Impact of COVID-19 and Cyber Attacks on the Multiple Disaster Management and Rapid Recovery Plans

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Abstract

There are multiple disasters, combinations of natural, human made and virus disasters happening at the same time around the world. Most disasters are localized but it is very difficult to predict and is having major impact on the growing population and commercial activities. In the past eight months, the coronavirus that causes severe acute respiratory syndrome (SARA-2 (COVID-19)) has impacted the entire world with the total human death of over 673,000. The COVID-19 virus is an organic structure with nucleic acid and protein coating and was transferred from bats to humans. There are many unknown factors including the modes of spreading (humans, animals, wind, water, wastewater, modes of transportation and many others) and critical environment. Also, there is an urgent need for developing gene therapy with the viral vector and also immunizing vaccine to control the COVID-19 virus disaster. It is also important to quantify the deaths, affected and recovered humans due to COVID-19 virus, and the modeling of the trends based on the location might help to better understand the critical parameters influencing the COVID-19 virus impacts. Also, the cyber-attacks are another major disaster management challenge and have increased by six times during the COVID-19 pandemic. In the current condition, any other disaster will add to the challenges in developing the multiple disaster management and rapid recovery plans (DMRRP), which is a 3-Phase operation includes preparedness (P), disaster response (DR) and rapid recovery (RR) plans. Because of the COVID-19 impact with the cyber-attacks, the available resources are limited and also the changes in the rules and regulations have to be taken into account for planning for all the 3-phases. Knowing the limitations and restrictions, preparedness (P) plays a critical role in the DMRRP. Also the DMRRP will be a parallel process (PLAN 2) because of the limitations in human interaction and sharing resources to optimize and minimize the losses and accelerate the rapid recovery with the available resources integrated with the advanced technologies.

New technologies representing real-time monitoring, drones, smart cement, flooding protection systems and debris issues integrated with prediction models including the artificial neural networks (ANN) for Artificial Intelligent (AI) are being investigated to be used in minimizing losses in preparedness, disaster response and rapid recovery for multiple disasters.

Introduction

Based on the losses, damages and affected population, hurricanes are the worst natural disasters impacting the United States in many ways. One hurricane can cause enormous economic losses, human deaths not comparable to COVID-19 virus and also place tremendous burden on the local, state and federal governments and insurance industry. In year 2017, United States had the worst hurricane season based on the total losses. In the Gulf of Mexico, there were three hurricanes in the year 2017 with hurricane Harvey (category 4) being the worst hurricane in the State of Texas history and hurricane Irma (category 4) being the worst hurricane in the State of Florida history. Uniqueness about this is that for the first time two hurricanes rated as category 4 happened in the Gulf of Mexico within two weeks originating from the Atlantic Ocean. The worst hurricane in the U.S. history was Hurricane Katrina in 2005, and the total recovery time was about one year. All these were single disaster happening at different time period. All these disasters were identified and predicted giving time for preparedness.

Despite significant improvements in predicting, tracking and warning the public about hurricanes using number of models, there has been relatively little progress in predicting inland flooding and estimating the expected hurricane losses in the built-in environments and industrial facilities with debris accumulation. These losses can be in the form of flooding of houses, structural damages to critical infrastructures, damage to utilities, power loss and interruptions to businesses and educational activities. It is important to develop reliable and resilient procedures for preparedness, disaster response and rapid recovery with damages to residential structures, transportation infrastructure and utilities in the region based on the zip codes.

The impact of virus attack and cyber-attacks (human based disaster) is different from hurricanes and flooding. Cyber-attacks have increased by six time during the COVID-19 pandemic. Virus attack and cyber-attacks can get initiated any ware around the world occupied by humans, about 5% of the earth surface. Hence monitoring is a major challenge before it starts spreading and impacting many humans in the region, unlike satellite monitoring of hurricane origin and pathway. Also, virus spreading among humans can have many pathways and there is an urgent need for understanding the basic and fundamental science behind the virus spreading based on the type of virus, origin and the environment. Over the past hundred years, over dozen viruses have impacted the humans around the world.

The prediction of the impact of a hurricane on the economic losses is not only beneficial to the public, but it could also be used by the insurance companies as the reference to decide their policies (Huang et al. 2001; Vipulanandan 2009 and 2018). Based on the current COVID-19 pandemic, it will also impact the economic losses due to multiple disasters.

(a) Virus

Viruses are found wherever there is life and have probably existed since living cells first evolved on earth. Scientific studies have evolved over the past 150 years focused on the composition (neulic acid (DNA, RNA) with protein coat), structure, size compared to bacteria. By the end of the 19th century, viruses were defined in terms of infectivity (ability to produce infection), ability to pass filters, and requirement for living hosts. Also pig corneal tissue and hen kidney were used in vaccine production. Another breakthrough came in 1931, when the pathologist Ernest William Goodpasture and Alice Miles Woodruff grew **influenza** and several other viruses in **fertilized chicken eggs**. In 1949, John Franklin Enders, Thomas Weller, and Frederick Robbins grew **polio virus** in cultured human embryo cells, the first virus to be grown without using solid animal tissue or eggs. This work enabled Jonas Salk to make an effective **polio vaccine**. The second half of the 20th century was the golden age of virus discovery and most of the over 2,000 recognized species of animal, plant, and bacterial viruses were discovered during these years.

Opinions differ on whether viruses are a form of life, or **organic structures** that interact with living organisms. A complete virus particle, known as a virion, consists of nucleic acid surrounded by a protective coat of protein called a capsid. Although they have genes, they do not have a cellular structure, which is often seen as the basic unit of life. Viruses do not have their own metabolism, and require a host cell to make new products. Viruses display a wide diversity of shapes and sizes, called 'morphologies'. In general, viruses are **much smaller than bacteria**. Most viruses that have been studied have a diameter between 20 and 300 nanometers.

Virus is transferred as a result of human interaction with living cells including animals, birds, plants and bacteria where the virus is very active and represented as follows:

Living Cells (Animal/bird/plants/bacteria) + human ⟶ Virus Transferred

Various types of viruses have impacted the world over the past century.

Lessons Learned

There have been12 worst virus killers in the past century, based on the likelihood that a person will die if infected with one of them, the total number of people they have killed and also the rate of deaths. Also, there is concern that the virus attacks represent a growing threat to humans.

Smallpox (Animal Unknown)

It is caused by variola virus (VARV) and was on earth 1000 BC. In 1980, the World Health Assembly declared the world free of smallpox. But before that, humans battled smallpox for years, and the disease killed about 1 in 3 of those it infected. **It left survivors with deep, permanent scars and, often, blindness**. Mortality rates were far higher in populations outside of Europe, where people had little contact with the virus before visitors brought it to their regions. In the 20th century alone, **smallpox killed 300 million** people. It was something that had a huge burden on earth, not just death but also blindness, and that's what spurred the campaign to eradicate from the Earth.

Influenza (Birds, Ducks, Chickens)

During a typical flu season, up to **500,000** people worldwide will die from the illness, according to WHO. But occasionally, when a new flu strain emerges, a pandemic result with a faster spread of disease and, often, higher mortality rates. The deadliest flu pandemic Influenza, sometimes called the Spanish flu, began in 1918 and sickened up to 40% of the world's population**, killing an estimated 50 million people**.

Rabies (Cats, Cattle, Dogs, Bats based)

Rabies is caused by lyssaviruses, including the **rabies** virus and Australian bat lyssavirus. **Although rabies vaccines** for pets**, which were introduced in the 1920s**, have helped make the disease exceedingly rare in the developed world, this condition remains a serious problem in Asia and parts of Africa. **It destroys the brain**, it's a really, really bad disease. We have a vaccine against rabies, and we have antibodies that work against rabies, so if someone gets bitten by a rabid animal the person can be treated.

Dengue (Mosquitoes)

Dengue virus first appeared in the 1950s in the Philippines and Thailand and has since spread throughout the tropical and subtropical regions of the globe. Up to 40% of the world's population now lives in areas where dengue is endemic, and the disease — **with the mosquitoes that carry it** — is likely to spread farther as the world warms. **Dengue sickens 50 to 100 million people a year, according to WHO**. Although the mortality rate for dengue fever is lower than some other viruses, at 2.5%, the virus can cause an Ebola-like disease called dengue hemorrhagic fever, and that condition has a mortality rate of 20% if left untreated. **A vaccine for Dengue was approved in 2019 by the U.S. Food and Drug Administration** for use in children 9-16 years old living in an areas where dengue is common and with a confirmed history of virus infection, according to the **CDC.** In some countries, an approved vaccine is available for those 9-45 years old, but again, recipients must have contracted a confirmed case of dengue in the past. Those who have not caught the virus before could be put at risk of developing severe dengue if given the vaccine.

Marburg virus (Monkey based)

Scientists identified Marburg virus in 1967, when small outbreaks occurred among laboratory workers in Germany who were **exposed to infected monkeys imported from Uganda**. Marburg virus is similar to Ebola in that both can cause hemorrhagic fever, meaning that **infected people develop high fevers and bleeding throughout the body** that can lead to shock, organ failure and death. **The mortality rate in the first outbreak was 25%, but it was more than 80% in the 1998-2000 outbreak in the Democratic Republic of Congo, as well as in the 2005 outbreak in Angola**, according to the World Health Organization (WHO).

Ebola virus (Bats, Chimpanzees, Apes, Monkeys based)

The **first known Ebola outbreaks in humans struck** simultaneously in the Republic of the **Sudan** and the Democratic **Republic of Congo** in 1976. **Ebola is spread**

through contact with blood or other body fluids, or tissue from infected people or animals. The known strains vary dramatically in their deadliness. One strain, **Ebola Reston**, doesn't even make people sick. But for the **Bundibugyo strain**, the fatality rate was up to 50%, and it was up to 71% for the Sudan strain, according to WHO. The outbreak underway **in West Africa began in early 2014** and was the largest and most complex outbreak of the disease to date, according to WHO.

Human Immunodeficiency Virus - HIV (Chimpanzee, Monkey based)

In the modern world, the deadliest virus of all may be HIV. It is still the one that is the biggest killer. **An estimated 32 million people have died from HIV** since the disease was **first recognized in the early 1980s**. The infectious disease that takes the biggest toll on mankind right now is HIV. **Powerful antiviral drugs have made it possible for people to live for years with HIV**. But the disease **continues to devastate many low- and middle-income countries**, where 95% of new HIV infections occur.

Hantavirus (Mice)

Hantavirus pulmonary syndrome (HPS) **first gained wide attention in the U.S. in 1993,** when a healthy, young man died within days of developing shortness of breath. A few months later, health authorities isolated Hantavirus from a deer mouse living in the home of one of the infected people. More than 600 people in the U.S. have now contracted HPS, and 36% have died from the disease, according to the Centers for Disease Control and Prevention. The virus is not transmitted from one person to another, but the humans contract the disease **from exposure to the droppings of infected mice.** Previously, a different Hantavirus caused an outbreak in the early 1950s, during the Korean War. More than 3,000 troops became infected, and about 12% of them died.

Rotavirus (Chicken, Pigs, Cattle)

Although children in the developed world rarely die from rotavirus infection, the disease is a killer in the developing world, where rehydration treatments are not widely available. The WHO estimates that worldwide, **453,000 children younger than age 5 died** from rotavirus infection in 2008. But countries that have introduced the vaccine have reported sharp declines in rotavirus hospitalizations and deaths.

SARS-CoV (Bats)

The virus that causes severe acute respiratory syndrome, or SARS, first appeared in 2002 in the Guangdong province of southern China, according to the WHO. **The virus likely emerged in bats,** initially, **then hopped into nocturnal mammals called civets before finally infecting humans**. After triggering an outbreak in China, SARS spread to 26 countries around the world, infecting more than 8000 people and killing more than 770 over the course of two years.

The disease causes fever, chills and body aches, and often progresses to pneumonia, a severe condition in which the lungs become inflamed and fill with pus. SARS has an estimated mortality rate of 9.6%, and as of yet, **has no approved**

treatment or vaccine. However, no new cases of SARS have been reported since the early 2000s, according to the CDC (Centers for Disease Control and Prevention).

MERS-CoV (Bats,Camels)

The virus that causes **Middle East respiratory syndrome**, or MERS, sparked an outbreak in **Saudi Arabia in 2012 and another in South Korea in 2015**. **The MERS virus belongs to the same family of viruses as SARS-CoV and likely originated in bats**, as well. The disease infected camels before passing into humans and triggers fever, coughing and shortness of breath in infected people.

MERS often progresses to severe pneumonia and has an estimated mortality rate between 30% and 40%, making it the most lethal of the known coronaviruses that jumped from animals to people. As with SARS-CoV and SARS-CoV-2, **MERS has no approved treatments or vaccine**.

SARS-CoV-2

SARS-CoV-2 belongs to the same large family of viruses as SARS-CoV, known as **coronaviruses**, and was first identified in **December 2019 in the Chinese city of Wuhan (Figure 1)**. The virus likely **originated in bats**, like SARS-CoV, and passed through an intermediate animal before infecting people.
Since its appearance, the virus has infected tens of thousands of people in China and millions of others around the world. The ongoing outbreak prompted an extensive quarantine of Wuhan and nearby cities, restrictions on travel to and from affected countries and a worldwide effort to develop diagnostics, treatments and vaccines.

The **disease caused by SARS-CoV-2, called COVID-19**, has an estimated mortality rate of about 2.3%. **People who are older or have underlying health conditions** seem to be most at risk of having severe disease or complications. **Common symptoms include fever, dry cough and shortness of breath, and the disease can progress to pneumonia in severe cases**.

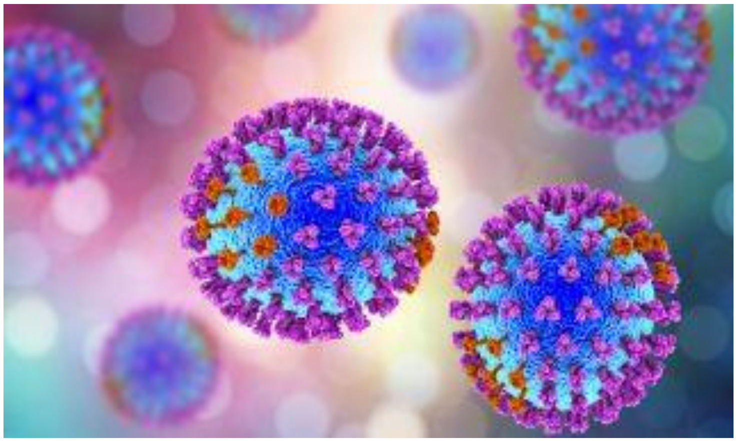


Figure 1 Image of COVID-19 Virus

The COVID-19 virus has really impacted the entire world. It has impacted all activities including education, business, construction and manufacturing. The oil price dropped to its minimum value of -$40 dollars a barrel on April 20, 2020 in the history of oil market. Hence there is an urgent need to understand the problem to make safe decisions to minimize losses.

Transfer Media

It started in China and then spread around the world in stages going across Indian Ocean and Atlantic Ocean from continent to continent. Initially it impacted many countries above the equator but now many countries below the equator are impacted. It is important to understand the modes of transfer of COVID-19 around the world in a very short time period. This will definitely help minimize the human deaths and infected cases. It is also important look at the ground conditions, environments, human activities and also international travel. In the U.S. coastal states have been impacted the most.

Virus therapy

There are two types of therapies characterized as gene therapy and cell therapy. Over the decade's gene therapy has been developed for controlling various types of virus attacks. In addition to developing the gene therapy, it is also important to develop the viral vector to deliver the medication to the right location in the body. Also, artificial virus is used as part of the viral vector.

(b). Cyber-attacks

Cyber-attack is a human based disaster. With the advancement of technologies almost all operations are controlled using computers connected to the internet. The internet platform is connected to the world and once any computer opened it is connected to the world. **Philosophically, internet is considered as the battery charger** for all the connected computers. Internet platform will provide all the requested information with minimum time delay, transfer data and also control systems including the power grids and water supplies. All **the connectivity (electrical connection with computer language)** makes the system very **vulnerable to misuse** using the computer language, **known as cyber-attacks**. Cyber-attacks can result in minor to major losses of personnel information and also security of the operating systems impacting individuals, cities, businesses and entire country. Cyber-attacks happen rapidly and by knowing the problem **pre-planning with security filtering and blocking will help**. Virus attack will start slowly but can spread rapidly. Hence it is important to **develop comprehensive disaster management and rapid recovery plans** to minimize the losses. Cyber-attack will impact human mental balance. Unlike **contaminated** sites, cyber-attacks has no **rules and regulations**. For cyber-attack pre-planning based on past experience is important **for preparedness**. The **rapid recovery (RR)** due to **cyber-attack (loosing personal information to large operating systems).**

A cyberattack is a malicious and deliberate attempt by an individual or organization to breach the information system of another individual or organization. Usually, the attacker seeks some type of benefit from disrupting the victim's network. It can also endanger public health, contaminate the water, devastate natural resources, and disrupt the economy. **It will also affect the animals and birds.** In an increasingly technological era, the world has become more dependent **upon computer-controlled operations to maintain our high standard of living**. Also, cyber-attack can impact the security, manufacturing and transportation industries and all other businesses.

(c). Hurricanes

Hurricanes are initiated as tropical storms over the moist warm waters in the Atlantic and Pacific Oceans near the equator. As the moisture evaporates it rises until enormous amounts of heated moist air are twisted high in the atmosphere. The winds begin to circle counterclockwise north of the equator or clockwise south of the equator. The relatively peaceful center of the hurricane is called the eye. Around this center, winds move at speeds between 74 and 200 miles per hour. As long as the hurricane remains over waters of 79^{o}F or warmer, it continues to pull moisture from the surface and grow in size and force. When a hurricane crosses land or cooler waters, it loses its source of power and its wind gradually slow until they are no longer of hurricane force--less than 74 miles per hour.

Hurricanes over the Atlantic often begin near Africa, drift west on the Trade Winds, and veer north as they meet the prevailing winds coming eastward across North America. Hurricanes over the Eastern Pacific begin in the warm waters off the Central American and Mexican coasts. Eastern and Central Pacific storms are called "hurricanes." Storms to the west of the International Date Line are called "typhoons."

The two NASA-GOES satellites keep their eyes on hurricanes from 22,300 miles above Earth's surface. These satellites were built by NASA and operated by the National Oceanic and Atmospheric Administration (NOAA). It helps with the weather forecasting and warning people when and where these severe storms will hit the land. Drones are being used for pre and post monitoring.

(d). Fires

Fire disaster can be a natural and/or human made disaster. Natural fire can be in the jungles and spreads rapidly in the direction of the winds. There is need for monitoring of the jungle fire to control it to minimize the impact on the animals, birds, vegetation and also polluting the environment. Human made fire can happen on power grids, buildings, storage facilities, transportation vehicles, gas pipelines and chemical plants on land and also on offshore oil platforms and ships. Unlike hurricanes, there is very limited warning about fire disasters, and it requires real-time monitoring.

Objectives

The objectives were to investigate the impact of COVID-19 virus and cyber-attacks on the disaster management and rapid recovery plans for many types of multiple disasters related to minimizing losses (mitigation), preparedness, disaster response and rapid recovery. The specific objectives are as follows:

(a) Identify the critical parameters to represent the COVID-19 virus impact. Also compare the confirmed cases and total deaths around the world, U.S., New York and Texas and develop models to predict the confirmed cases and the deaths.

(b) Develop processes for DMRRP for multiple disasters including COV-19 Impact and cyber-attacks. Identify the important issues/factors that have to be considered for future planning of multiple disasters.

(c) Review the potential use of new technologies that can be adopted to support the preparedness, disaster response and rapid recovery related to multiple disasters.

In this study, data collected on COV1D-19 impact over the past eight months was used. The data was collected from various data bases and it included the world, U.S.A. and different states in the U.S.A. Unfortunately, there are no data available based on the zip codes in the U.S.A.

1. COVID-19 Virus

Data Analyses

In March of 2020, European countries such as Italy, Spain and United Kingdom, above the equator and also very high Gross Domestic Product (GDP), had the largest impact based on the deaths and total number of confirmed cases. There was very little impact on the North and South American continent. Since April 2020, United States (North) and Brazil (South) in the American Continent became the badly affected countries in the world based on the deaths and confirmed cases. In June, Russia and India became two of the leading top 5 countries based on the number of people affected by the COVID-19 virus.

It is important to quantify and interpret the trends observed around the world and the U.S.A. Both the total confirmed cases and deaths continuously increased around the world. In this study, the focus will be on monthly changes in the confirmed cases and total deaths.

World Versus U.S.A.

It will be of interest to compare the impact of COVID-19 impact on the world and the U.S.A. with the highest GDP of $21.5 trillion (Year 2019). The actual difference in the numbers between the world and the U.S.A (equal = world-U.S.A.) will be the confirmed total cases and deaths the rest of the world.

World

There are over 210 countries around the world with a total population of 7 billion. The COVID-19 has impacted the countries in many different ways based on the location, environment, economic activities (GDP) and population density. In Table 1, the confirmed cases per month and death rates per month are summarized.

Confirmed Cases: The confirmed cases continue increase every month and the highest increase was in July which was **6.8 M/m**.
Death Cases: The death rate peaked in April and was **159K/m.** The death rates have reduced in May, June and July to about **146K/m**, **122k/m** and **371K/m**. The death rate was maximum in July, more the 2.3 times the previous maximum of 159K/m. The total death was **673,233** as of July 31, 2020.

United States of America (USA)

U.S.A. had its highest rate of confirmed cases and deaths in April (Tax Month in the U.S.A) (Table 1).

Confirmed Cases: The confirmed cases in April were **905K/m**. In the month of May, the confirmed cases decreased to **757K/m**. In the month June the confirmed cases have increased to **877K/m.** The confirmed case in July increased to **1.8M/m**. The highest confirm cases per day were on July 1, and it was 51,091.

Table 1. Comparing the COVID-19 Impact on the World and U.S.A.

Date	World		United States		Remarks
	Confirmed Cases	Total Deaths	Confirmed Cases	Total Deaths	
1/31/2020	8,234		0	0	**World** confirmed and deaths cases increased by **78K/m** and 8K/m. **U.S.** confirmed and deaths were **68/m** and **Zero**.
2/15/2020	69,050		15	0	
2/29/2020	86,009	8,000	68	0	
3/15/2020	168,941		3,613	69	**World** confirmed cases and deaths increased by **786K/m** and **68.5K/m. U.S.** confirmed, and deaths were over **190 K/m** and **5K/m**.
3/31/2020	871,976	74,565	189,967	5,151	
4/15/2020	2,066,00		648,003	32,712	**World** confirmed cases and deaths increased by **2.4M/m** and **159K/m**. **U.S.** confirmed, and death were **905K/m** and **58.7K/m** (Highest death rate for the U.S.A.)
4/30/2020	3,268,000	233,704	1,095,023	63,856	
5/15/2020	4.538,000	283,001	1,484,285	88,507	**World** confirmed cases and death increased by **2.9M/m**
5/31/2020	6,162,000	380,000	1,852,029	106,432	

					and **146K/m**. **U.S.** confirmed and death rate were **757K/m** and **42.6K/m.**
6/15/2020	**8,010,000**	**425,093**	**2,186,553**	**120,247**	**World** confirmed cases and death increased by **4.3M/m** and **122K/m**. **U.S.** confirmed and death rate were **877K/m** and **23.7K/m**.
6/30/2020	**10,450,000**	**502,048**	**2,728,856**	**130,122**	
7/15/2020	**13,561,000**	**582,000**	**3,463,480**	**137,420**	**World** confirmed cases and death increased by **6.8M/m** and **171K/m**. **U.S.** confirmed and death rate were **1.8M/m** and **22.5K/m**.
7/31/2020	**17,297,276**	**673,233**	**4,495,014**	**152,670**	
Remarks	Millions of humans have been affected in short period of time	Very high death and rate of deaths and the highest was 171K/m	U.S. has the highest confirmed cases.	U.S. has the highest total deaths	**COVID-19 has impacted the world. U.S.A. has the highest confirmed cases and total deaths (No. 1) and matched with the GDP rating.**

Death Cases: The death rate in April was **58.9K/m**. The highest death rate for a day was **2683/day** on April 21 and on April 15 it was **2631/day**. In the month of May, the death rate was **42.6K/m** and in June it has reduced to **23.7K/m**. In July the death rate was **22.5K/m**. The total death is over **152,670**, about 23% of the world deaths and is the highest in the world and **matched with the GDP ranking**. The U.S. population is only 4.5% of the world population, so the death rate is over 5 times higher and hence doesn't match with the total population, which is ranked 3rd in the world.

New York Versus Texas

In the U.S.A. the coastal states were more impacted by the COVID-19. For comparison, State of New York (GDP no.3 in the U.S.) was selected to represent the east coast with the Atlantic Ocean and Texas (GDP no.2 in the U.S.) along the Gulf of Mexico (GOM). Both these states are also impacted by hurricanes and flooding.

New York State (GDP 1.7 Trillion, 8% of U.S. GDP and #3 in the U.S.)

New York State has had the highest confirmed cases and deaths in the U.S.A.

Confirmed Cases: New York had its highest rate of confirmed cases in April (Tax Month in the U.S.). The confirmed cases in April were 234K/m (26% of U.S.). In the month of June, the confirmed cases and the death rates have reduced to 79K/m, and 6.7K/m. The last few weeks death rate has dropped to below 40/day. The highest confirm cases per day was on **April 15, and it was 11,661** with death rate of 888/day. The total confirmed cases on July 31 was over 443,000 (July 31), 10% of the U.S. confirmed cases.

Death Cases: New York had its highest rate of deaths in April (Tax Month in the U.S.). The death rate was 21.1K/m (36% of U.S.). The highest death rate for a day was

1025/day on April 17 and on April 15 it was 888/day. In the month of June, the death rate has reduced to 6.7K/m. The last few weeks death rate has dropped to below 40/day. The total deaths is over 32,765 (July 31), 23% of the U.S. deaths.

The population in New York city is about 8.4 million and the population density is 27,558 people/square miles. This is about 7.6 times higher than Houston, largest city in Texas.

Texas State (GDP 1.89 Trillion, 11.3% of U.S. GDP and #2 in the U.S.)

Texas has very high confirmed cases comparable to New York, but the total deaths are much lower.

Confirmed Cases: Texas had its highest rate of confirmed cases of **276K/m in July** (Table 2). The confirmed cases in May was 36.4K/m. In the month June the confirmed cases have increased to 102K/m. The highest confirm cases per day was on July 28, and it was 11,037 with death rate of 45/day. The total confirmed cases were over 443,000 (July 31), comparable to New York and 10% of the U.S.

Death Cases: Texas had its highest rate of deaths in July of **4.5K/m**. The highest death rate for a day was 154/day on July 15 and on April 15 it was 30/day. In the month June the death rate was 810/m. The last few weeks death rate has increased, and the maximum was 499/day on July 13. The total deaths is 6998 (July 31), about 21.4% of the New York deaths.

The population in Houston, largest city in Texas is 2.3 million and the population density is 3,634 people/square miles. Houston population is 27.4% and population density is 13% of New York City. The Houston death percentage is in between the population and population density.

Table 2. Comparing the COVID-19 Impact on New York and Texas

Date	Texas		New York		Remarks
	Confirmed Cases	Total Deaths	Confirmed Cases	Total Deaths	
2/29/2020	0	0	20	0	**Texas** confirmed cases and deaths were 3.7K/m and 56/m. **New York** confirmed, and deaths were 77K/m and 2.7K/m
3/15/2020	73	0	740	10	
3/31/2020	3,666	56	76,946	2677	
4/15/2020	16,009	375	218,562	15,500	**Texas** confirmed cases and deaths increased by 24.8K/m and **746/m**. **New York** confirmed cases and death were **234K/m** and **21.1K/m** (Highest for New York)
4/30/2020	28,455	802	310,839	23,780	
5/15/2020	46,787	1,308	356,016	28,411	**Texas** confirmed cases and death increased by **36.4K/m** and **884/m**. **New York** confirmed, and death rate were **79K/m** and **6.7K/m.**
5/31/2020	64,899	1,686	389,903	30,509	

6/15/2020	**91,380**	**2,016**	**406,081**	**31,548**	**Texas** confirmed cases and death increased by **102K/m** and **810/m**. **New York** confirmed and death rate were **27.9K/m** and **1.6K/m**.
6/30/2020	**167,269**	**2,496**	**417,836**	**32,129**	
7/15/2020	**302,817**	**3,625**	**430,277**	**32,495**	**Texas** confirmed cases and death increased by **276K/m** and **4.5K/m**. **New York** confirmed and death rate were **26K/m** and **636/m**. (Highest for Texas)
7/30/2020	**443,026**	**6,998**	**443,745**	**32,765**	
Remarks	Confirmed cases were highest in July	Deaths were highest in July	Highest confirmed cases in the U.S.	Highest deaths in the U.S.	**COVID-19 has impacted the coastal states with high GDP rating and populations**

Vipulanandan p-q Model

It is important to predict the observed trends for both the total confirmed cases and total deaths (Y) with time (t) using analytical models. Preliminary investigation was done using Vipulanandan p-q model. The model parameters can be used to evaluate the important parameters that are impacting the COVID-19 confirmed cases and the total deaths.

$$Y = \left[\frac{\frac{t}{t_f}}{q_2 + (1 - p_2 - q_2)\frac{t}{t_f} + p_2 \left(\frac{t}{t_f}\right)^{\left(\frac{p_2 - q_2}{p_2}\right)}} \right] Y_f \qquad (1)$$

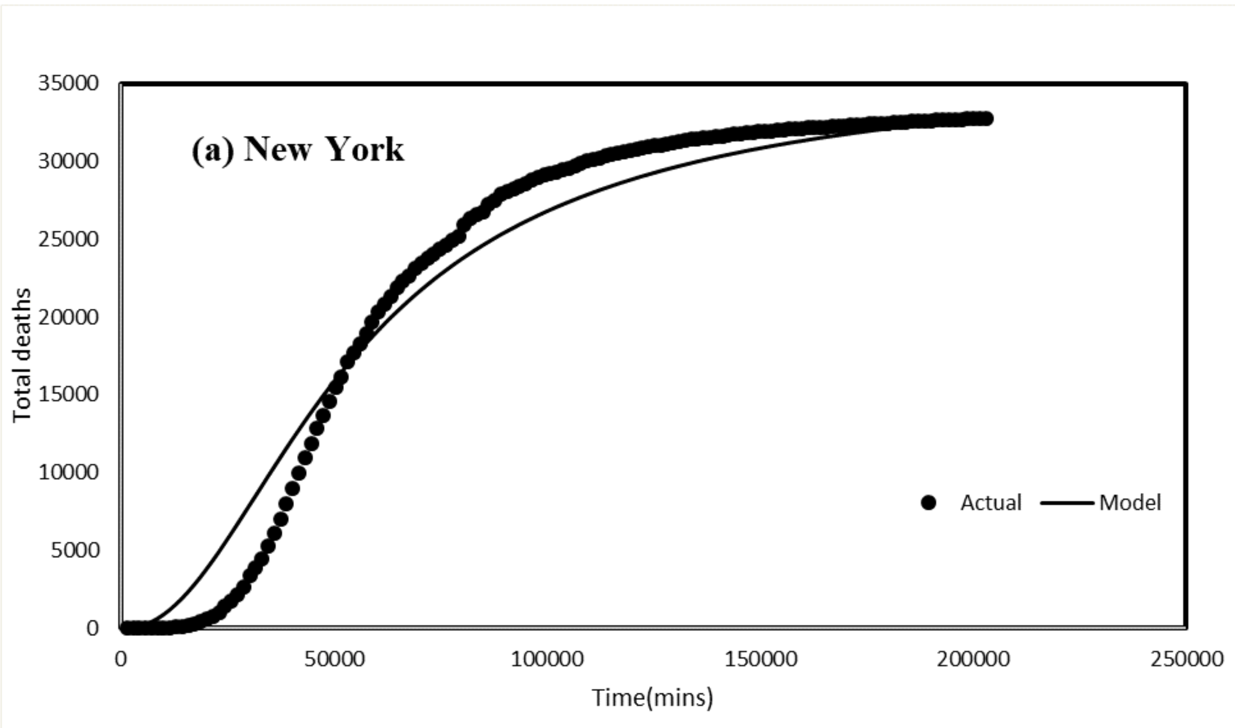
Model parameters (p_2, q_2 and Y_f) will be related to the critical variables such as population, population density, GDP (economic activity), temperature, relative humidity, food, transport facilities, animals and others.

The model predictions are compared to the data in Figure 2 for New York and Texas. Also, the model parameters are summarized in Table 4. The Model parameter ratio q_2/p_2 was 2.29 and 0.60 for New York and Texas respectively and represents the shape of the trends for the equal time period. Also, both model parameters decreased with the increased death.

Table 4. Vipulanandan p-q Model parameters for the death predictions

State	**Maximum Death (Y_f)**	**Time for Max. Death (t_f) (min.)**	**p_2**	**q_2**	**R^2**	**RMSE (Number of people)**	**Remarks**
New York	32,765	203,040	0.035	0.08	0.98	1,970	Rate of deaths initially

							increased but decreased with time
Texas	6,998	185,760	2.5	1.5	0.98	253	Rate of deaths increased with time
Remarks	New York had the highest number of deaths in the U.S.	Middle of March to end of July about 4.5 months.	Decreased with number of deaths.	Decreased with number of deaths.	Coefficient of verification was very high and good	Represents the accuracy of the predictions	Predicted the total deaths with time very well.



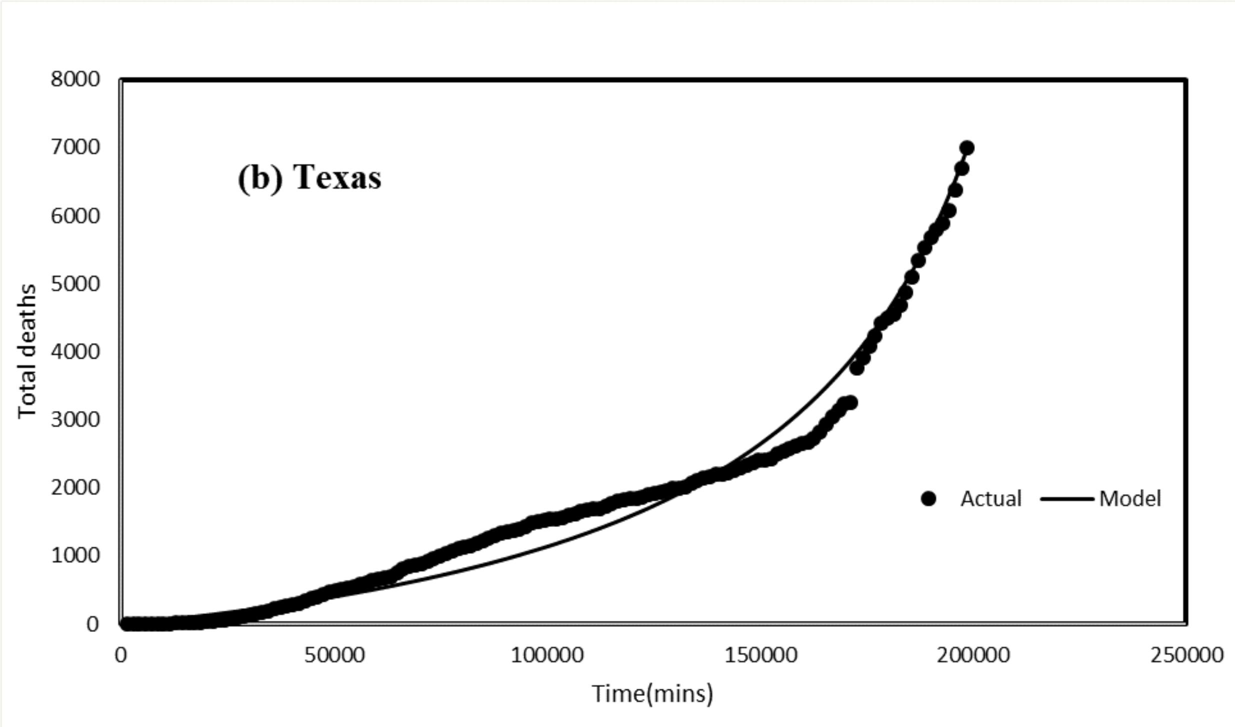


Figure 2. Vipulanandan p-q model predictions are compared to the death data (a) New York and (b) Texas

Potential Methods of Spreading

It is important to know how the COVID-19 virus was spread around the world in very short time period. COVID-19 is a 120 nm organic nanoparticle. Transmission Electron Microscope (TEM) has been used to determine the particle size of COVID-19. There is no life to this virus and can be considered as an **organic dust particle**. There is no clear evidence of the surface charge, but the bacteria, organic micro size particle is negatively charged. There is ongoing investigation of COVID-19 virus attachment to various surfaces including metals and mail packages. As shown in Fig. 1, in addition to humans, number of other factors may influence the COVID-19 spread. There is no life to COVID-19 like the dust particle so the stability of the COVID-19 under various environments (temperature, pH, humidity) must also investigate to develop control methods. The filters and face masks that are used have to be effective with the nanoparticles or must have some coating to capture organic nanoparticle. The potential methods of spreading are shown in Figure 3. All these must be investigated in much more detail with available data around the world and in the U.S. because U.S. is the worst impacted country ranked number one GDP in the world.

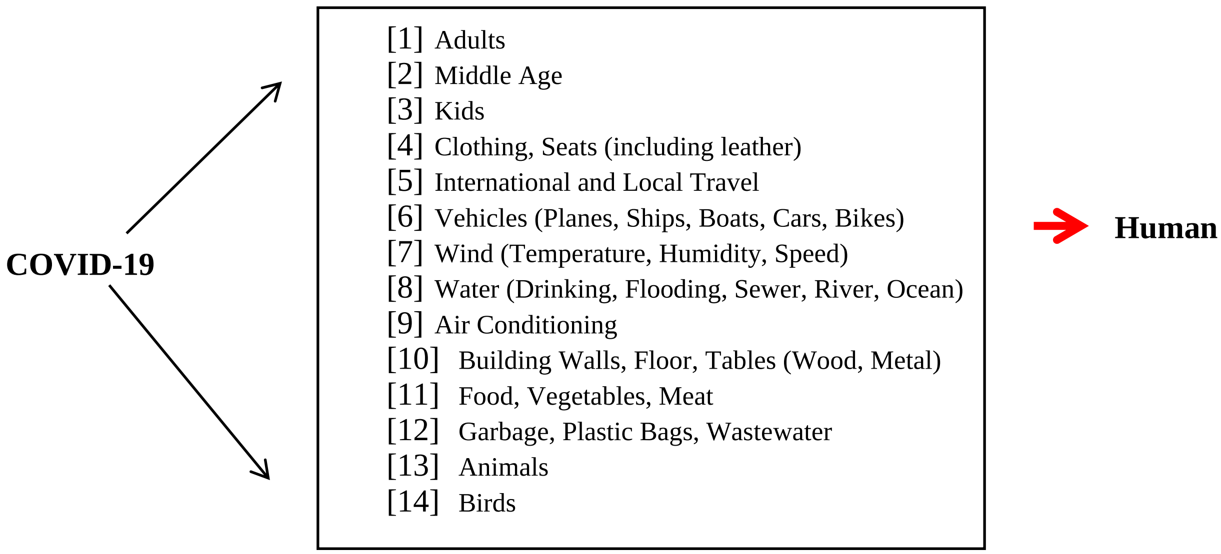


Figure 3. Potential Method of COVID-19 Spreading in the World

Critical parameters

(1). Need to develop a **gene therapy** with a **viral vector** to control the spread of COVID-19 virus.

(2). Identify the critical modes of spreading of the COVID-19 virus.

(3). Develop vaccine to improve the immune system of the humans.

(4). For the affected humans develop a disaster response (DR) and rapid recovery (RR) processes for hurricanes, fires and others including cyber attacks.

2. Disaster Management and Rapid Recovery Plans (DMRRP)

In order to optimize the DMRRP, it is important to identify and quantify the major processes based on the type of disasters.

Models

It is important to develop models to quantify the (a) Preparedness, (b) Disaster response and (c) Rapid recovery for various disasters. Based on experiences it is being proposed to represent Disaster Management and Rapid Recovery as a 3- Phase Model as follows:

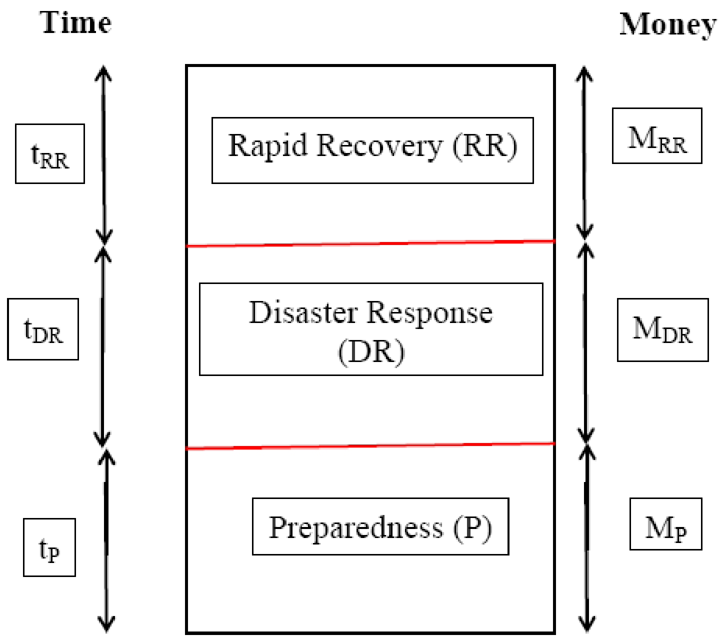


Figure 4. 3-Phase Representation of Disaster Management and Rapid Recovery

Both time (t) and money (M) are two most important parameters. Many factors will influence the **parameter M**, and will depend on the time (t), sources (Local, State, Federal), regulations and many other factors. The preparedness parameters tp and Mp will depend on the approaches selected to do the preparations including communications and evacuation.

(ii). Preparedness (P) and Critical Parameters (tp and Mp)

It is important to identify the critical parameters for preparedness for each type of disaster related to **individuals, families, project teams and communities**.

OBJECTIVES

Overall objective of **preparedness (P)** includes **plans to minimize losses** of humans (H), animals (A), environment (E) and property damages. Also organize the **temporary removal of people** (Evacuation) and property (valuables) from threatened locations, and facilitate timely and effective rescue, relief and rehabilitation. The specific objectives are as follows:

(1). Building a networking team **with leaders** representing communities, schools, hospitals, nursing homes, cities, counties, state emergency managers, power utilities, groceries, department of transportation and industries.

(2). Identify the **potential single and multiple disasters** related to natural, human made and virus for the **area of interest**.

(3). Develop alternative plans to **build resiliency** in the communities and also **training programs** for kids and adults. With the COVID-19 virus the training program must be online.

(4). Preparedness plans should identify the **critical elements** to be purchased (water, food, medicine) and **filling the gas tanks in the vehicles** before the disaster. Also prepare the communities for **power failures**. Identify the amounts to be stored in your **food banks**. Have **multiple insurances** for health, cars and home (flooding, fire, broken windows).

(5). Develop alternative **evacuation plans**.

(6). **Minimize** the parameter **tp** and **optimize** the parameter **Mp** based on the alternative plans.

(7). Develop alternative **communication methods** for pre-warning before the disasters and also for communicating during and after the disaster with and without the impact of **cyber-attacks**.

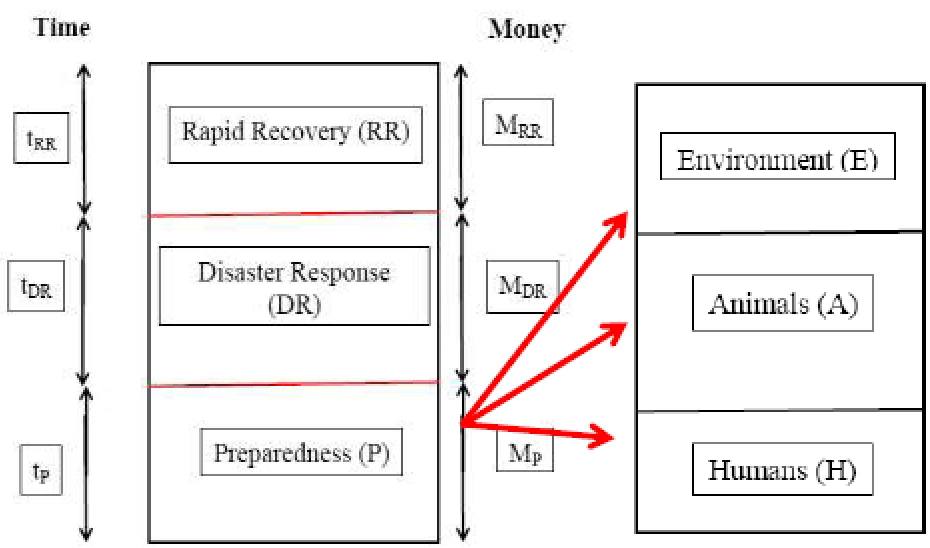


Figure 5. Parameters for Preparedness (P) (for you, family, team, city, country)

EVACUATION OBJECTIVES

Overall objective for **evacuation** includes **plans to temporarily move** the humans (H), animals (A), and valuable properties (cars, computers, phones) and documents. The specific objectives are as follows:

(1). Identify the **types of disasters** related to natural, human made and virus for the **location of interest**. Based on the types of disasters develop the evacuation plans.

(2). Determine the mode of **public transport** (trains, buses) or **private transport** (cars, vans) that can be used for evacuation.

(3). Identify **more than one safe location** to evacuate with the **family and pets** based on weather predictions and government guidelines to build the resiliency in the evacuation plan This will also help with **avoiding roadblocks and traffic** to reach the safer place quickly. Be aware of **cyber-attacks.**

(4). Select the evacuation location (Government shelter, hotels, schools) with faster returning opportunity. Protect against **virus spread**. Attention to **sanitation issues**, **drinking water and food**.

(5). **Basic items** that need to be taken during the evacuation are as follows:

- Prescriptions and other medicines
- First aid kit
- Important documents (birth certificates, passport, home insurance, bank accounts)
- Bottled water
- Food (canned, bagged)
- Flashlight, battery-powered radio and extra batteries
- Clothing and bedding (sleeping bags, pillows)
- Masks
- Special equipment for infants or elderly or disabled family members
- "Comfort items," such as special toys for children
- **Computer hard drive and laptop**
- Pet food and other items for pets (litter boxes, leashes)
- Avoid glassware

(6). Develop plans for **quick return** and **potential repairs** for the house and job-related construction sites and applying for loans and insurance.

This will be part of the **Disaster Response (DR) parameters t_{DR} and M_{DR}.**

(iii). Disaster Response (DR) and Critical Parameters (t_{DR} and M_{DR})

It is important to identify the major issues related to disaster response (DR) and rapid recovery (RR) with parameters, t_{DR}, t_{RR} M_{DR} and M_{RR}. The disaster response and recovery are very much influenced by the losses and debris removal.

Return from Evacuation

In order to accelerate the DR and RR, it is important to return home as soon as possible taking the safe pathway. There could be roadblocks and damages that needs to be factored into the return plan.

Losses

The losses can be divided into short-term and long-term losses. Losses will result in influencing the **parameters time and money.**

Short-term Losses

The timeline will be between 0.5 month and 1 month to recover and get the lost items (less than 1 month) for **you, family and team.**

- Roadblocks
- Prescription medicine
- Damaged car or truck
- Insurance policies — homeowners, auto, life and any others
- Employment information
- Power failure
- Traffic lights failure
- Closed restaurants and stores
- Lost phone and charges
- Financial information such as bank accounts and credit cards

(iv). Rapid Recovery (RR) and Critical Parameters (t_{RR} and M_{RR})

It is important to identify the major issues related to disaster responses to rapid recovery (RR) with parameters, t_{RR} and M_{RR}. The disaster response and recovery are very much influenced by the losses and debris removal.

Long-term Losses

The timeline will be **over one (1) month** to recover and get back most of the lost items for **you, family, team, community, city, country.**

- Debris
- Power Loss and Grid Failures
- Roadblocks
- Deaths (humans, pets, animals)
- Property lost (house, buildings, highways)
- Damaged transport facilities (trains, buses, cars, 18 wheelers and others)
- Closed businesses, schools, Universities
- Closed Airports and Ports

3. MULTIPLE DISASTERS

There are multiple disasters happening around the world. Also, the current COVID-19 pandemic and cyber-attacks will add to the multiple disasters. Multiple disasters could be totally natural or human based or a combination. Multiple disasters will have two or more disasters at one time. For example, during a hurricane there can be virus pandemic (human) and also cyber-attacks (human), fire (human), oil spill (human) and flooding (natural).

In planning all these potential challenges, it is important to integrate the GIS (Geographical Information System) to identify the critical locations including hospitals, food supply and gas supply. It is also important to determine the resources available for preparedness (P), disaster response (DR) and rapid recovery (RR) plans.

Modelling of Multiple Disasters

It is important to understand the import parameter need for modelling multiple disasters. Base on the model, importance of various parameters can be identified for disaster management and rapid recovery planning

Monitoring

It is important to develop new technologies for **real time monitoring of the multiple disasters. To ensure the health and safety of the humans and animals**, real-time **monitoring of disasters (flooding, wind speeds, power grids), evacuations, hospital and other critical facilities** will be a good use in disaster response and rapid recovery. Real-time monitoring will also help in developing procedures to minimize the virus attacks and cyber-attacks.

Disaster Management and Rapid Recovery Plans

During a multiple disaster (more than one), it is import to have a comprehensive disaster management and rapid recovery plans. Base on the disasters, following plans can be considered for implementation.

PLAN 1: Combine processes (**mixture theory**) for the disaster management plans for multiple disasters. For example, if there was a natural disaster with the cyber-attacks the DMRRP can be a combined process (PLAN 1) by integrating both disasters to minimize the cost (M_{NC}) and time (t_{NC}) (Fig. 6).

PLAN 2: Develop a **parallel process** (**parallel electrical circuits**) for the disaster management and rapid recovery plan. This will be the approach with the COVID-19 pandemic and cyber-attacks currently in place, because the COVID-19 patients cannot be mixed with the general population. For example, if there was a natural disaster with the COVID-19 and cyber-attacks the DMRRP can be a parallel process (PLAN 2) to minimize the costs (M_{NC} and M_{VC}) and time (t_{NC} and t_{VC}) as shown in Figure 7.

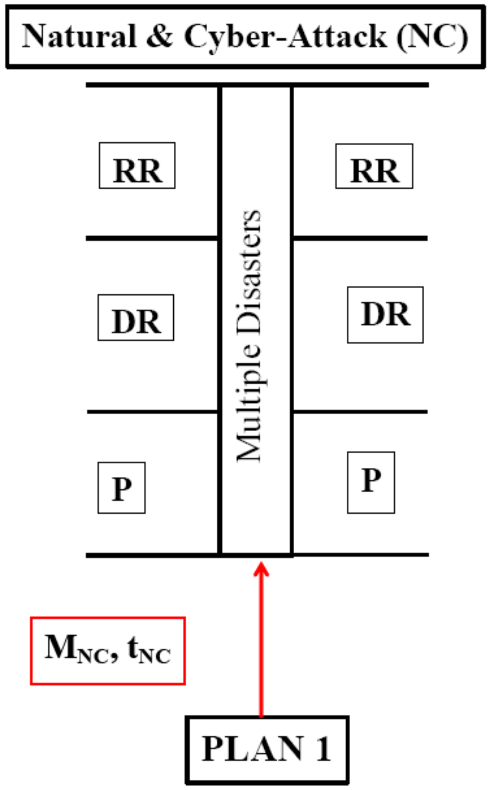


Figure 6. Multiple Disaster Plan 1 Combined Process

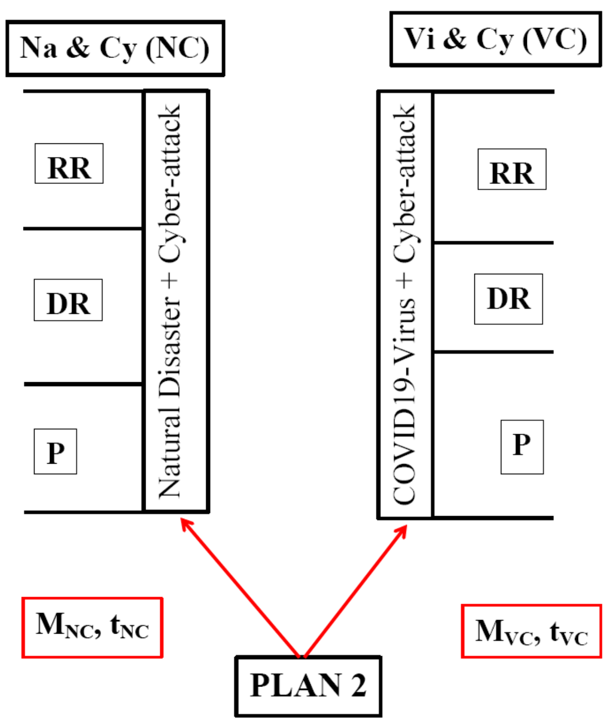


Figure 7. Multiple Disaster Plan 2 Parallel Process with the COVID-19 Pandemic

Preparedness (P)

Based on the potential disasters, PLAN 1 or PLAN 2 must be selected for the preparedness (P) process. There will be **some warning before some of the disasters** and hence **preplanning and preparedness with adequate training will be important.** Virus attacks with and without cyber-attacks may result in **shut down of schools, businesses, airports** and **grocery stores** which have to be taken into account for when developing the preparedness (P) with PLAN 2. **Humans affected by the COVID-19 can be evacuated to the ships along the coast and others can be evacuated inland away from the coastal areas.** Also, potential virus treatment methods and also protection of the populations and animals have to be incorporated into the preparedness (P) plans. Also, **resilience communication methods** have to be developed. This will help with the disaster response (DR) and rapid recovery (RR).

Disaster Response (DR)

Based on the disasters, PLAN 1 or PLAN 2 must be selected. This will also be related to the **available hospitals** to treat the affected patients. New treatment methods for patients also protecting the general population must be evaluated. **Also, ways and methods to open the business, schools and stores with the needed protection systems must be considered.**

Rapid Recovery (RR)

Based on the disasters, PLAN 1 or PLAN 2 must be selected. PLAN 2 will be very much impacted by the **scale of the virus-attack** on the population and daily operations. Also, comprehensive plans have to be developed for **rapidly recover after the multiple disasters**. The rapid recovery time and cost must be minimized. With the COVID-19 virus, the disposal of debris could become an issue and must be planned alternative methods during the preparedness (P).

4. New Technologies

(a) **Real-Time Monitoring**: Recent advances in sensor technology and communication have catalyzed progress in remote monitoring capabilities. Monitoring is only effective if the collected information can be stored and interpreted real-time. These advances have led to improved statistical and mechanistic modeling in monitoring.

(b) **Drones:** The earliest recorded use of an unmanned aerial vehicle (UAV) for warfighting occurred on July 1849. Since then technology has evolved to make very efficient light weight aircrafts with cameras for monitoring before and after disasters.

(c) **Smart Cement**: Highly sensing smart cement has been recently developed for real-time monitoring (Vipulanandan et al. 2017-2018). Smart cement is a chemothermo-piezoresisitive cement and a 3D sensor that could detect gas leaks, seismic activities, loadings and fire (Vipulanandan et al. 2019)

(d) **Flooding Protection**: There is an urgent need to developing simple and innovative methods to protect houses and streets from flooding. The flooding is greatly affected by the rate of run-off of the rainwater which has to be controlled.

(e) **Modeling:** It is important to quantify the 3-Phase DMRRP model parameters (losses, money and time). Also developing new models and using Artificial Neural Network (ANN) for Artificial Intelligent (AI) to do the predictions related to losses and debris.

CONCLUSIONS

Based on the experiences from the worst hurricane in the State of Texas history, fire disasters and the recent COVID-19 pandemic data analyses and evaluating new technologies following conclusions are advanced:

1. Consider parallel process, PLAN 2, for the DMRRP due to the COVID-19 impact with and without cyber-attacks.
2. Real-time monitoring is critical for minimizing urban area fires and losses due to hurricanes, cyber-attacks and COVID-19 pandemic.
3. Identify the transfer mechanisms of COVID-19 among humans to minimize the impact and loss of lives.
4. Educate the communities regarding preparedness, minimize losses and rapid recovery.
5. Minimize the drinking water infrastructure damages. Build redundancy in the power grids to minimize losses.
6. Improve debris removal and minimize the delay. Also consider the effects of COVID-19 and cyber-attacks in the debris removal and also disposal.
7. Consider adopting new technologies for real-time monitoring using drones, smart cement, flood protection and debris removal.
8. Evaluate the adaptation of the new 3-phase model with prediction models and Artificial Neural Network (ANN) in Artificial Intelligent (AI) for alternative approach methods with losses, money and time predictions related to preparedness, disaster response and rapid recovery.

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