4.2: Disaster Mitigation Strategies

Rapporteurs: Bill Read

Regional Specialized Meteorological Center (RSMC) WMO Region IV
11691 SW 17th Street Miami, Florida 33165
Bill.read@noaa.gov
305 229 4402

Lixion Avila

Regional Specialized Meteorological Center (RSMC) WMO Region IV
11691 SW 17th Street Miami, Florida 33165
lixion.a.avila@noaa.gov
305 229 4402

Working group: Jose Rubiera, Andrew Burton, Dale Destin

4.2.1: Introduction

Mitigation is commonly defined in various dictionaries as: To moderate (a quality or condition) in force or intensity; alleviate. Disaster mitigation is best defined as risk mitigation, or: efforts taken to reduce either the probability or consequences of a threat. The fact that societies around the world have mostly inadvertently put people and property in places subject to impact from tropical cyclones is the primary driver on the increasing importance of mitigation. From a meteorologist perspective, our primary role in mitigation is to continue to improve our warnings and forecasts of the events and provide timely communication of the threat to disaster officials and the public. An assumption taken by the working group is that no matter how good warnings and forecasts become, we will continue to observe increasing property losses due to the continued movement of people and property into tropical cyclone prone coastal areas. Thus we will continue to see the need to advocate for non meteorological mitigation strategies. Also, regardless of improvements to our warnings and forecasts, failure to communicate the threat clearly to an educated populace will continue to raise the possibility for catastrophic loss of life, particularly in flood prone communities.

While the definition of mitigation would allow for efforts taken to modify the strength, track, or other potential adverse aspects of the tropical cyclone, we will not be covering weather
4.2.2 Mitigation Strategies

4.2.2.1 Land Use Policy

The most effective and least expensive mitigation strategy available is restriction to development in areas at risk from tropical cyclones. Given adequate building codes and construction practices, the main land use restrictions concern the potential for flooding, both salt water due to waves and surge and freshwater due to excessive rainfall. By not permitting building of homes and businesses in areas threatened by flooding, you immediately reduce the greatest risk of loss of life. At opposition to this solution is the economic benefit of developing in coastal areas. Many enterprises, including transportation, seaports, large industry complexes tied to proximity of ports, and of course tourism make the high risk areas for tropical cyclone impact desirable for population centers growth. We have found only minimal restrictions to growth in high risk areas worldwide, thus must look to other strategies to mitigate the reality of development in the coastal regions.

4.2.2.2 Building Codes

Proper building codes that specify the resistance to wind, wind driven debris, and height above defined flood risks are another well defined strategy for mitigating property loss. Considerable advances in structural design and building materials have occurred over the past several decades. In the United States there have been a number of code related improvements that will result in less loss of property and provide a higher level of safety to people. Various engineering associations have developed building techniques to meet design criteria to protect against wind. Where building codes are adopted and builders are careful to learn and follow the engineering practices, successful mitigation takes place. On the other hand, where local politics subverts the carefully designed engineering code or where the construction practice is flawed, failures still occur. A success story followed Hurricane Andrew, which struck south Miami Dade County, Florida in August, 1992. Local officials enacted the strongest building code to resist wind in the United States. In the 18 years since Andrew, the state of Florida has adopted a strong code statewide. Hurricane Charley, 2004, struck southwest Florida as a tiny category 4 hurricane. Damage survey teams discovered that the newer structure build under the Miami Dade code fared much better than older, pre or no code structures (Figure 1).
4.2.3 Figure 1. Tale of two houses. The house on the left was a 1970s era house with no significant structural code. The house on the right was built to resist 140 mph wind. These houses are within sight of each other and went through Hurricane Charley’s 140 mph winds. Which one would you rather have?

The challenges of enacting and following better codes are another matter and will be discussed later.

4.2.2.3 Education

Education is a key component to improving mitigation strategies. Citizens need to know the science behind the risks they face and what can be done to reduce the risk. Emergency response officials, policy makers, and construction workers need to be educated on the wisdom and proper techniques for implementing mitigation plans and policy. Various methods have been used successfully to educate the public. In some countries hazard awareness and preparedness training has been incorporated into the public education system, the thought being that education at the earliest age practical will yield a better educated populace over time. This has been documented as particularly successful in Cuba based on experience during tropical cyclone threat and public response.

Another key strategy used to educate the public is the provision of focused hazard awareness programming on television. In the most developed countries the local or national television outlets run annual hurricane preparedness programming, and then reinforce the learning with short spots on topics during the hurricane season.

Education of emergency response personnel is another important strategy. Some countries offer specific tropical cyclone hazard awareness classes to emergency responders, thus making these important leaders in the community another avenue for educating the public. The same is true for the professional meteorologists. Training on hazard education for officials and the public adds skills for assisting in the community preparedness effort.
4.2.2.4 Preparedness

Closely tied to education is preparedness. Preparedness is taking the necessary actions for a person, family, business, city and country to minimize the loss of life and property from and impending event. Preparedness involves making plans, identifying and procuring resources needed, and testing your plans through exercises. At the state and local level, officials need to have in place action plans and resources to respond when a storm threatens. Typically these plans are developed prior to the start of the season. The larger the urban area in the risk zones, the more complex preparedness action plans become. Transportation and industry issues, as well as vulnerable population issues, require longer lead times in order to get ready. For example, hospitals, nursing care centers, and retirement homes all contain a concentration of highly vulnerable citizens who will require much different level of care than otherwise healthy citizens.

Preparedness for the general public centers on having the supplies one needs to survive on hand, a means of protecting one’s house, and, if required, a plan for evacuation if in a high risk area due to storm surge. In most tropical cyclone prone countries, there are official publications with check lists and other information readily available to aid the public in getting prepared. Grocery store and home improvement stores frequently provide similar material that also points out the availability of food and supplies one should have. In the United States there are companies that market complete home preparedness kits which take the guesswork out of what one needs to get.

Figure 2. Example of hurricane kit checklist provided by FLASH and picture of a readymade kit for a family of four.
4.2.2.5 Evacuation, Shelter in place, and Refuge of last resort

The primary mitigation strategy for the saving of lives from an impending tropical cyclone is providing adequate shelter from the expected impacts. With the risk of storm surge, evacuation is the most commonly successful strategy – move people in low lying surge prone areas to safe structures outside the area. A second strategy, sometimes as a back up for the evacuation, is to identify existing structures or build structures in the surge zone that can serve as a save refuge as the storm hits. Shelter in place is a primary strategy to protect life from wind.

Evacuation as a strategy has grown in practice with increased accuracy in forecasting. Since evacuation of hundreds of thousands of people requires a day or more to accomplish, the importance of advance planning and preparation cannot be understated. Cuba is an example of highly successful evacuation planning, the results being a remarkable modern era experience of low loss of life in spite of frequent direct impacts from major hurricanes. Cuba attributes this success to excellent planning, public education, direct involvement of key stakeholders including meteorologists, and a culture of preparedness followed by the public.

For evacuation to be successful there has to be a coordinated transportation plan, clear instructions on where to evacuate to, and a commitment to act when the time to evacuate arrives. Recent large scale evacuations for Hurricanes Katrina, Rita and Ike along the Gulf Coast of the United States are evidence of the growing understanding of the at risk public of the need to get out of the surge zones in advance of the storm.

If buildings are constructed to safely ride out the storm, then shelter in place is a viable alternative to evacuation. In areas of the tropics where the population does not have transportation, shelter in place is the only workable solution for survival from storm surge. Building of just such structures in Bangladesh has resulted in reduction of loss of life.

Refuge of last resort refers to structures capable of surviving the storm but not designed to be a formal shelter. When people no longer have an opportunity to evacuate, refuges of last resort are vital for survival. Communities that adopt stronger building codes for public buildings and schools can increase their capability to provide safe haven for citizens as a last resort.

4.2.2.7 Engineering

Engineering strategies discussed here refer to large scale community protection systems such as sea walls, levees, flood diversion canals, etc.

An example of a strong engineering mitigation strategy would be the Netherlands flood protection system, which is designed to protect the low country from a surge with a 1 in 10,000 risk. Almost all other systems fall way short of this level of protection, for example, in the USA the standard protection from flooding is designed at or slightly above the 1 in 100 risk. The post Katrina project to shore up the levee system that protects the area is designed to protect for the
100 year event. The climatology of hurricanes along the Gulf coast of the U.S. suggests at most a direct hit from a category 3 hurricane represents the 100 year event. Thus New Orleans is still quite vulnerable should a category 4 storm make landfall just west of the city.

Another mitigation strategy adopted in some communities has been to raise the elevation of roadways that are used for evacuation. This strategy also helps response and recovery activities as the roadway will still be intact following the event.

### 4.2.3 Challenges in Mitigation

Challenges in mitigation are many, including cost, public acceptance, political pressures, and acceptable risks. Costly measures such as an engineered levee system generally cannot be done by developing nations. Post Katrina levee mitigation is estimated to cost just under $15 B. Lower risk land use, on the other hand has little monetary cost, but encounters resistance from political pressure to allow developers to build out. Public acceptance, or more correctly lack of, relates to conflicting information on cost and impact of mitigation. For example, when local officials propose a stronger building code and developers protest that the cost will be prohibitive.

Another challenge impacting mitigation is growth. As large urban areas grow the complexity of evacuations create challenges that begin to deter citizen willingness to evacuate. Highway contrition rarely keeps up with population growth, therefore while the number of cares needing to evacuate keep increasing while the flow rate of traffic slows down because no new capacity to the system is added. Long stressful travel to safety may at the time seem less desirable than taking a chance the impact won’t be bad.

Figure 3. Gridlock during Hurricane Rita evacuation, Houston, Texas.