operations. OSHA further underlined, "these are not isolated problems. They appear to indicate the general system failure on BP's part to ensure the safety and health of the workers responding to the disaster" (LEAN, 2010). BP representatives said the equipment was "unnecessary and would only spread hysteria" (YourLawer.com, n.d.).

"One of the areas documented by OSHA is BP's inadequate response to avoidance of heat stress and heat strokes by the cleanup workers on or near shore. OSHA expressed the need conveyed to BP for shade for workers and liquids to avoid dehydration and to watch carefully for signs and symptoms of exposure. However in response to the focus on heat stress and heat strokes, suddenly the use of respirators, to avoid inhalation of toxic chemicals, has been discouraged due to the threat of heat strokes. Such an approach trades off the breathing in of toxic chemicals for protection of workers from heat stress" (LEAN, 2010).

May 28, 2010. Cleanup efforts in the Gulf of Mexico were briefly halted Wednesday after four workers in three separate vessels became sick. Their symptoms included nausea, high blood pressure, chest pain, headaches and shortness of breath. "They say we don't need respirators," one fisherman said, shaking his head "I don't know" (San Francisco Chronicle, 2010).

May 30, 2010. "This scares everybody, the fact that we can't stop this well," - BP Chief Operating Officer Doug Suttles. "As of Saturday afternoon, May 29th, ten oil spill clean-up workers had been admitted to West Jefferson Medical Center (WJMC) in Marrero, Louisiana. All but two have been hospitalized suffering from chest pains, dizziness, headaches, and nausea." But the thought was, said [hospital spokesperson Taslin Alonzo], that symptoms were caused by some kind of chemical irritant. When asked if the hospital tested incoming cases like these for evidence of chemical exposure, Alonzo told me that it doesn't. "We just treat the symptoms," she said. No respiratory protection was issued, said [Coast Guard Captain Meredith Austin, Unified Command Deputy Incident Commander in Houma, LA] "because air ratings were taken and there were no values found to be at an unsafe level, prior to us sending them in there" (Science Blogs, 2010).

June 1, 2010. Hundreds of fisherman have been hired to attach booms to their shrimp boats in place

of nets and drive their boats directly through the oil slicks to corral and collect the oil that is spilling from BP's broken well in the Gulf of Mexico. These fishermen have one of the highest potentials for exposure to toxic air pollutants from the crude oil out of all of the responders working the spill. In addition to crude oil there is the added danger posed by the aerial application of dispersant chemicals and there have already been reports that fishermen working on the spill feel that they have been impacted by the dispersants. It is only prudent that these fishermen be provided respiratory protection and encouraged to use it. Instead, they have not only NOT been provided respiratory protection, they have been threatened with being fired for using their own respiratory protection (Louisiana Environmental Action Network, 2010).

June 2, 2010. About 20,000 workers are toiling long hours to clean up all that oil in the Gulf of Mexico. This is considered to be a dirty and labor exhaustive work. The question rose: are these workers endangering their health by spending all that time around crude oil and chemical dispersants? "Sometimes they are," says Damon Dietrich, an emergency room doctor at West Jefferson Medical Center, just south of New Orleans. The hospital has seen 11 cleanup workers in the past few weeks with symptoms such as dizziness, headache and nausea, Dietrich says. "We've got to believe that it's either the burning of the oil, working around the oil spill or the dispersants that are causing their symptoms," he says (National Public Radio, 2010).

The symptoms that health care workers were seeing from persons helping clean up the oil included dizziness, headache, nausea and heat stress. It was reported that high temperatures could release toxins that would otherwise stay locked inside of tar-balls. Also, it was reported that nearly a million gallons of chemical dispersant have been used to break up the oil in the Gulf, far more than was used in the Exxon Valdez cleanup in Alaska (National Public Radio, 2010).

"One fisherman working on the oil spill cleanup filed suit against BP after he was hospitalized for respiratory problems, headaches and nausea. The plaintiff sought to compel BP to give workers masks and not harass those who publicly voiced their health concerns. The complaint also requested that BP refrain from "altering, testing or destroying clothing or any other evidence or potential evidence" when workers become ill. In his affidavit, the plaintiff claimed BP confiscated his clothing after he became ill, and he was told it would not be returned.

According to CNN, the president of the Louisiana Shrimpers Association has also accused BP of threatening to fire fisherman – most of whom are unemployed because of the spill – from cleanup work if they complain about health problems. In some cases, workers have been threatened with firing if they wear masks, he said. CNN also reported that fisherman it contacted did not want to speak publicly, with some expressing fears that they could lose their jobs with BP "(YourLawer.com, n.d.; Democracynow.org, 2010).

July 21, 2010. *The Nation* magazine has revealed new details about how BP is receiving tax credits by relying on cheap or free prison labor to help clean up the Gulf spill. BP's reliance on prison labor has been criticized by many in the region since the disaster has left so many people out of work. However, the hiring of prison labor has apparently been financially beneficial for BP. Each new prisoner hired by BP comes with a tax credit of $2400. On top of that, BP may earn back up to 40% of the wages they pay to prisoners. Prison workers are required to work up to twelve hours a day, six days a week, and are liable to lose earned good time if they refuse the job. Inmates are also forbidden to talk to the public or media. It is unclear how many prisoners are working on the cleanup, in part because they now wear unidentifiable clothing. In the days after the spill, prison workers were seen wearing scarlet pants and white T-shirts with the words "Inmate Labor" printed in large red block letters (Young, 21 July 2010).

July 23, 2010. Oil spill workers toiling along the Gulf Coast have suffered 1753 illnesses and injuries, according to most recent figures from BP. That's more than double the tally of a month ago. Records collected from April 22 through July 15 include 718 illnesses ranging from dehydration and heat exhaustion to seasickness, and 1035 injuries, mostly cuts, bruises and strains caused by accidents. On July 11, for instance, a worker slipped and caught his arm on a fish hook, which was embedded so deeply it reached the bone. Meanwhile, poison control centers had received 863 calls from people in 18 states reporting exposures to oil and dispersants, with symptoms that include headaches, nausea, vomiting and dizziness. People who called from states outside the Gulf Coast region may have been in the area to work or visit or may have family there, said a staffer with the American Association of Poison Control Centers. Another 536 people had called seeking information about the health effects of the spill, according to the poison centers. The largest number of reports came from Louisiana, where health officials have logged 290 health complaints, including 216 from workers and 74 from the general population. Most frequent symptoms include headache, dizziness and nausea (Aleccia, 22 July 2010).

Health Data as of December 2010

Heat stress. Approximately 141 out of the total number of 192 (73%) related to the heat stress

illnesses occurred "onshore." Based on job title information provided in the data, 110 of the 141 onshore heat stress cases occurred among laborers such as beach cleanup workers, boom decontamination workers, heavy equipment operators, and general laborers (NIOSH, 2010).

Of the 192 Heat stress illnesses, 21 were OSHA-recordable, and of these, 2 were listed as resulting in restricted duty or a missed day of work. Of the 171 heat illness cases recorded as being treated by "First Aid", four were listed as being "transported to hospital", but according to best available information, were transported for evaluation only (NIOSH, 2010).

Multiple symptoms. The "multiple symptoms" designation refers to symptoms occurring in more than one organ system for a given case which were not attributed to a single, specific underlying cause. Examples from the database include cases of: nausea, vomiting, headache, and dizziness; and stomach ache, dizziness, and stiff neck (NIOSH, 2010).

The majority of all "multiple symptoms" cases occurred onshore (133 cases of the total number of171 case, 78%), as opposed to offshore where exposure to oils vapors and dispersants is considered greater or more likely (NIOSH, 2010).

Of the 23 OSHA-recordable cases involving multiple symptoms, 16 occurred onshore. Many of these had symptoms consistent with heat stress, but were not identified as such in the database. Of the 7 recordable cases which occurred offshore, none reported exposure to oil, dispersant, or other chemicals (NIOSH, 2010).

Of the 148 multiple symptoms cases listed as treated by First Aid, 117 occurred onshore. Of the 31 which occurred offshore, 7 were from a cluster of fishermen whose cases are part of a NIOSH Health Hazards Evaluations (HHE) investigation. Of the remaining 24 cases, none reported exposure to oil, dispersant, or any other chemical exposures (NIOSH, 2010).

Gastrointestinal. There were 122 recorded gastrointestinal cases, with 87 cases (71%) occurring onshore. Sixty-eight of the 87 cases reported as "onshore" occurred among the following three job titles: beach workers, laborers, and technicians. Eleven of all 122 GI cases reported diarrhea among their symptoms of nausea and/or vomiting, with 55% of those cases occurring onshore. One of these cases was explicitly attributed to oil exposure, and none to dispersant exposure (NIOSH, 2010).

Dermatologic. There were 78 dermatologic illness cases recorded between April 23 and July 27, 2010, of which 74 were listed as a case of "dermatitis." Four of these 74 dermatitis cases were attributed to oil or dispersant exposure. Sixty of the 78 dermatologic illness cases occurred onshore. Of the 60 onshore cases, 22 were listed as onshore "laborers," 3 were listed as "beach workers," and 17 as "technicians." Ten dermatitis cases overall were attributed to the use of sunscreen wipes, which appeared to cause an allergic/irritant skin reaction in these cases; seven were attributed to heat rash; and three to skin infections (NIOSH, 2010).

General Symptoms. There were 42 cases which were coded using the OIICS classification system under codes for "general symptoms." General symptoms refer to cases in which the symptoms described were not specific enough to place within a specific organ system or systems. This includes cases of malaise, fatigue, and non-specified allergic reactions. Thirty-one of the 42 cases occurred "onshore," and 36 out of 42 (86%) cases required only first aid for treatment (NIOSH, 2010).

Cardiovascular. There were 28 cardiovascular cases recorded in the data, with 20 of these cases involving the symptom of chest pain. Nearly half of the cases were OSHA-recordable (13 out of 28 cases), with four of these cases leading to missed days of work. The most common job titles of these cases were technicians (11) and laborers (9) (NIOSH, 2010).

Respiratory. Thirteen cases were recorded that were respiratory in nature, ten of which occurred onshore. The 13 cases could be grouped into four categories: four cases of obstructive airway symptoms consistent with asthma, six with multiple general respiratory symptoms (primarily shortness of breath), and 3 cases of respiratory infection. Three out of 13 cases required medical treatment, and 2 of these led to a missed day of work or restricted duty. In none of these cases neither oil nor dispersant exposures were recorded (NIOSH, 2010).

Chemical exposures - Crude/weathered oil/dispersants. Oil and/or dispersants were explicitly mentioned as a contributing factor in a total of 13 cases, all 13 of which were treated by first aid alone. Nine of the cases occurred offshore. Six cases were dermatologic in nature, four led to injury (such as slipping on oily surface), and three were attributed to oil or dispersant vapor exposure (NIOSH, 2010).

Common Injuries

Among the most common injuries seen by persons helping clean up the oil included burns, trauma, bruises, sprains and strains, cuts, lacerations, and punctures. The most occurring injured locations included the hands, arm/elbow, back, and knee/leg. Also all reports of injuries and illnesses dealt with cleanup workers (Pattillo, September/October, 2010) (NIOSH, 2010).

Staying Safe

Air Quality

Basically people were being told that if they smelled gas or saw smoke or knew that fires were nearby, to stay indoors, set their air conditioner to reuse indoor air, and avoid physical activities that put extra demands on lungs and heart (CDC, 2010).

Food

The public was being told that although crude oil has the potential to taint seafood with flavors and odors caused by exposure to hydrocarbon chemicals, they should not be concerned about the safety of seafood in the stores at this time (U.S. Food and Drug Administration, 2010).

Water

Again the public was being told that drinking water and household water were not expected to be affected by the spill. However, water used for recreation activities may be affected. Swimming in water contaminated with chemicals from the oil spill could cause health effects (CDC, 2010).

Dispersants and Oil

For most people (as they were being told), brief contact with a small amount of oil spill dispersants would do no harm. However, longer contact can cause a rash and dry skin. Dispersants can also irritate eyes. Breathing or swallowing dispersants can also cause negative/adverse health effects. If citizens got oil on their skin, they were told to wash with soap and water, baby oil, petroleum jelly, or a cleaning paste for hands such as those sold at auto parts stores. Use of solvents, gasoline, kerosene, diesel fuel, or similar products to clean oil off skin was prohibited for these purposes.

Crude Oil Chemicals

List of Chemicals in Oil

Benzene. Benzene is an aromatic hydrocarbon that is produced by the burning of natural products. It is a component of products derived from coal and petroleum and is found in gasoline and other fuels. Benzene is used in the manufacture of plastics, detergents, pesticides, and other chemicals. Research has shown benzene to be a carcinogen (cancer-causing). With exposures from less than five years to more than 30 years, individuals have developed, and died from, leukemia (Agency for Toxic Substances and Disease Registry, 2011). Long-term exposure may affect bone marrow and blood production. Short-term exposure to high levels of benzene can cause drowsiness, dizziness, unconsciousness, and death.

Hydrogen sulfide. Hydrogen sulfide is both an irritant and a chemical asphyxiant with effects on both oxygen utilization and the central nervous system. Its health effects can vary depending on the level and duration of exposure. Repeated exposure can result in negative/adverse health effects occurring at levels that were previously tolerated without any effect. Low concentrations irritate the eyes, nose, throat and respiratory system (e.g., burning/tearing of eyes, cough, shortness of breath). Asthmatics may experience breathing difficulties. The effects can be delayed for several hours, or sometimes several days, when working in low-level concentrations. Repeated or prolonged exposures may cause eye inflammation, headache, fatigue, irritability, insomnia, digestive disturbances and weight loss. Moderate concentrations can cause more severe eye and respiratory irritation (including coughing, difficulty breathing, accumulation of fluid in the lungs), headache, dizziness, nausea, vomiting, staggering and excitability.

Ethylbenzene. Short-term exposure to airborne ethylbenzene can affect the central nervous system, causing dizziness, sleepiness, headache, or difficulty with hand coordination. Ethylbenzene also irritates the eyes, nose, throat and skin. Long-term exposure to airborne ethylbenzene has a lasting effect on the nervous system. Animal studies show that long-term exposure causes liver and kidney damage. Although the health effects of drinking ethylbenzene are not well known, animal studies show that large doses impact the central nervous system. Mice and rats that breathed ethylbenzene developed cancers of the lungs, liver and kidneys. Ethylbenzene was named as a possible cancer-causing substance.

Toluene. Inhaling high levels of toluene can cause death or unconsciousness. Repeatedly breathing toluene over long periods of time at work, or through deliberately "sniffing" or "huffing" glue or paint, can cause death, permanent brain damage, or depression. Repeated exposure to toluene in pregnant women may increase the risk of damage to the fetus. Exposure to high levels of toluene may affect the kidneys, nervous system, liver, brain, and heart. Direct, prolonged contact with liquid toluene or vapor can irritate the eyes, and cause dry skin and skin rashes. Ingesting toluene can cause vomiting, diarrhea, and difficult breathing. Exposure to low to moderate levels of toluene can cause confusion, light-headedness, dizziness, headache, fatigue, weakness, memory loss, nausea, appetite loss, coughing, wheezing, and hearing and color vision loss.

Xylene. No health effects have been noted at the background levels that people are exposed to on a daily basis. High levels of exposure for short or long periods can cause headaches, lack of muscle coordination, dizziness, confusion, and changes in one's sense of balance. Exposure of people to high levels of xylene for short periods can also cause irritation of the skin, eyes, nose, and throat; difficulty

in breathing; problems with the lungs; delayed reaction time; memory difficulties; stomach discomfort; and possibly changes in the liver and kidneys. It can cause unconsciousness and even death at very high levels.

Naphthalene / Methylnaphthalene. Naphthalene can be inhaled, absorbed through the skin, or ingested through contaminated water. Exposure to high levels of naphthalene can cause nausea, vomiting, diarrhea, blood in urine, rash and yellow skin. Exposure to extremely elevated levels (500 ppm) of airborne naphthalene can be fatal. Long term exposure has been linked to hemolytic anemia (a disorder of red blood cells). Symptoms of this anemia include fatigue, lack of appetite, restlessness, and pale skin.

Generic alkanes. Alkanes include such chemicals as octane, hexane, and nonane can be inhaled, absorbed through the skin, or ingested in contaminated water. Inhaling high levels of n-hexane (a specific type of medium-sized alkane), can cause numbness in the feet and hands and muscle weakness in the feet and lower legs. Inhaling high levels of some alkanes can cause asphyxiation. Toxicity is dependent on type of alkane as well as route and duration of exposure. Long-term exposure to n-hexane can causes weakness and loss of feeling in the arms and legs. In one study, exposed workers removed from the exposure site recovered in six months to a year (Agency for Toxic Substances and Disease Registry, 2011).

Chemicals Found in Dispersants

Chemical dispersants accelerate the dispersal process, although they may have significant side-effects. Corexit EC9500A and Corexit EC9527A have been the principle dispersants employed. The dispersants are usually sprayed from airplanes. Dispersants helps in reducing the oil slick on the top surface of water. Corexit can be injected into the sea directly into the oil spill. However, much of the Corexit in the Gulf was sprayed from aircraft onto the spill. When sprayed, much of the dispersant lands on the surface of the water. Some mist however, floats into the air, drifting to other sea areas and on land. This escaping mist can potentially adversely affect sea life in unaffected ecosystems and the health of humans (CDC, 2010).

These chemicals can combine in the air with other chemicals such as Volatile Organic Compounds (VOCs). No testing on the toxicity of Corexit has been done nor, has there been any testing of these kinds of chemicals merging in the atmosphere. These new emerging atmospheric chemical compositions may actually be worse when inhaled than if these chemicals fumes were separate (CDC, 2010).

Dispersant Exposure

Some warning signs of dispersant exposure include the following signs and symptoms: on Skin(rash and dry skin from unmixed dispersants); in eyes (dry and irritated eyes if dispersants blow or splash); if inhaled (irritated nose, throat, and lungs; and if swallowed (upset stomach, vomiting, and diarrhea.) Other symptoms include having a metallic taste in the mouth, having liver and kidneys problems, and passing out or being in a coma (US EPA, 2010).

Detrimental effects of dioxin emission due to the deepwater Horizon Burns Controlled burning of oil on the surface of the ocean (also called in situ burning) was one method used by the Unified Command during the Deepwater Horizon BP oil spill, to reduce the spread of oil and environmental impacts at the shoreline. A total of 411 controlled burn events occurred of which 410 could be quantified, resulting in the combustion of an estimated 222,000 to 313,000 barrels of oil (or 9.3 to 13.1 million gallons) (Aurell & Gullett, 2010).
On November 11, 2010, the U.S. Environmental Protection Agency today released two peer reviewed reports concerning dioxins emitted during the controlled burns of oil during the Deepwater Horizon BP spill. Dioxins describe a group of hundreds of potentially cancer-causing chemicals that can be formed during combustion or burning. The reports found that while small amounts of dioxins were created by the burns, the levels that workers and residents would have been exposed to were below EPA's levels of concern (Schaum, Cohen, Perry, Artz, Draxler, Frithsen, et al., 2010).

The results indicate that increased cancer risk due to exposure to the dioxins released from the controlled burning of oil was small - less than a 1 in 1,000,000 increased cancer risk. Additional cancer risks for inhalation by workers, onshore residents and fish consumption by residents were lower than risk levels that typically are of concern to the Agency. Typically, the Agency has a concern when the risk is greater than 1 in 1,000,000 (Schaum, et al., 2010).

Ecology/ Oil Spill Impact on the Environment

The spill threatens environmental disaster due to factors such as petroleum toxicity, oxygen depletion. Eight U.S. national parks were threatened. More than 400 species that live in the Gulf islands and marshlands were affected, including the endangered Kemp's ridley turtle, the green turtle, the loggerhead turtle, the hawksbill turtle, and the leatherback turtle. In the national refuges most at risk, about 34,000 birds have been counted, including gulls, pelicans, roseate spoonbills, egrets, terns, and blue herons. A comprehensive 2009 inventory of offshore Gulf species counted 15,700.

Fisheries

On May 2, 2010 the National Oceanic and Atmospheric Administration closed commercial and recreational fishing in affected federal waters between the mouth of the Mississippi River and Pensacola Bay. The closure initially incorporated 6,814 square miles (17,650 km²). By June 21, NOAA had increased the area under closure by (225,290 km²), or approximately 36% of Federal waters in the Gulf of Mexico, and extending along the coast from Atchafalaya Bay, Louisiana to Florida. On May 24 the federal government declared a fisheries disaster for the states of Alabama, Mississippi and Louisiana. Initial cost estimated loss to the fishing industry were $2.5 billion.

Future Impact of the BP Gulf of Mexico Oil Spill

As of November 25, 2010 there are more than 125 research vessels covering hundreds of square miles of the Gulf of Mexico taking thousands of water and sediment samples. In that period of time scientists reported several effects on marine life.

Dead and dying coral colonies were found about 7 miles southwest of the wellhead at a depth of 4600 feet. Normally, yellow vibrant coral colonies occur here with seemingly dark "wilted" or reduced polyps. The commonly symbiotic brittle starfish do not typically have white (bleached) arms. Scientists suggest that the corals were destroyed by oil, chemical dispersant, depleted oxygen because of organisms' consuming the oil and/or some combination of effects of the spill.

Long Term Effect on Food Chain

One research effort is looking at what effect the gush of oil during the spring spawning season had on fish eggs and larvae. NOAA had five research missions to look at plankton, fish and larvae. It would be years before fish that were spawned this year matured, so it could be a long time before it's clear how exposure to oil in their early life stages affected their populations. Carbon from the oil had ended up in plankton that consumed the oil-eating microbes. In the warm water, it's likely that bacteria ate all the consumable parts of the oil. The compounds that remained, such as tars and asphalts, probably dropped to the bottom, and we may be dealing with that for a long time.

Long-term Effects on Health

Prior oil spills have shown that contact with oil and chemicals can affect the lungs, kidneys, and liver, and the mental strain can boost rates of anxiety, depression and post traumatic stress, and raise in cancer morbidity and mortality as many as six years later.

The Gulf of Mexico oil spill, the worst oil spill in U.S. history, have left many Americans concerned about the environmental implications and costs it caused. In an interview in *SOPHE News & Views*, Dr. Dhitinut Ratnapradipa, Chair of the Environmental Health Community of Practice, discussed some of the implications (SOPHE, 2010). He explained that to find out precisely the short-term and long-term implications of the oil spill, ecological and social assessments should be carried out. He elaborated that such assessments will help experts determine the geographical extent and contamination depth of the oil spill. Moreover, it will help evaluate the effectiveness of the clean-up efforts and will unveil any improper cleaning practices (SOPHE, 2010).

Further, Ratnapradipa explained that, in general, the oil spill directly and greatly affected fishermen to the extent that many might have to relocate seeking new employments at a critical time economically. In addition, that the oil spill most likely affected the health of these fishermen who were subjected to hydrocarbons and other chemicals released by the spill. On a different note, the oil spill lead to the loss of several plants and animal species, especially those near the bottom of the food chain, which in turn can have long-standing impacts (SOPHE, 2010). Finally, Ratnapradipa noted that the Gulf of Mexico oil spill was not the first of its kind in the United States. Accordingly, he went on to indicate that more efforts should be dedicated for appropriate inspections and control measures on oil stations in an attempt to minimize the risk of future spills. Furthermore, health education professionals should aim to raise public awareness on the environmental, economic and health costs and implications of oil spills. People need to understand that an oil spill is more than just clean up. He also added that people should critically weigh the costs versus benefits of continuing off-shore drilling for oil (SOPHE, 2010).

References

Agency for Toxic Substances and Disease Registry (2011). *Toxicology profiles: Information about contaminants found at hazardous waste sites.* Retrieved February 16, 2011 from: http://www.atsdr.cdc.gov/toxprofiles/index.asp.

Aurell, J., & Gullett, B.K. (2010). *Aerostat sampling of PCDD/PCDF emissions from the Gulf oil spill in situ burns.* U.S. Environmental Protection Agency, Office of Research and Development, National Risk Management Research Laboratory, Research Triangle Park, NC 27711, USA.

Aleccia, J. (22 July 2010). *Oil spill illnesses, injuries double in past month.* Retrieved November 19, 2010 from: http://fieldnotes.msnbc.msn.com/_news/2010/07/

22/4279816-oil-spill-illnesses-injries-double-in-past-month.

Centers for Disease Control and Prevention (2010). *Gulf oil spill 2010: food/air quality/water information for coastal residents.* Retrieved February 16, 2011 from: http://emergency.cdc.gov/gulfoilspill2010/information_residents.asp.

Centers for Disease Control and Prevention (2010). *Oil spill dispersant (COREXIT®EC9500A and EC9527A) information for health professionals.* Retrieved February 2, 2011 from: http://www.bt.cdc.gov/gulfoilspill2010/dispersants_hcp_info.asp.

Centers for Disease Control and Prevention (2010). *What to expect from the oil spill and how to protect your health.* Retrieved February 1, 2011 from: http://emergency.cdc.gov/gulfoilspill2010/what_to_expect.asp.

DemocracyNow.org. (2010). *Coast Guard grounds ships involved in spill cleanup after 7 fall ill; BP reportedly preventing fishermen from wearing respirators.* Retrieved November 11, 2010 from: http://www.democracynow.org/2010/5/27/coast_guard_grounds_ships_involved_in

Louisiana Environmental Action Network. (2010). *Protecting the health of fishermen performing cleanup activities.* Retrieved February 2, 2010 from: http://leanweb.org/news/latest/protecting-the-health-of-fishermen-performing-cleanup-activities.html.

Louisiana Environmental Action Network (LEAN). (2010). *BP tells fishermen working on the oil spill that they will be fired for wearing a respirator.* Retrieved November 20, 2010 from: http://leanweb.org/news/latest/bp-tells-fishermen-working-on-the-oil-spill-that-they-will-be-fired-for-wearing-a-respirator.html.

NIOSH (2010). *Report of Deepwater Horizon response/BP illness and injury data (April 23 – July 8, 2010).* Retrieved March 10, 2011 from: http://www.cdc.gov/niosh/topics/oilspillresponse/pdfs/NIOSHrot-BPilnessAndInjuryDataApril23-July8-2010.pdf.

National Public Radio (2010). *Oil cleanup dirty, not toxic, for workers.* Retrieved November 20, 2010 from: http://ww.npr.org/blogs/health/2010/06/02/127374111/oil-cleanup-workers-might-face-health-risks.

Orr, P. (2010). Protecting the health of fishermen performing cleanup activities. *Save Our Gulf Org.* Retrieved November 13, 2010 from: http://saveourgulf.org/updates/protecting-health-fishermen-performing-cleanup-activities?page=1.

Pattillo, R. (2010). Potential health problems related to oil spill in Gulf of Mexico. *Nurse Educator, 35*(5), 185. Retrieved February 1, 2011 from: http://journals.lww.com/nurseeducatoronline/Fulltext/2010/09000/Potential_Health_Problems_Related_to_Oil_Spill_in.3.aspx.

Paulnock, D. (2010) *Current events in human communication.* Blog. Retrieved November 13, 2010 from: http://currenteventsinhumancommunication.blogspot.com/2010/07/for-want-of-nail.html.

Roiz, M. (2010). BP works to clean up more than just oil. *Maroon Weekly.* Retrieved February 1, 2011 from: http://maroonweekly.com/featured-stories/bp-works-t-clean-up-more-than-just-oil.

San Francisco Chronicle (2010). *Thin green line: oil spill cleanup workers falling sick.* Retrieved November 25, 2010 from: http://www.sfgate.com/cgi-bin/blogs/green/detail?entry_id=64595.

Science Blogs. (2010). *The pump handle.* Retrieved November 24, 2010 from: http://scienceblogs.com/thepumphandle/2010/05/this_scares_everybody_the_fact.php#more.

Schaum, J.,Cohen, M., Perry, S., Artz, R., Draxler, R.., Frithsen, J.B., et al. (2010). *Screening level assessment of risks due to dioxin emissions from burning oil from the BP Deepwater Horizon Gulf of Mexico spill.* U.S. Environmental Protection Agency, Office of Research and Development, Washington, DC.

Society for Public Health Education (SOPHE). (September/October, 2010). Environmental health CoP calls upon health educators to raise awareness of oil spills' health costs, implications. *SOPHE News & Views, 37*(5), 5.

YourLawer.com (n.d). *Is BP trying to hide the truth? Clean-up health problems.* Retrieved November 14, 2010 from: http://www.oil-rig-explosions.com/clean-up-health-problems/is-bp-trying-to-hide-the-truth/.

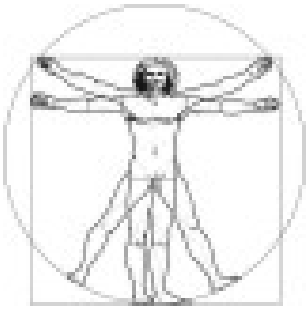
U.S. Department of the Interior (2010). *U.S. scientific teams refine estimates of oil flow from BP's well prior to capping.* Retrieved February 1, 2011 from: http://www.doi.gov/news/pressreleases/US-Scientific-Teams-Refine-Estimates-of-Oil-Flow-from-BP-Well-Prior-to-Capping.cfm.

U.S. Environmental Protection Agency (2010). *COREXIT® EC9500A - technical product bulletin #D-4.* Retrieved February 2, 2011 from: http://www.epa.gov/swercepp/web/content/ncp/products/corex950.htm.

U.S. Food and Drug Administration (2010). *Gulf of Mexico oil spill update.* Retrieved November 20, 2010 from: http://www.fda.gov/Food/ucm210436.htm.

Young, A.B. (21 July 2010). *BP hires prison labor to clean up spill while coastal residents struggle.* Retrieved November 19, 2010 from:

http://www.thenation.com/article/37828/bp-hires-prison-labor-clean-spill-while-coastal-residents-stru.



ABOUT THE AUTHORS

Dale O. Ritzel (dritzel@siu.edu) is Professor of Health Education and Director Emeritus of the Safety Center, Southern Illinois University, Carbondale, Illinois, USA. Dhitinut Ratnapradipa (dhitinut@siu.edu) is Assistant Professor of Health Education, Southern Illinois University, Carbondale, Illinois, USA. Maria Alexandrova (malex@siu.edu) is a doctoral student in the Department of Health Education and Recreation, Southern Illinois University, Carbondale, Illinois, USA.

An earlier version of this paper was presented at the 4th International Consortium for Interdisciplinary Education about Health and the Environment, Cologne, Germany, December 2010.