NATURAL DISASTER EVACUATION POLICIES AND RECOMMENDATIONS FOR ELDERLY ASSISTED LIVING FACILITIES ON OAHU

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I certify that I have read this thesis and that, in my opinion, it is satisfactory in scope and quality as a thesis for the degree of Bachelor of Science in Global Environmental Science

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Abstract

After Hurricane Katrina, states, cities and counties re-examined their disaster preparedness plans. One area of neglect that was found in most of these plans concerned the elderly and those with special health needs and Hawaii was no exception. The only policy that exists in Hawaii for the evacuation of residents of assisted living facilities is in the Hawaii Administrative Rules in Title 11 Chapter 100-12. This policy states that it is the responsibility of the facility to evacuate the residents, not the government. Currently, the plan for the elderly in assisted living facilities is to shelter in place unless it is not possible. However, there is nowhere else for these citizens to evacuate to that can accommodate their needs. Agencies from all levels of government in Hawaii are designing a plan to incorporate these citizens by retrofitting an estimated 32 shelters to meet their special health needs, and by educating facilities on hardening and retrofitting their buildings. Unfortunately, these shelters will not be available for a least a decade and most retrofitting is quite expensive. This paper offers an alternative to these current plans for elderly preparedness during natural disasters. If the state were to mandate a consortium among the assisted living facilities, the common goal could be to protect the residents by allowing for cost sharing and providing sufficient sheltering before the public shelters are completed. The consortium would choose certain facilities dependent on size, location and physical integrity of the building to act as a hub during a natural disaster. All facilities would participate in cost sharing for supplying, retrofitting and hardening the hubs. The consortium could single handedly reduce over-crowding in shelters during a natural disaster and allow space for elderly not associated with a living facility.

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CHAPTER 1: INTRODUCTION

The horrible stories that were told during the aftermath of Hurricane Katrina were not just stories, they were an astonishing reality. Stories of nurses and care takers who abandoned their elderly patients surfaced to mainstream media along side stories of loved ones euthanized after days of chaos and sweltering heat. These stories made the nation weep and then ask why?

Hurricane Katrina is an extreme case of catastrophe in that all levels of government took no immediate action in preparing the citizens of New Orleans for evacuation. Because of this, most disaster managers do not like to reference Hurricane Katrina when planning for disasters, except to reference what not to do. What Hurricane Katrina did do for the United States is that it made states, cities and counties look at their own disaster management plans to see if they could handle a natural disaster. Most plans are up-to-date but one area remains a blind spot, the elderly and those with special health needs. Hawaii realized this and state, cities and counties agencies had met in October 2005 to begin to address this issue by creating a working group and designing guidelines to include the elderly population and those with special health needs. These guidelines are laid out in the Interagency Action Plan of 2007.

The state of Hawaii is severely at risk for natural disasters simply based on its geographic location. In particular, Hawaii is susceptible to hurricanes, earthquakes and tsunamis.

Hurricanes occur in all ocean basins and can cause severe damage to property and life. There have not been any hurricanes in the last 16 years in the state of Hawaii. The last hurricane Hawaii endured was Hurricane Iniki in 1991. Because of this fact, residents tend to forget the vulnerability of their state. However, if there were a threat of a hurricane, the State of Hawaii has an excellent warning and forecast system that tracks every tropical depression in its jurisdiction, and allows for proper warning to the community.

Earthquakes however, are on the mind of the residents and scientists in Hawaii because of the recent earthquakes in October 2006. These earthquakes were caused by isostatic response to crustal loading. Hawaii, however, also experiences earthquakes that are more directly associated with volcanic activity. In addition to the local earthquakes, Hawaii is also at risk to earthquakes that occur in all areas of the Pacific Ocean, known as the "ring of fire". When these earthquakes are shallow enough, they have the capacity to generate a tsunami. Depending on the location and size of the earthquake Hawaii has up to several hours to prepare. However, if a Big Island earthquake generates a tsunami, the preparation time for Oahu is expected to be about one half hour (Time Travel for a Kona Tsunami, accessed 2007).

While the general population will be greatly affected by these natural disasters, it is the elderly population that has a disproportionate vulnerability before, during and after a natural disaster (Ngo, 2001). The purpose of this paper is to investigate the policy of evacuation of licensed elderly assisted living facilities on the island of Oahu during a natural disaster. Figure 1 shows the assisted living facility locations in relation to the FEMA flood zones and tsunami inundation zones. It is easy to see that there are many facilities that will need to evacuate in the events of a tsunami or hurricane. However, it is not immediately clear if there are federal, state, city and county policies for these residents. If there are policies, do the caretakers at these facilities know what to do? Do they practice evacuation drills? Do they know where to go? Do they have transportation arranged to evacuate the residents to a safe place or to a nearby shelter? What is Oahu's current preparedness in regards to these citizens? Has the state made any changes in accommodating the elderly and those with special health needs? In addition to the Interagency Action Plan of 2007, what else could be done? Are there alternatives? These questions all need to be answered.

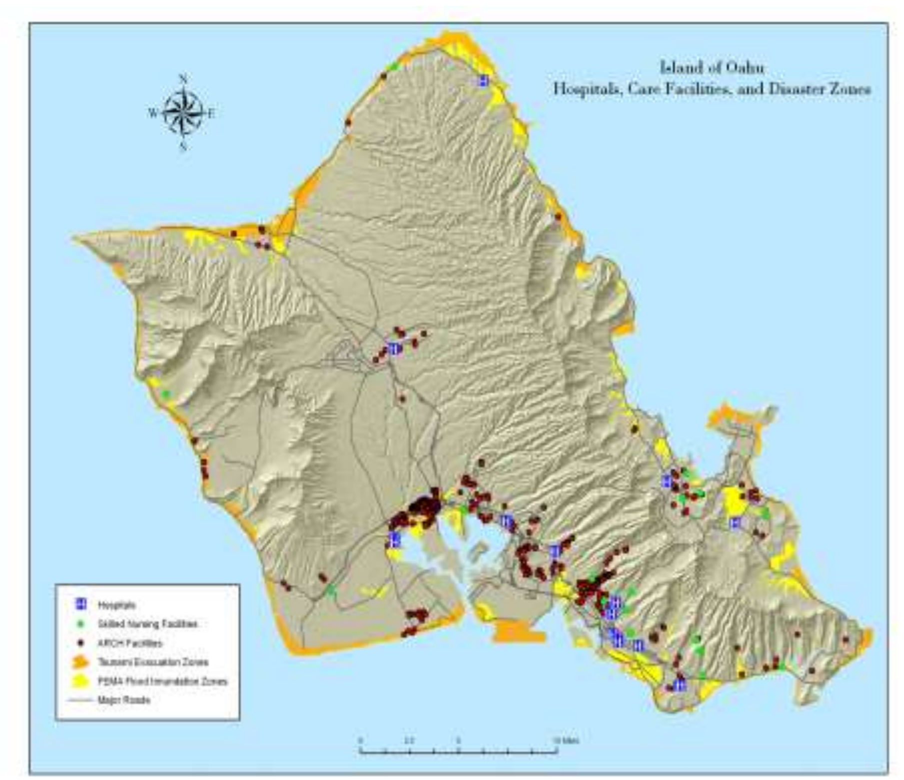

Figure 1.Map of ARCH facilities on the Island of Oahu. Source: State Department of Health. (Not for reprint)

CHAPTER 2: HURRICANES

2.1 Introduction

One of the most threatening natural disasters to the Hawaiian Islands is a hurricane. In simplistic terms a hurricane is a large tropical cyclone, which is a great mass of warm, humid, rotating air. The name Hurricane is derived from Huracan which is the god of wind of the Caribbean Taino people (Garrison, 1999), more specifically “evil spirit and big wind” (Fitzpatrick, 1999). Hurricanes only develop in certain areas of the earth’s oceans, with distinct partiality for certain periods of the year (Pielke 1990). This paper is concerned with hurricanes that occur in the Central North Pacific Ocean. The boundaries of this region are the equator, 140° West Longitude and the International Dateline which are the boundaries that the Central Pacific Hurricane Center uses to watch tropical depressions and storms that may affect Hawaii.

2.2 Structure of a Hurricane

Hurricanes occur worldwide and have different names in different geographic locations of the world. They are known as *typhoons* in the Northwest Pacific west of 180° E, *severe tropical cyclones* in Australia and *severe cyclonic storms* in India. Although they have different names, they are characterized by two stages: the genesis phase, and the intensification stage (Fitzpatrick, 1999).

2.2.1 Genesis Stage

Hurricane formation is favorable in warm oceans where pre-existing regions of relatively low surface pressures exist along with a cold air mass that overlies associated thunderstorms (Figure 2). This instability enables convection and strong updrafts that lift the air and the moisture upwards. The surrounding air tends to move toward the center of the low pressure region, which is the surface convergence depicted in figure 2. The rotation of the Earth, along with the Coriolis Effect deflects this air into a counter clockwise rotation in the Northern Hemisphere and clockwise rotation in the Southern Hemisphere. Along with differences in atmospheric pressure, the presence of warm ocean water temperatures (>27°C) help influence hurricane formation. Warm water allows for heat transformation to further sustain the thunderstorm. As air rises it cools and condenses water vapor into liquid, a process that releases latent heat into the atmosphere (http://earthsci.org/index.html, 2007) and causes air to expand creating divergent air flow at upper atmospheric levels (Cotton, 1990). This divergence removes air mass from the vertical column of air and creates a lower pressure at the surface of the ocean and low-level convergence. Lastly, hurricane genesis requires weak wind shear meaning that the wind must have roughly the same speed and come from the same direction at all levels of the atmosphere. Together, all these conditions set the stage for hurricane formation. The stages of development of a hurricane are listed in Figure 3.

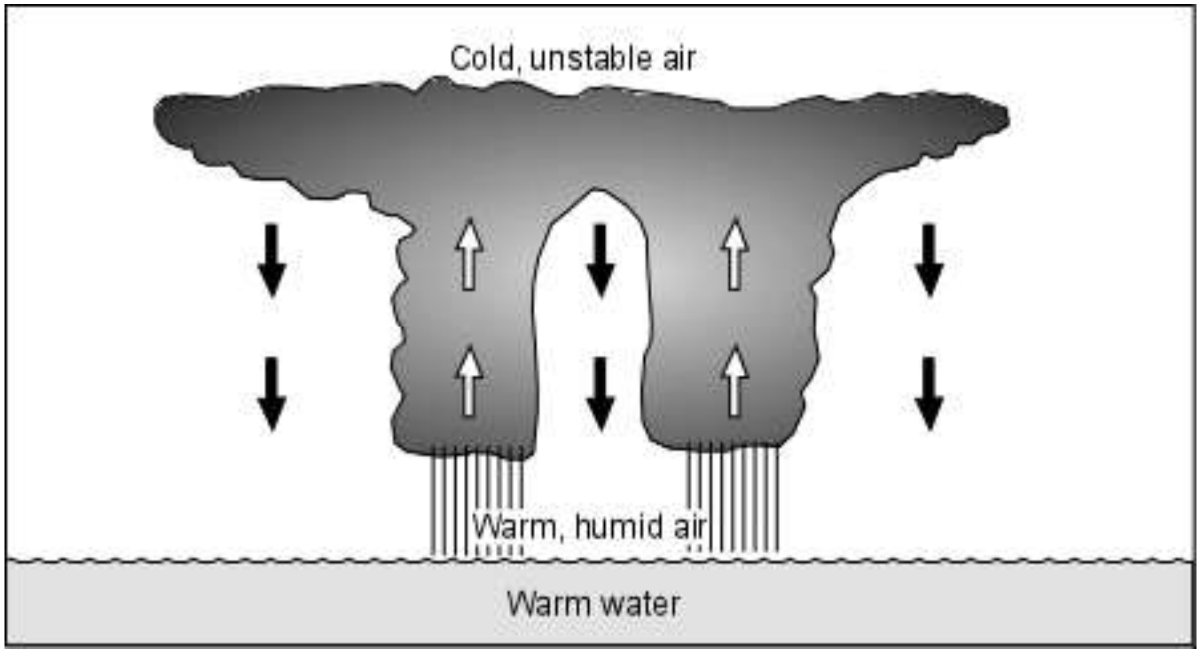

Figure 2. Air flow diagram of unstable air in atmosphere. Source: Earth Science Australia

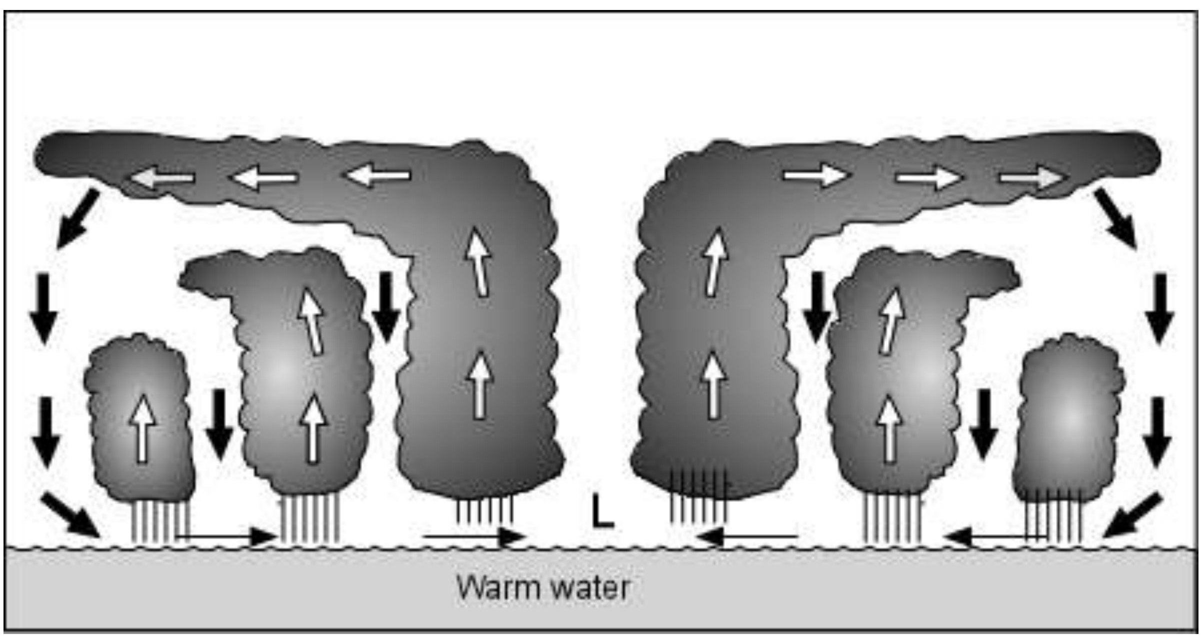

Figure 3 Air flow to lower pressure area. Source: Earth Science Australia.

2.2.2 Intensification stage

As the wind increases during hurricane development, more heat and moisture are transferred into air via the ocean. The surface pressure begins to lower as the air column warms up, allowing for faster cyclonic winds. The central surface pressure drops as the winds increase, intensifying thunderstorm production and creating greater air inflow, leading to a feedback loop (Figure 3). This loop intensifies until the wind speeds reach 74 mph, which is the threshold of official classification as a hurricane. These winds generate a calm area in the center because now no air can reach the center (Pielke, 1997). The center is called the eye (Figure 5) and the diameter can vary from 13 to 16 kilometers.

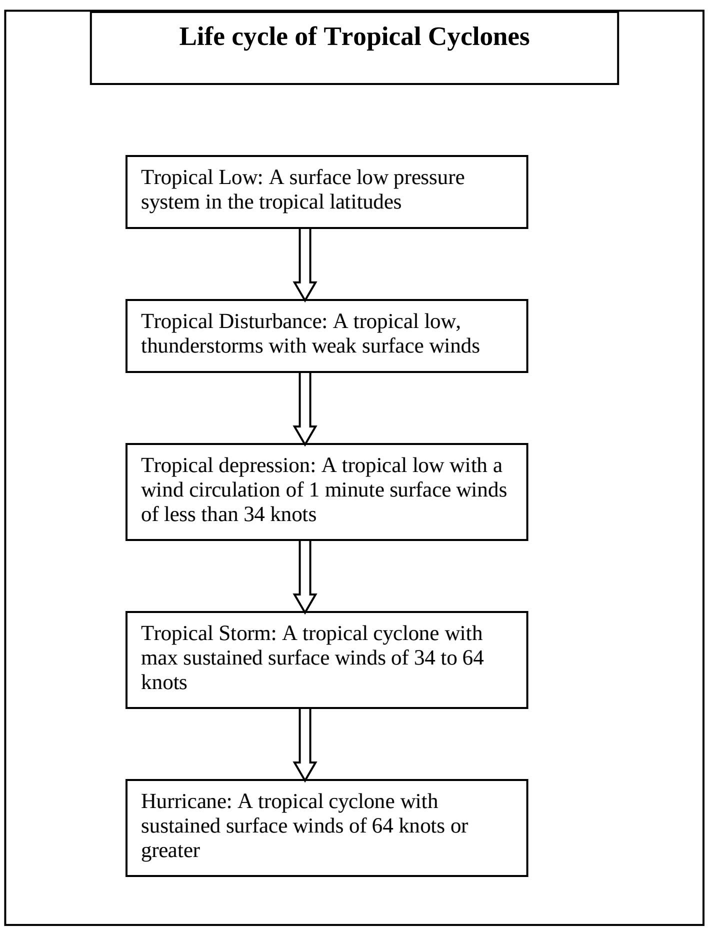

Figure 4. Life cycle of a hurricane. Adapted from Pielke and Pielke 1997

The eye is commonly cloud free due to the cool dry sinking air. This leads to clouds dissipation in the eye (Garrison, 1999).About 30 to 35 km outward from the center of the eye is the eyewall. This area is characterized by the rapid upward flow of air rushing toward the center of the storm (Cotton, 1990). The area just beyond the eyewall is characterized by stratisform clouds and rain bands (Figure 5). The rain that falls can sometimes exceed 2.5 centimeters per hour. If the storm is large enough, 20 billion metric tons of water can rain out in a day. Not only that, the power that is generated by a large hurricane in one day can equal the electrical demands of the United States for a whole year, which is 2400 billion kilowatt-hours of power! Energy is supplied to the storm as long as it remains over warm water and has hot humid air available. Plus, solar energy helps power the storm by heat absorption, evaporation, condensation, and conversion of heat energy to kinetic energy (Garrison, 1999).

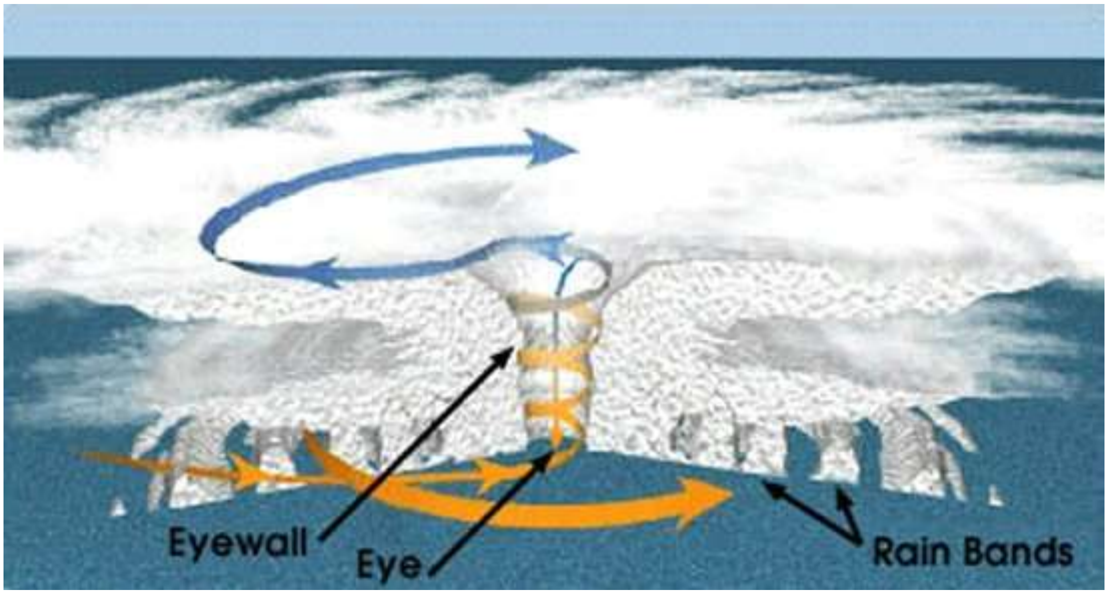

Figure 5. Basic schematic model of a hurricane. Source: Aerospaceweb.Org

2.3 Hurricanes and Climate Change

It has been suggested that hurricane intensity, occurrence and landfall frequency (Pielke, 1997) as well as storm size, tracks and rainfall (Knutson, 1999) may be affected by human-caused global warming. According to the Intergovernmental Panel on Climate Change (IPCC, 2007), 1995 through 2006 were among the twelve warmest years on instrumental record. This increase of the earth's temperature is due to anthropogenic warming by emission of greenhouse gases.

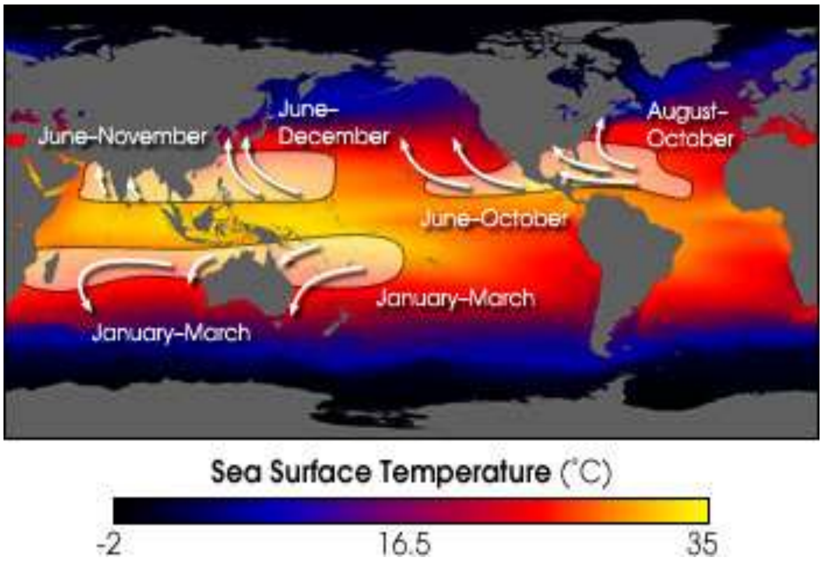

Figure 6. Sea surface temperature and global hurricane generation areas. Source: earth observatory

The major greenhouse gases are carbon dioxide, methane, nitrous oxide and water vapor. Increased concentrations of these gases are due to human activities including deforestation, fossil fuel burning, rice paddy cultivation, agricultural practices, fertilizer consumption, and the use of synthetic materials such as chlorofluorocarbons (CFCs).

According to the IPCC (2007) carbon dioxide is the most important of the greenhouse gases. Since 1750, there has been an increase in atmospheric concentrations of these greenhouse gases to levels that far exceed pre-industrial values as recorded in ice-core data. For instance, carbon dioxide concentrations have increased from the pre-industrial value of 280 ppm (parts per million) to 379 ppm as of 2005 (IPCC, 2007). This 2005 value for carbon dioxide is well beyond the natural range (180-300 ppm), which has been determined from ice-cores from the past 650,000 years (IPCC, 2007).

The increase in carbon dioxide is directly related to increase in the atmospheric temperature, which in turn directly affects the temperature of the global ocean. The ocean is absorbing more than 80% of the heat added to the climate system (IPCC, 2007). This rise in sea surface temperature (SST) has penetrated to the depth of at least 3000 m, which expands the seawater. This increase in SST is thought to increase the intensity of tropical cyclones in the North Atlantic, which have been observed since 1970. However, there is no clear trend of the annual numbers of tropical cyclones (IPCC, 2007). The lack of a clear trend of annual numbers in tropical cyclones reflects technological advances in the ability to track intensities within the past 30 years. It is extremely difficult to draw a conclusion of what normal hurricane activity is for any of the ocean basins because of the short time period. To predict future activity and intensity, scientists have focused on modeling including future climates due to global warming.

Modeling by Kossin et. al. (2007) shows that global warming produces stronger Atlantic Ocean hurricanes compared to other ocean basins with similar rises in SST. With limited data on hurricane track intensities, it was hard for Kossin et.al. to claim that the number of Atlantic hurricanes are increasing in both the number of hurricanes generated and their intensity. However, if their data are representative of the Atlantic Ocean hurricane activity, more research must be conducted to help better understand the relationship between global warming and hurricane formation.

However, a climate model simulation by Vecchi and Soden (2007) suggests the conclusions opposite to those of Kossin et.al. in that global warming in the tropical Atlantic Ocean might decrease the number of hurricanes due to a possible increase in wind shear. This is one of the first studies to incorporate wind shear when modeling hurricane formation under global warming conditions. Interestingly, the Vecchi and Soden (2007) models predicted that the western tropical Pacific would become more active than the Atlantic because conditions in the Pacific basin may be more favorable to hurricane formation.

These current models for hurricane formation and global warming show differing outcomes and they illustrate problems due to the lack of historic data of hurricanes in any of the global oceanic basins. According to the IPCC 2007, it is “likely” that the intensity and activity of tropical cyclones will increase. Even with the current lack of certainty, disaster management plans should incorporate the probability that hurricane intensity and activity will increase.

2.4 Hurricane Warning and Forecast

The forecast responsibility for the Central North Pacific Ocean resides at the Central Pacific Hurricane Center, which is located within the National Weather

Service Forecast Office in Honolulu. The forecast areas for the Central Pacific Hurricane Center (CPCH) are from 140º W longitude to the date line. If the storm forms in this area or crosses into this area it becomes the responsibility of the CPHC (Browning, 2006). If the storm then crosses the date line the CPCH informs the Japanese centers.

The CPHC uses a program called Automated Tropical Cyclone Forecasting system (ATCF) that was first developed by the navy. The ATCF provides information on current position, intensity and forecast track of a hurricane. The program keeps a record of all the cyclones that have been active over the year.

The CPHC issues a forecast package every 6 hours. If there is a tropical disturbance within the boundaries of the CPHC, the employees fix the center of the storm using satellite imagery and a multitude of specialized models and compare their estimates with those received from Washington D.C. and the Navy based in Pearl Harbor. After the center has been fixed, several detailed models of the atmosphere are run to estimate the possible track and intensity of the storm using the estimates of intensity and track from Washington as a guideline and reference. The CPHC model data from QuikSCAT which is a satellite that has special radar that measures near-surface wind speed and direction at a 25 km resolution. More specifically, QuikSCAT measures scatter of microwave beams by the surface of the ocean to then estimate wind speed. Wind speed can help locate the center of circulation. Once the center is estimated, the disturbance is classified as an invest area. Numerical models are then used to forecast the possible strength and track of the storm.

Once the CPHC determines the tropical storm as a threat, they send out advisories and warnings to customers (i.e. Oahu Civil Defense, Red Cross, local media, etc) and issue public advisories on their website. If a storm or disturbance comes close to the islands they issue a watch and if it is an imminent threat (predicted to hit the islands within 24 hours) a warning is issued.

Track forecasting is not a “slam-dunk” science and relies heavily on models to predict different outcomes. These models differ because they may use different initial conditions and different equations that are exponentially magnified throughout the model. The most complicated aspect to predict is the intensity of the hurricane.

The CPHC has a back-up generator that is tested once a week. The building is reinforced for hurricanes, is equipped with a safe room, and the windows have hurricane shutters. However, if the CPHC center on the UH Manoa campus is damaged during a natural disaster, the Naval Research Lab Marine Meteorology Division in Monterey, California would take over the local forecasting duties for the State of Hawaii while the National Hurricane Center in Miami Florida would take over other hurricane forecasting duties.

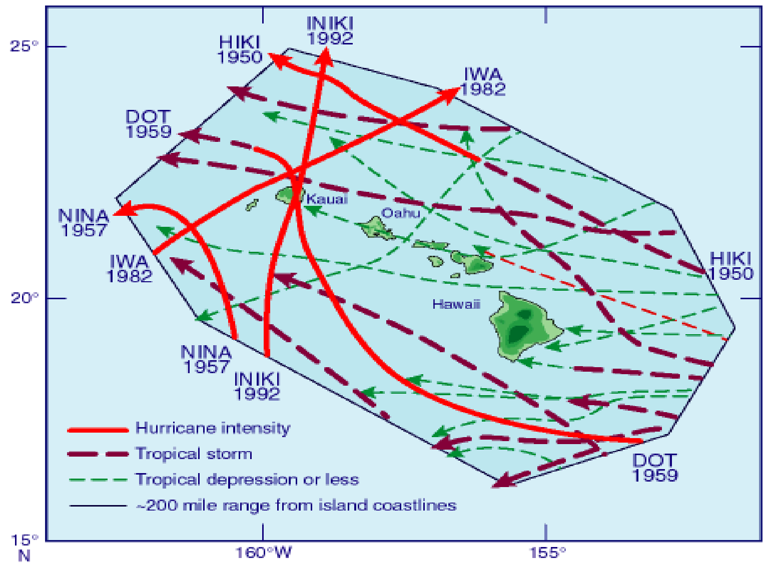

Figure 7. Hurricanes, tropical storms, and tropical depressions in Hawaii. Source: Steven Businger

2.5 Hurricane Damage

Hurricanes do not necessarily need to make landfall to cause damage. Damage that can be expected is far reaching. The ocean surf before and during hurricanes can be expected to damage coastal hotels, roads, and homes.

Winds from Hurricane Iniki and Iwa (figure 7) uprooted trees and damaged buildings that could not withstand hurricane force winds. The building codes have since changed to minimize damage so that if hurricanes are to make landfall again that destruction will not be as devastating. Oahu has also adopted these building codes, however there are still many facilities that will not fair well during high winds and have been noted as such. Other issues that should be expected and planned for are listed in table 1.

Loss of telephone lines	Coastal Flooding from storm surge
Closed airport , damage to airplanes diverted flights and cancelled flights	Backed up cell phones
Downed power lines	Closed gas stations
Crowded shelters	Water shut off
Closed roads	Inland flooding from rain
Wind damage to buildings	

Table 1. Expected damage due to hurricanes.

CHAPTER 3: EARTHQUAKES

3.1 Introduction

Simply defined, an earthquake is a shaking of the ground resulting from volcanic activity or energy being released at faults. As energy accumulates, rocks slip, shift or break (Raven, 2001). Most slippage occurs in regions of the earth's crust or upper mantle where continuing deformation takes place. The point where the rock slips is considered the focus (Press, 1974). The epicenter is located directly above the focus at the surface.

The release of the immense energy is in the form of low frequency waves known as seismic waves. Two wave types are associated with earthquakes and are generated simultaneously. The first wave, the P-wave (primary wave) travels through solid rock at about 5 km/s. The P wave is a compressional wave that travels through solid, liquid or gaseous materials as a succession of contractions and relaxations (Press, 2001). P waves can also be thought of as push-pull waves. These waves push or pull material in the direction of their propagation. The S-wave (secondary wave) travels through rock at roughly half the rate of the P wave. These S-waves push matter at right angles to their path of travel therefore they are called shear waves (Press, 2001).

3.2 Earthquake Magnitude

There are two methods that scientists and researchers use to scale earthquake magnitudes; the Richter Scale and the Mercalli Scale. The magnitude of an earthquake is determined by a rating or size given to an earthquake independent of origin of observation. For earthquakes in Hawaii, the magnitudes are calculated by the Hawaiian Volcano Observatory (HVO). The HVO uses the height of wave motion in millimeters (amplitude) and/or length in seconds of wave motion (duration) to determine the magnitude (Felt Earthquakes, 2007). The Richter Scale can be simply defined as amplitude magnitude. The public is more familiar with the Richter scale method than the Mercalli Scale.

3.2.1 Richter magnitude scale

The Richter magnitude scale of earthquake intensity was invented by Charles Richter in 1935. Each unit on the Richter scale represents about 30 times more released energy than the unit immediately below it (Raven, 2001). This method is based on the amplitude of seismic waves that are recorded by seismographs. The magnitude is based on a logarithm of the maximum amplitude which is adjusted by a factor that includes the weakening of seismic waves as they get further from the focus (Press, 1974).

3.2.2 Mercalli Scale

The Mercalli scale is used to express the various physical effects of earthquakes. The Mercalli Scale rating of an earthquake will vary depending on location.

I. People do not feel any Earth movement.
II. A few people might notice movement if they are at rest and/or on the upper floors of tall buildings.
III. Many people indoors feel movement. Hanging objects swing back and forth. People outdoors might not realize that an earthquake is occurring.
IV. Most people indoors feel movement. Hanging objects swing. Dishes, windows, and doors rattle. The earthquake feels like a heavy truck hitting the walls. A few people outdoors may feel movement. Parked cars rock.
V. Almost everyone feels movement. Sleeping people are awakened. Doors swing open or close. Dishes are broken. Pictures on the wall move. Small objects move or

are turned over. Trees might shake. Liquids might spill out of open containers.
VI. Everyone feels movement. People have trouble walking. Objects fall from shelves. Pictures fall off walls. Furniture moves. Plaster in walls might crack. Trees and bushes shake. Damage is slight in poorly built buildings. No structural damage.
VII. People have difficulty standing. Drivers feel their cars shaking. Some furniture breaks. Loose bricks fall from buildings. Damage is slight to moderate in well-built buildings; considerable in poorly built buildings.
VIII. Drivers have trouble steering. Houses that are not bolted down might shift on their foundations. Tall structures such as towers and chimneys might twist and fall. Well-built buildings suffer slight damage. Poorly built structures suffer severe damage. Tree branches break. Hillsides might crack if the ground is wet. Water levels in wells might change.
IX. Well-built buildings suffer considerable damage. Houses that are not bolted down move off their foundations. Some underground pipes are broken. The ground cracks. Reservoirs suffer serious damage.
X. Most buildings and their foundations are destroyed. Some bridges are destroyed. Dams are seriously damaged. Large landslides occur. Water is thrown on the banks of canals, rivers, lakes. The ground cracks in large areas. Railroad tracks are bent slightly.
XI. Most buildings collapse. Some bridges are destroyed. Large cracks appear in the ground. Underground pipelines are destroyed. Railroad tracks are badly bent.
XII. Almost everything is destroyed. Objects are thrown into the air. The ground moves in waves or ripples. Large amounts of rock may move. (FEMA, 1996)

3.3 Earthquakes in Hawaii

Most of Hawaii's earthquakes are associated with volcanic activity. There are two varieties of earthquakes that are generated on the Big Island; deep earthquakes and shallow earthquakes. The deep earthquakes are related to crustal loading, and the shallow earthquakes are related to volcanism. Figure 8 and Table 2 depicts historic earthquakes that had magnitudes of 6.0 on the Big Island, excluding the October 2006 events.

3.3.1 Deep Earthquakes

Earthquakes originate in zones of structural weakness located at the base of the volcanoes or deep within the earth beneath the islands (USGS, 1997). Hawaiian volcanoes of the Big Island are large, weak, and built of fragmental material and pillow lavas. Newly created lava weighs down the weak flanks of the volcano. According to Jim Kauahikaua, the Hawaiian Volcano Observatory chief, the weight of the Big Island is causing the sea floor to flex (isostatic response). As the sea floor flexes, it adds pressure to the mantle rocks below. Over time, the pressure builds and when the mantle can no longer handle the overlying weight of the Big Island the rocks slip, resulting in an earthquake. The earthquakes in October 2006 on the Big Island were caused by isostatic response.

3.3.2 Shallow Earthquakes

The majority of Hawaii's earthquakes are caused by magma moving beneath the Big Island's volcanoes, Kilauea and Mauna Loa. Shallow earthquakes commonly accompany eruptions of these two volcanoes. However, earthquakes are also associated with magma that never reaches the surface, most commonly associated with rift zones (Fryer (a), 2007). The rift zones are characterized by dikes and massive gabbro and are typically stronger than the volcanoes that they are associated with. New magma from deep within the surface is continually spreading Kilauea's east rift zone. This spreading causes the south flank of Kilauea to shift outward because the north flank is immobilized by Mauna Loa. This outward shift of the south flank is a response to the immense pressure of the rift zone spreading and is accompanied by earthquakes (Fryer, 2000).

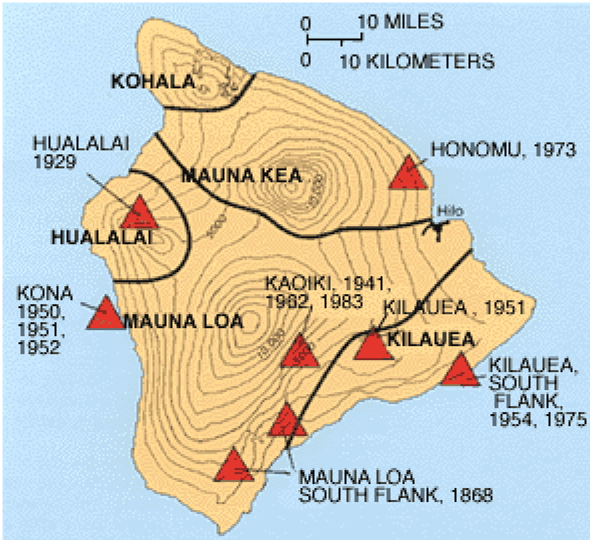

Figure 8. Earthquakes of significance on the Big Island. Source: USGS, 1997

Year	Date	Region	Magnitude	Depth (Mi)
1868	Mar. 28	Mauna Loa south flank	6.5-7.0*	No data
1868	Apr. 2	Mauna Loa south flank	7.5-8.1*	No data
1929	Oct. 5	Hualalai	6.5*	No data
1941	Sept. 25	Kaoiki	6.0*	No data
1950	May 29	Mauna Loa southwest rift	6.2	No data
1951	Apr. 22	Kilauea	6.3	20
1951	Aug. 21	Kona	6.9	5
1952	May 23	Kona	6.0	5
1954	Mar. 30	Kilauea south flank	6.5	5
1962	June 27	Kaoiki	6.1	6
1973	Apr. 26	Honomu	6.2	25
1975	Nov. 29	Kilauea south flank	7.2	6
1983	Nov. 16	Kaoiki	6.6	7
1989	June 25	Kilauea south	6.1	9

Table 2. Damaging earthquakes on the Big Island of Hawaii excluding the October 2006 earthquakes. Source: USGS, 1997

The last big earthquakes to disturb the Hawaiian Islands were on the morning of October 15th, 2006 (Figure 9). There were two major earthquakes that were about 6 minutes apart. The first one occurred about 6 miles NNW of Pauanahulu off the northwest coast of Hawaii and about 20 km northeast of the Kona airport at 7:07 am. The second earthquake's epicenter was 44 km north of the Kona airport and its focal depth was 20 km (Pararas-Carayannis, 2006). These earthquakes were caused by isostatic response to crustal loading on the Big Island. The aftershocks were located below Hualalai volcano and along a east-west slip plane close to the Hualalai volcano rift zone. This rift zone extends offshore and is truncated by the Moana Loa volcano to the east (Pararas-Carayannis, 2006).

3.4 The Last Time

During the October 15th 2006 earthquakes many things went wrong. The Civil Defense on Oahu had information pertaining to the earthquake (i.e. magnitude, location, etc) within minutes of the earthquake, however no employee knew how to operate the broadcasting machine to update the community (Gilbert, 2007). Even if the Civil Defense did know how to operate the machine, the broadcasting machine was not working properly.

The Civil Defense was not the only agency having difficulties that day. The Hawaiian Electric Company, Inc (HECO) experienced problems of their own. For example HECO had been trying to reach KITV-4, the Honolulu Advertiser and KHON-2 to update the community on the power outage and were finally successful around 8 am. However, attempts to reach Perry and Price at KSSK, the primary emergency broadcast radio station, were unsuccessful until 11:44 a.m. due to heavy caller traffic.

According to the Investigation of the 2006 Island-wide Earthquake Outage-Review of External Communications on the Islands of Oahu, the delay to communicate to the community and media were due to the high volume of calls that overwhelmed the available phone circuits, poor cell phone reception, and loss of power to the external land line service provider for HECO's Ward Avenue facility.

Despite the limited communication outlets, HECO did make efforts to reach the media, the public, emergency personnel and government officials by hand delivering messages and doing in-person briefings.

The Earthquake proved a lesson that Oahu needs to upgrade many proponents of emergency management. Many changes have been made since.

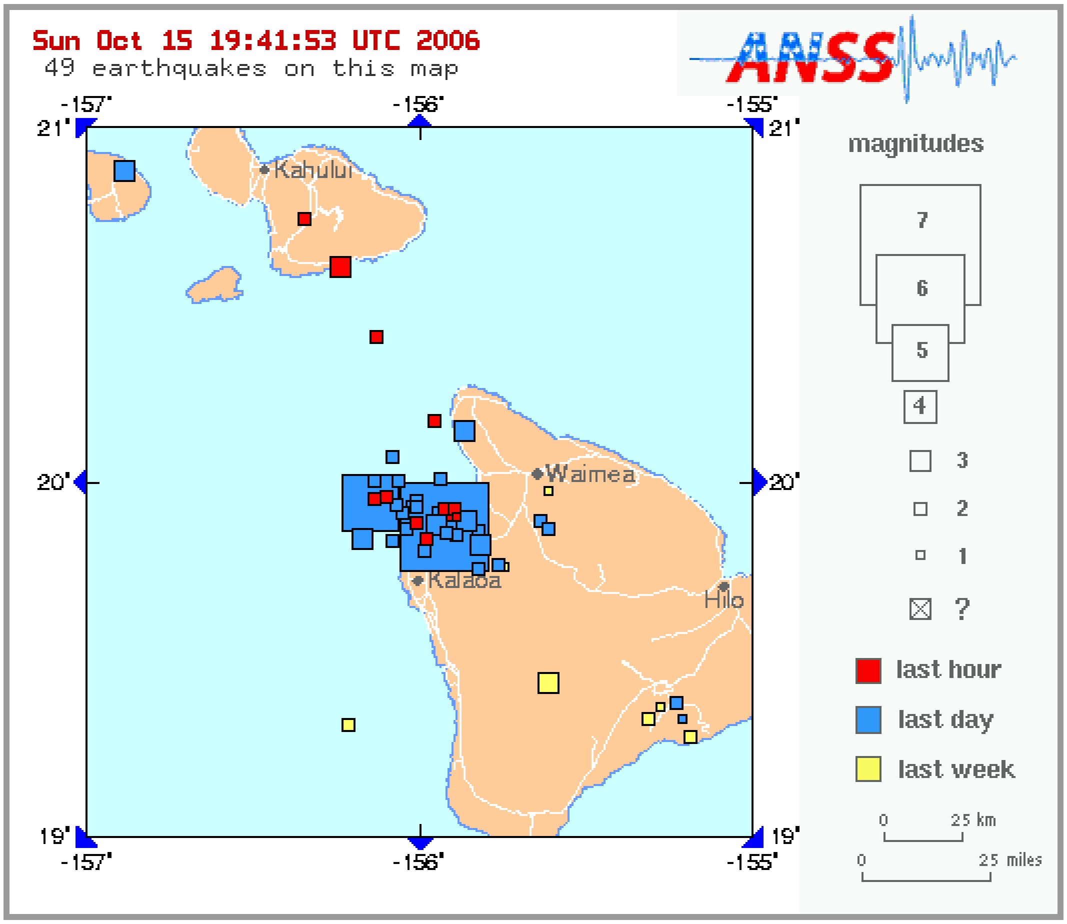

Figure 9. October 15th 2006 earthquakes. Source: Storm Track, 2006

3.5 The Next Time

When the next major earthquake strikes the state of Hawaii, Civil Defense plans to send an alert via radio and television even if there is no immediate threat of a tsunami (Shapiro, 2007). The policy has been changed since the October 15th 2006 earthquakes. Previously, the officials thought that alerting the public of "no tsunami" would be confusing, so no message was sent. The plan is that either the City or State will run the "civil emergency message" across the bottom of broadcast television and release a message on the radio to inform the public of tsunami danger, but no siren will sound if there is no threat of tsunami (Shapiro, 2007).

One of the major complaints of the Oct 15th earthquakes was that there was a lack of communication to the public from the government officials. It took three hours and coordination with the Civil Defense to issue a civil emergency message when the personnel at Honolulu's Emergency Operating Center (part of Oahu's Civil Defense) had the essential information within minutes (Shapiro, 2007). There have been changes that allow the Civil Defense to dispense relevant information to the public. One such change is that Oahu Civil Defense employees have been trained in issuing civil emergency messages through the Emergency Alert system (Shapiro, 2007). There is a back up plan to use the city's Traffic Management Center because it has direct links to radio stations. On the day of the earthquake the radio stations KSSK and KRTR that are emergency broadcast centers were flooded with calls from the general public which made it nearly impossible for the officials to get through. The Hawaiian Electric Company has already installed a direct line into KSSK; this is to provide more timely and frequent updates regarding blackouts. Cox Radio is also looking into direct lines for the county and state civil defense. One major adjustment Cox has made is that they have added two new back up generators. KRTR lost generator power only 45 minutes after the quake. Now there is a new generator in Makakilo that can hold four days worth of fuel along with one above Nui Valley. These generators are to help two Cox stations and Hawaii Public Radio to stay on air during black outs. Oceanic is also looking into updating their system. They are trying to work out how to keep phone services up as well as the internet. Oceanic estimates three to five years to overhaul their current system (Shapiro, 2007). Oahu is also in the process of changing the building codes to withstand earthquakes.

3.6 Earthquake Damage

Because most earthquakes in Hawaii are located on or near the Big Island, earthquake damage is less severe on Oahu. Large earthquakes, however, may result in state-wide damage. Table 3 lists issues that can be expected and should be planned for.

Damage to buildings, roads	Power outages
Damaged phone lines	Gas leaks
Fires	Crowded shelters
Closed stores	Damage to shelters
Closed gas stations	Small tsunami or large tsunami dependant of depth of earthquake
Damage to hospitals	Inundation of coasts including roads

Table 3. Expected damage due to earthquakes

CHAPTER 4: TSUNAMIS

4.1 Introduction

Tsunamis are among the most terrifying natural disasters known to man. Tsunamis are responsible for immense loss of life and destruction of personal and public property. The most destructive water wave that occurs naturally is the tsunami. Literally translated from Japanese, "tsu" means harbor, and "nami" means wave. The geographical location of the Hawaiian Islands makes them the largest risk area in the world; Hawaii averages one tsunami every year with one that causes damage every seven years (Seismic hazards, 2007). The awesome power of this natural disaster affects human, social and economic areas of our societies.

4.2 Tsunami Basics

The primary seismic mechanism responsible for the generation of tsunamis appears to be tectonic earthquakes which are earthquakes that cause a deformation of the seabed (Houston, 1977). However, to generate a tsunami, a shallow earthquake (67.5 km deep or less) or fault dislocations greater than several meters must occur underneath or near the ocean and cause vertical movement that exceeds several meters over a large area (UNESCO-IOC, 2006). The vertical movement transfers the energy from the earth's crust to the ocean by displacing the water column. It is the physical displacement of the fault that generates the tsunami, not the earthquake (UNESCO-IOC, 2006).

Other tsunami causing events are coastal and submarine landslides and volcanic eruptions. However, these events occur less frequently and are not as common a source for tsunami generation.

A tsunami has indistinguishable characteristics in the open ocean. Compared to a wind-driven wave the tsunami has an exceptionally long period. The tsunami periods are anywhere between 5 minutes to several hours whereas the wind-driven periods are anywhere between 5 to 20 seconds. Tsunami waves in the open ocean have an average wavelength that may exceed 200 km (125 miles) compared to the average wavelength of a wind-driven wave which is 100-200 m (300 -600 ft) (Kong, 2003). However, it is nearly impossible to see tsunamis from an airplane or feel them from a ship. This is because the 200 km wavelength which spreads out the height of the wave which averages 0.5 meters. Tsunamis can propagate across the ocean with speeds that can exceed 800 km/hr or 500 miles/hr. The tsunami waves travel at a speed that is directionally proportional to the depth of the water. This is interesting to note because the Pacific Ocean is a deep ocean and therefore the tsunami speed is very high. As tsunamis approach the shallow waters of the coasts, the wave speed slows allowing for water to pile up to tens of meters in height (Karling, 2005). However, local bathymetry and topographic features may also increase or decrease wave heights as the waves near the coastal regions. This is due to wave refraction, shoaling and bay or harbor resonance.

4.3 Remote Source Generated Tsunamis

The Pacific Ocean is ringed by a series of trenches that are unstable margins of lithospheric plates (figure 10), where large-magnitude earthquakes occur. Earthquakes that have a shallow focus (depth less than 70 km) in subduction zones are usually the most disastrous because of tsunami generation (UNESCO-IOC, 2006). These undersea earthquakes have magnitudes greater than 6.5 on the Richter scale. The tsunamis that struck the Hawaiian Islands in 1837, 1868, 1877 and 1946 were all associated with tectonic earthquakes (Dudley, 1998).

Hawaii is located in the central Pacific Basin, which makes it vulnerable to remote-source tsunamis created in the North Pacific and along the coast of South America. The most destructive tsunamis in the Hawaiian Islands have been generated along the coast of South America. Approximately one fourth of all the tsunamis recorded in the islands came from this region. The Kuril-Kamchatka-Aleutian region is where more than half of the recorded tsunamis in Hawaii have originated (Houston, 1977).

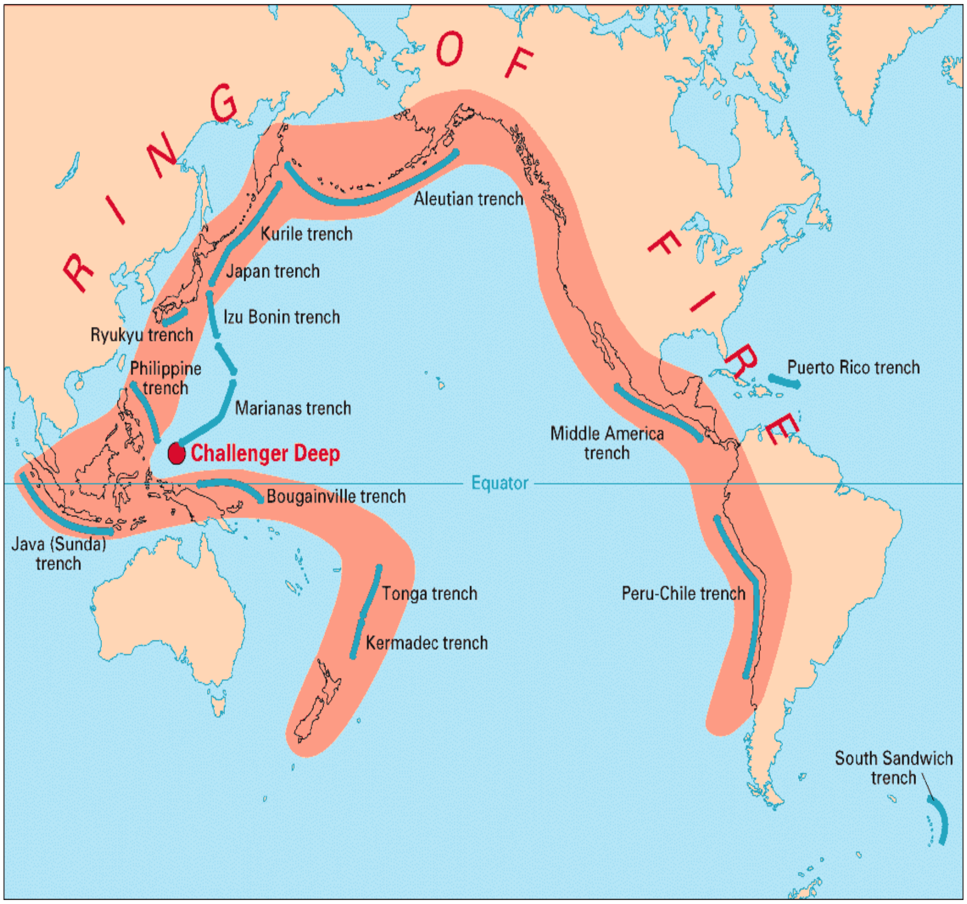

Figure 10. Hawaiian Islands vulnerability to the ring of fire. Source: Pacific Ring of Fire

Waves of a remote-source tsunami from the center of an earthquake are directional, depending on the topography and geometry of the seafloor in the source region. “The source region for major tectonic earthquakes is usually elliptical, and the major axis is as much as 600 km long and corresponds to the activated part of the fault” (Seismic Hazards, 2007). The energy is propagated at right angles to the direction of the major axis, both toward the near shore and along a great circle path toward the shore on the opposite side of the ocean.

4.4 Locally Generated Tsunamis

The Hawaiian volcanoes of the Big Island are large, weak and built of fragmental material and pillow lavas. The rift zones associated with these volcanoes are stronger than the volcano and characterized by dikes and massive gabbro. As new lava is created it weighs down the weak flanks. When the weight becomes too much to bear, the flanks may collapse or slump. This can cause a debris avalanche, or an earthquake. This will then vertically displace the ocean and cause a tsunami. Also, if the rift zones are filled with magma, pressure will build that may cause the flanks to wedge apart causing a basal-slip earthquake, which may or may not produce a tsunami depending on the depth at which it occurs.

Over the last one hundred years there have only been four locally generated tsunamis in Hawaii (Seismic Hazards, 2007). Of those four, one caused damage to the island of Oahu. Earthquakes and tectonic landslides related to the volcanic activity were the causes for these tsunamis. The biggest local threat to Oahu is tsunami generated by earthquakes off of the Kona Coast (figure 11).

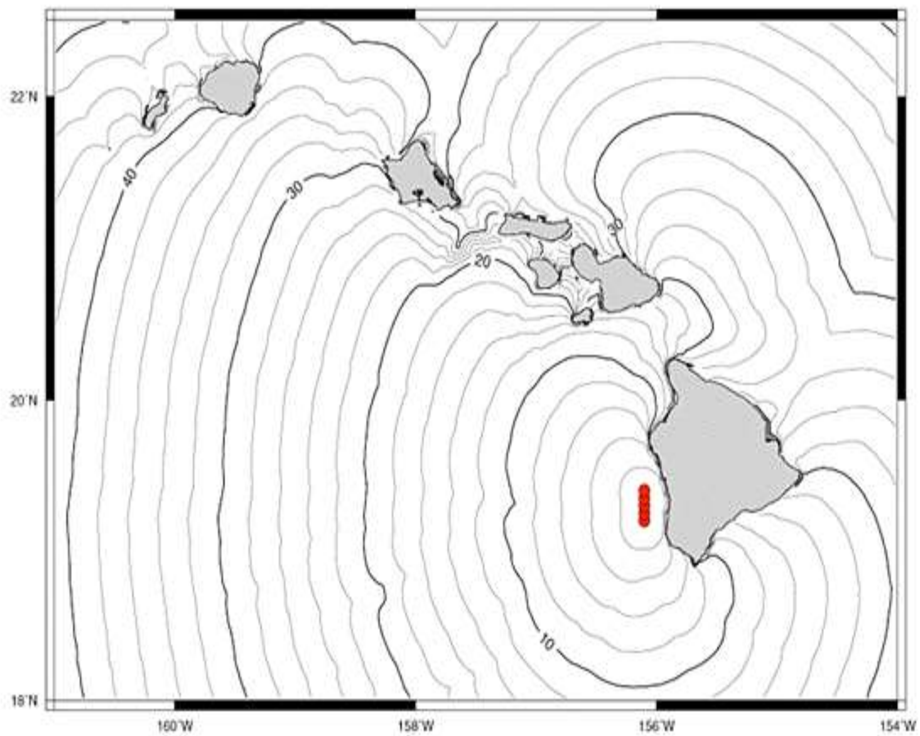

Figure 11. Computer model of large earthquake off the Kona coast of the Big Island Source: Travel Times for a Kona tsunami.

4.5 Frequency of Tsunamis for the Island of Oahu

There have been 26 historic tsunamis to hit the Hawaiian Islands with flood elevations greater than 1 meter. Of those 26 tsunamis, 10 have had significant damaging effects on Oahu. Since the tsunami of 1946, there have been 4 tsunamis to cause damage on Oahu. The largest run-up experienced for Honolulu was 2.5 meters, which was produced by the Chilean Earthquake of 1837 (Walker, 2007). The largest historic run-ups for the entire island of Oahu are generally along the North Shore where some of the values reach up to 10.9 meters.

Although the tsunami that hit Oahu on November 15th, 2006 was not damaging, it was the biggest tsunami to hit the islands in more than four decades. It was thought to have a wavelength of 100 miles and traveled in deep ocean waters as fast as 500 miles per hour (Gordon, 2006). The tsunami was triggered by an 8.3 maginude earthquake near Japan. The tsunami was not large enough to warrant a warning or evacuation. However, there was a threat to swimmers because of noticeable surges in and out of the shoreline.

4.6 Tsunami Warning and Forecast

Following the tsunami of 1946 the U.S. Seismic Sea Wave Warning system was set up at the Honolulu Observatory (Kong, 2003). The purpose of the program was to alert military and civil authorities in and around the Hawaiian Islands of earthquakes. Then in 1965, after two destructive tsunamis hit Chile in 1960 and Alaska and Hawaii in 1964, the United Nations Educational Scientific and Cultural Organization – Intergovernmental Oceanographic Commission (UNESCO/IOC) sponsored the International Pacific Tsunami Warning System (PTWS) to protect life and property (Pararas-Carayannis, 2005). There are 30 member states that comprise the PTWS to oversee the entire global warning system. Their main objective is to detect, locate and determine the seismic parameters of potentially tsunamigenic earthquakes (IOC, 2006). There are more than 150 stations around the Pacific that collect seismographic data which are shared by the US Geological Survey, Incorporated Research Institutes for Seismology Global Seismic Network, and many other national and international agencies (UNESCO-IOC, 2006). The PTWC also receives data about the sea level from more than 100 stations in connection with US National Ocean Service and the University of Hawaii Sea Level Center among other sources nationally and internationally.

The PTWC provides timely and effective information and warnings to the population of the Pacific Region (Pararas-Carayannis, 1982). In 1997, the US addressed the limitation of tide gauges that were solely located on shores by implementing the National Tsunami Hazard Mitigation Program. As part of the Deep-ocean Assessment and Reporting of Tsunamis (DART) program (figure 12), NOAA deployed deepwater instruments in the Pacific Ocean off the Oregon coast and along the Aleutian Islands of Alaska. Each instrument has a bottom pressure sensor and surface buoy with a sensor held to the ocean floor by a weight. The sensor is so sensitive that it can detect the slightest increase in pressure that is caused by added volume (Kong, 2003). The mooring system can be viewed in Figure 13. There are currently 28 DART buoys in the Pacific Ocean with a total of 39 expected by 2008 (Booker, 2007).

In addition, PTWC has received more money for the tsunami warning system, which allows for 12 new broadband seismometers that are being installed throughout the islands (Altonn, 2007). Each of these seismometers has a strong motion seismometer better known as an accelerometer. Fifteen additional accelerometers are to be installed at a later date including 11 coupled with existing short-period seismometers. Currently, there have only been four installed (as of April, 2007). This technology allows the scientists to understand the source of the earthquake and whether a tsunami has been generated (Altonn, 2007).

The present tsunami warning system uses twenty four seismic stations, fifty three tide stations and fifty two dissemination points scattered throughout the Pacific Basin under the varying control of the twenty eight member nations of the

International Co-ordination Group and the International Tsunami Information Center (ITIC). The ITIC is located in Honolulu, Hawaii and is hosted by the USA and Chile. The ITIC acts as the information service for the Intergovernmental Oceanographic Commission (UNESCO-IOC, 2006), which is responsible for coordinating the implementation of the global tsunami warning and mitigation system.

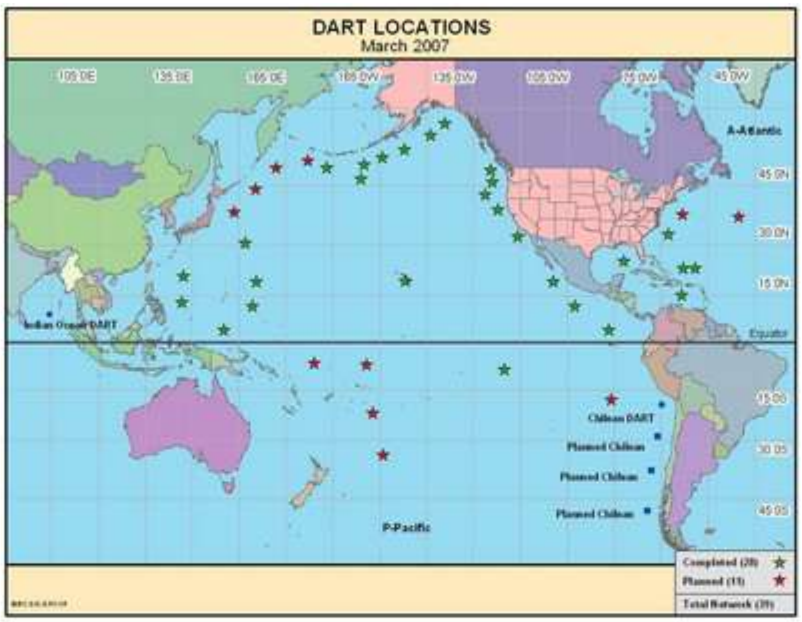

Figure 12. Dart locations. Source: NOAA: Center for tsunami research: Dart (Deep Ocean Assessment and Reporting of Tsunamis).

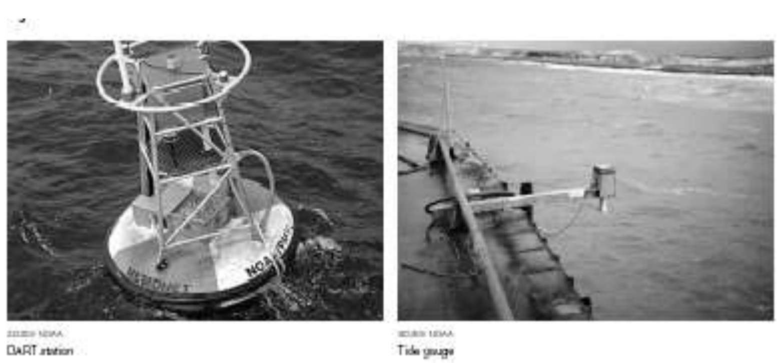

Figure 13. Dart mooring system and tide gauges. Source: GAO, 2006

Hawaii Civil Defense officials run tsunami drills twice a year, most recently on April 2, 2007. The Civil defense coordinated with the Pacific Warning Center (PWC) and county emergency operation centers to issue a mock tsunami warning caused by a 7.0 earthquake at 11:41 a.m. (Staff, 2007) with its epicenter off the southwest coast of the Big Island (Booth, 2007). Under these mock circumstances there was immediate damage to 23 to 25 homes in Hawaiian Ocean View Estates by a tsunami with the expected arrival on Oahu shores at 12:12 p.m.. By 11:45, the warning center had alerted civil defense officials to begin mobilizing while the civil defense spokesman Ray Lovell was broadcasting to television and radio stations an explanation of why sirens were going off (Staff, 2007).

The drill was deemed a success but there are still a few upgrades that are needed. There are 279 sirens that still need to be installed or upgraded with 58 of those being in tsunami inundation zones (Booth, 2007). The state civil defense has allocated $5 million to this cause but needs an additional $10 million.

4.7 Our current inundation maps

According to Gerard Fryer, a Senior Geophysicist at the National Oceanic and Atmospheric Administration's Richard H. Hagemeyer Pacific Tsunami Warning Center, the current evacuation maps were last updated in 1991. Technology and modeling techniques have improved since 1991 and new maps are currently being generated for all coastal communities in Hawaii. Most of the computations necessary for Oahu have already been completed by Kwok Fai Cheung, a Professor in Ocean and Resource Engineering at University of Hawaii. Cheung’s work is mostly funded by the National Tsunami Hazard Mitigation Program with additional funding from the State.

Before revision of evacuation maps completed calculations, must be approved through the Science Advisory Working Group (SWAG) of the State's Tsunami Technical Review Committee. SWAG is still discussing the South Shore findings whereas the North Shore maps have already been approved. Once the maps are approved by SWAG they are sent to the State Geologist for review. Once approved the maps are sent to the City and County of Honolulu to be used as an aide in determining evacuation zones (Fryer, 2007).

Also in the works are two-dimensional maps to further aide in updating evacuation maps. It is not known when these maps will be available.

4.8 Modeling of tsunamis in Hawaii

The Pacific Disaster Center (PDC) uses software to generate information about potential impacts of natural disasters. The output that is created is then coupled with Geographic Information System (GIS) to provide information on the infrastructure, populations and critical facilities located in at risk areas. When a tsunami warning is issued in the Pacific Basin by the PTWC a model called Tsunami Travel Time (TTT) is activated to generate a contour map showing the geographical distribution of tsunami arrival times. The map is then posted on PDC's website. The PDC is working on models that include storm surge and inland flooding.

According to Stuart Koyangi, a geophysicist with the Pacific Tsunami

Warning Center tsunami science in the state of Hawaii has a long way to go; their computers had a difficult time tracking the recent small tsunami (TenBruggencate, 2006). According to Koyangi, tsunamis need to be localized in order to account for local variations. However, this science requires a lot of money and computer power.

4.9 Tsunami Damage

A tsunami similar to the one that devastated Indonesia has not occurred in Hawaii, however there is a possibility that a tsunami of that magnitude will occur. Some issues that should be planned for are listed in Table 4.

Coastal inundation	wave impact on structures
Erosion	Storm surge
Hotel damage	Impassable roads
Waikiki shut down	Damage by floating debris

Table 4. Expected damage due to tsunamis.

CHAPTER 5: CURRENT POLICY IN HAWAII REGARDING ELDERLY AND EVACTUATION

5.1 Current Policy

The only state policy on emergency care of residents in licensed assisted living facilities and disaster preparedness is that it is the responsibility of the assisted living facility, not the government, to move the residents if and when necessary during a natural disaster. This policy is specified in Hawaii Administrative Rules (HAR) Title11 Chapter 100.1-12, July 24, 2006. The policy for state licensing requires Adult Residential Care Homes (ARCH) to have a written evacuation and transportation plan for emergencies within and within the environment of the facility, and to rehearse emergency procedures quarterly. There must be records of ARCH disaster evacuations and safety drills available for inspection by the civil defense. Also, when necessary, ARCH facilities are to arrange for resident transfer to an emergency shelter or crisis response unit. There is no current policy for elderly evacuation at the federal level.

5.2 Current Preparedness

On August 29th, 2007 there was an article in the Honolulu Advertiser "Few Shelters from the Storm" written by Mike Gordon about Hawaii's preparedness if a disaster should occur. The news is quite discouraging and frightening especially for the seniors. There are currently 219 shelters on Oahu and not one has been retrofitted to meet the needs of the elderly. This is because Hawaii Civil Defense is about 6 million dollars short on making changes to these buildings. Not only that, the expected date of completion to accommodate the elderly and those with special health needs is more than a decade away. In 2006, the legislature authorized more than $8 million dollars to be used for disaster related projects. About $4 million is to retrofit emergency shelters, $2 million to add new warning sirens and update older ones, $1 million to stockpile disaster related supplies, $500,000 to have round the clock staff for the Civil Defense headquarters and $250,000 to update tsunami inundation maps. For the time being, Danny Tengan, the Civil Defense employee in charge of the retrofit shelter program, has told care homes that if possible they should shelter in place and to look into ways to make their homes into shelters. Tengan was quoted as saying "Don't count on the government. We do not have enough to house them all. What if 50 percent evacuated? Or if 60 percent? We are dead." With that being said, the goal now is to add 14,000 shelter spaces within 32 schools and try to allocate more space in these shelters for those that have specialized medical equipment and caregivers. No money has been spent on this plan; it is still in the design phase.

5.3 2007 Interagency Action Plan For the Emergency Preparedness of the People with Disabilities and Special health care needs

The agencies that are involved in the Interagency plan (IAP) are State Departments and Agencies (Department of Education (DOE), Department of Health (DOH), Department of Human Services (DHS), Disability and Communication Access Board (DCAB), Executive Office of Aging (EOA), State Civil Defense (SCD) and State Council on Developmental Disabilities (DDC)) and County Departments (City and County of Honolulu, Civil Defense Agency) along with the Red Cross and

Healthcare Association of Hawaii (IAP,2007). These agencies organized in the wake of September 11th and Hurricanes Katrina and Rita to prepare a strategic guideline to incorporate the elderly and those with special health needs during natural disasters.

It is important to note that the IAP "is not a comprehensive emergency preparedness document, nor is it a special health needs response plan" (IAP, 2007). The document is intended to be used as a roadmap for legislative and administrative efforts to include special health needs and persons with disabilities during natural disasters. The current IAP acknowledges that people with special health needs and disabilities must be included with the rest of the community for disaster preparedness. This document also acknowledges that the document is evolving and this copy is mainly focused on the most pressing issues dealing with emergency preparedness, notification and sheltering.

5.3.1 Basic Premises and Assumptions

It is presumed and assumed by this document that emergency preparedness is an individual's responsibility, or, if the person is in the care of another person, it is then the responsibility of the caregiver.

The buildings that are already designated as emergency shelters should be physically accessible to Level I individuals (see appendix). There should also be designated shelters for Level II individuals (see appendix) who require more space for maintaining proper care.

5.3.2. Goals and Objectives of the Plan

The Interagency Action Plan has set forth 7 goals to obtain by an unspecified date:

Goal 1*: All pre-designated locations used and managed as emergency evacuation shelters shall meet minimum requirements for facility access in the area of ingress and use of restroom (toilet) facilities to meet the needs of Level I individuals.*

Goal 2*: The capacity of the community to "shelter-in-place" shall be increased.*

Goal 3*: The number and dispersion of community emergency shelters as centers to provide augmented health support for Level II individuals shall be increased, with the long-term goal of having ALL community shelters able to support Level II individuals.*

Goal 4*: An accessible public and professional personal emergency readiness campaign shall be developed to assist everyone to make plans for themselves and their families in the event of an emergency. Individuals with disabilities or special health needs shall have an emergency evacuation plan in place developed by themselves or by their caregivers to implement in the event of a notification of evacuation.*

Goal 5*: Education shall be provided to all health care providers in order that appropriate emergency evacuation plans for health care facilities and/or settings are in place.*

Goal 6: *Individuals with disabilities or special health needs shall receive notification of an evacuation through the State Civil Defense mechanisms in an accessible format.*

Goal 7: *Each County shall have a plan for providing accessible transportation for individuals with disabilities and special health needs who have no transportation options or means to get to and from an emergency shelter.*

It is important to note that this is not an implemented policy nor does it plan on becoming a policy. These are simply goals and objectives with no set completion date to better prepare the special health needs community for natural disasters. It is also important to note that this document is constantly evolving.

5.4. Current Legislation Under Review

There two bills currently in the legislative process that involve the elderly directly. One pertains to the long term elderly care and the other pertains to ensure that preparations of this State, and the government provided for this State, will be adequate to deal with the disasters or emergencies.

5.4.1 House Bill 807

The Report Title is: Appropriation; Office of the Long-Term Care Ombudsman. This Act is to formally establish an office of the long-term care ombudsman within the Executive Office on Aging. The Older American's Act mandates the executive office on aging's long-term care ombudsman program. This long-term care ombudsman currently advocates for and protects the rights of residents of nursing homes, adult residential care homes, assisted living facilities and other long term care facilities. This care program ombudsman currently serves over eight thousand residents in approximately seven hundred and thirty one licensed facilities. The status of this Act as of 4/17/07 was Received notice of appointment of House conferees (Hse. Com. No. 786).

http://www.capitol.hawaii.gov/site1/docs/getstatus2.asp?billno=HB807

In addition to common rights as a citizen, it could be argued that the rights of the elderly residents could include shelters to accommodate their needs, a practical evacuation plan from their assisted living facility, and if these needs are not met it could be seen as a form of neglect.

5.4.2 State Bill 2304

The title of this Bill is: Civil Defense; federal conformity. This Act is to bring Hawaii's civil defense laws into conformance with the current federal laws. In addition, this act also will implement best practices to ensure that the state is prepared for man-made and natural disasters. "*It is the policy of this state that civil defense functions of the State should be coordinated to the maximum extent with private agencies, federal and county governments, and non-profit organizations to address natural and man-made disasters or related emergencies.*" The Civil Defense Act of 1950 has since been repealed and replaced with the Robert T. Stafford Disaster Relief and Emergency Assistance Act as of October 2000. This is to "*ensure that* *preparations of this State and the government provided for this State will be adequate to deal with the disasters or emergencies*."

This Act 2304 provides new definitions of disaster, emergency and civil defense.

"Disaster" includes any natural catastrophe, including: hurricane, tornado, storm, high water, wind driven water, tidal wave, tsunami, earthquake, volcanic eruption, landslide, mudslide, snowstorm, or drought…

"Emergency" is "any occasion or instance for which, in the determination of the Governor, state assistance is needed to supplement the efforts and capabilities of local governments and state agencies to save lives and to protect property and public health and safety, or to lessen or avert the threat of catastrophe in any part of the state"

"Civil Defense" means the preparation for and the carrying out of all functions that are not the primary responsibility of military forces. This does include the evacuation of persons from stricken or danger areas and emergency transportation.

Section 6 of this Act appears to be intended to clarify that a healthcare facility has the benefit of the liability immunity provided by Section 128-19 (Immunity of liability of private shelter) when providing shelter to patients or residents during disasters or emergencies. This Act clarifies that compensation received by the facility for the care of patients does not constitute "compensation" for the license, privilege or permission granted to the director of civil defense to use the property for sheltering persons, as set forth in Section 128-19 provided that "the healthcare facility is operating in accordance with applicable local, state, and federal laws, rules and regulations, and any requirements for emergency care and disaster planning, and the operator has not abandoned its patients or residents." The status as of 2/16/06 is that the report has been adopted and passed the second reading, as amended (Senate Draft 1) and referred to Judiciary of Hawaiian Affairs (JHW). (http://www.capitol.hawaii.gov/session2006/status/SB2304.asp, 2006)

CHAPTER 6: DISCUSSION AND RECCOMENDATIONS

6.1 Discussion of Current Policy and Action on Oahu

It was disturbing to find that there is only one state policy concerning the evacuation of elderly patients from their assisted living homes (HAR Title11 Chapter 100.1-12). The policy states that it is responsibility of the ARCH facilities, not the governments to move the residents during an emergency. If the ARCH facilities are to receive their license they must comply with certain rules regarding emergency care of the residents. One such rule is that a written evacuation and transportation plan for emergencies within and within the environment of the facility must be made and rehearsed quarterly. However, calls to random ARCH facilities revealed the majority practiced only fire drills on a monthly basis and some were not even aware if their facility had a disaster plan. This finding was alarming and reinforced that something has to change to avoid possible devastating outcomes.

As mentioned earlier, it was actually the devastation that occurred during Hurricane Katrina and Hurricane Rita that made the State of Hawaii look at their own disaster management operations. In response to the hurricanes State of Hawaii, County, Community departments and agencies all realized that there is a great need for improvements on multiple levels of disaster preparedness and planning for those with special health needs and for those that are disabled, not to mention the public at large.

The IAP for 2007 is not a policy or comprehensive emergency preparedness document but what the Federal government likes to call guidelines. This is because policies are too rigid and evacuation for different disasters calls for different plans.

Although the IAP is revolutionary for the state of Hawaii in that it includes the needs of the elderly and those with special health needs, alternative actions could be taken.

6.2 Recommendations -In addition to the 2007 Interagency Plan

The City, State and County governments prefer to have the assisted living facilities shelter in place during a disaster because currently the shelters are not able to meet the needs of the elderly or those with special needs. Based on these issues and challenges, I have developed a recommendation to increase the capacity of ARCH facilities in Hawaii to shelter in place. This recommendation stems from the IAP goal #2 and Tengan's suggestion to look into ways to make the ARCH facilities into shelters and grew out of a conversation with Kenneth Gilbert of the Civil Defense.

My recommendation is to have the State of Hawaii mandate a consortium for all public assisted living facilities. The common goal of the consortium, with the help of the Civil Defense, would be to designate "hubs" or home bases that other predetermined ARCH facilities could evacuate to during a natural disaster. The hub would be chosen based on size, location and the physical integrity of the facility. The hub would be able house up to 2-6 facilities; this is dependent on hub size. Each hub would be retrofitted and hardened to withstand earthquakes and hurricane force winds. Lastly, all supplies will be stored at the hub and will be able to accommodate the special needs of the elderly.

Each "hub" would have:

- Trained emergency and disaster certified staff.
- Established and coordinated chain of command with wire-diagrams placed at key areas (www.aoa.gov, 2006)

- Security with one door for entry and ID badges for all staff, badges to be prepared for this emergency (www.aoa.gov, 2006)
- A transfer log to track the locations of patients (www.aoa.gov, 2006)
- Satellite phones and cell phones (text messaging) and amateur radios
- Walkie Talkies to communicate within the facility
- A disaster team made of ARCH facility employees to be prepared to stay for several days, families and pets allowed if space is available
- A written agreement to come into work (if roads and weather allow) to care for the residents
- Disaster relief team of ARCH facility employees to come in a couple days after the disaster
- File sharing: all patient and information regarding the patient from other facilities already in the "hub" computer
- Backup files of patient information
- Cache of supplies: mattresses, medicine, blankets, hygiene products, pillows
- A back up generator
- A fuel tank for generator
- Incentives to allow staff to use residents cars during natural disasters
- Federal government subsidized vans (RAM3500) to be used and maintained daily but main purpose is to transport residents to "hub" facility.

The process of retrofitting current shelters to meet the needs of elderly requires huge expenditures, and will not be finished for more than a decade, if that. The elderly and/or special health needs populations are expected to increase in a decade from now. So, if the current ARCH facilities begin to retrofit their buildings now, they could single handedly offset the demand for space in emergency shelters in the future.

It would be beneficial for elderly to shelter in place because it has been proven that long term disruption and environmental changes are taxing on the health of elderly people (Ngo, 2001), especially those that are in the care of others. If the elderly from one facility are transferred to the hub, the residents would be around people of the same age, therefore they would be a little more at ease. Another benefit would be the ease of delivery of food and fuel after a disaster to these hubs rather than to all 695 current assisted living facilities.

Many ARCH buildings are not up to code and currently must evacuate because of expected damage to the building during a natural disaster. These buildings have already been identified by the civil defense. The expected cost of fixing these facilities to meet the current building codes and future earthquake codes is quite large. Currently, there is little or no incentive to meet these codes.

With a consortium, the neighboring shelters could cost share the maintenance, the construction of a large recreation room if there is not already one, the supplies needed during a natural disaster, etc. Obviously, there would need to be an incentive for the "hub" facility. This could come in the form of a lowered insurance premium[1] if the ARCH facilities were to disaster train their staff, or a certain percentage of money spent when retrofitting the building would be returned to ARCH facility.

Because earthquake damage is not predictable and damage may effect any and all assisted living facilities that are not up to code and even those that are, personnel would be required to check for damage to the structure and see if operations can continue as normal without jeopardizing the safety of the staff or patients. If operation

[1] Idea of Kenneth Gilbert

is not able to continue, residents should be evacuated immediately to a safer location. Call an outer island contact and update on current location and status of residents.

6.3 Conclusion

The state realizes there is a great need for improvements on multiple levels of disaster preparedness and planning for those with special health needs and for those that are disabled, not to mention the public at large. My recommendation is while focusing on ideas from the IAP for those not in the care of ARCH facilities, it would be wise to consider alternatives such as a consortium among the ARCH facilities on the island of Oahu. The City and County prefer that the ARCH facilities should be able to shelter in place because the appropriate staff is there to care to the fragile needs of certain individuals. Also the convenience of familiar surroundings would be less stressful during a time of distress.

If the state mandated a consortium, costs could be offset by cost sharing among the ARCH facilities in regards to retrofitting one hub per several facilities. Also, the facilities could cost share the cache of supplies needed to house elderly individuals and caregivers during a natural disaster. They could also help cost share maintenance and updates of the cache. With the certain hubs being self sufficient immediately after a natural disaster, this will help save lives and help free up money and supplies to elderly and special health need individuals and other individuals that must rely on a shelter.

A decade from now, there should be more elderly people on Oahu than there are today. If the consortium is started today, it could offset the burden in the future. I think that it is time to bring the ARCH community together today to make a difference in tomorrow.

APPENDIX

Long-term Care Facility	• Skilled nursing facility as defined in section 1819(a) of the Social Security Act, as amended. • Nursing facility, as defined in section 1919 (a) of the Social Security act, as amended. Adult residential care home, including any expanded adult residential care home. • Assisted living facility. • Intermediate care facility as defined in section 1905 (c) of the Social Security Act, as amended. • Other similar facility licensed by the state serving elders
Level I patients These are individuals with disabilities who are independent and capable of self-care by those who are their daily caregivers (exclusive of the need for electrical power, generator, etc).	• Those who use wheelchairs but are capable of transfer from their wheelchair; • Those with stable, controlled conditions such as arthritis; • Those with mild to moderate muscular conditions with a stable or assisted gait; • colostomy patients; • patients on special diets; • Those with artificial limbs or prosthesis; • Those with mechanic devices, such as pacemakers, implanted defibrillators, insulin pumps; • Those with visual, speech or hearing impairments; • Those with managed, non-acute behavioral, cognitive or mental health illnesses;
Level II Patients Those individuals that have ongoing 'enhanced special health needs' and who, by the nature of their condition, need a heightened level of attention.	• Those with attendant medical care and continuous health care support; • Those with special bed care and/or special toileting arrangements; • Those with life support equipment; • Those requiring significant supportive nursing care such as kidney dialysis; • Those with physician-ordered observation, assistance, or maintenance, or custodial care; • Those requiring skilled nursing care due to recent medical treatment; • Those whose disability prevents them from sleeping on a cot; • Those who require equipment normally found in a hospital or skilled nursing facility; • Those who require assistance in performing activities of daily living or have health conditions whereby they cannot manage for themselves in an evacuation shelter.

Level III Patient Those that need acute medical care	• Women giving birth; • Individuals having heart attacks; • Individuals experiencing trauma or injury;

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