ISLANDS TASK FORCE REPORT

A Briefing on Hurricane Evacuation Study Needs in the United States Island Communities

December 2001

Prepared For

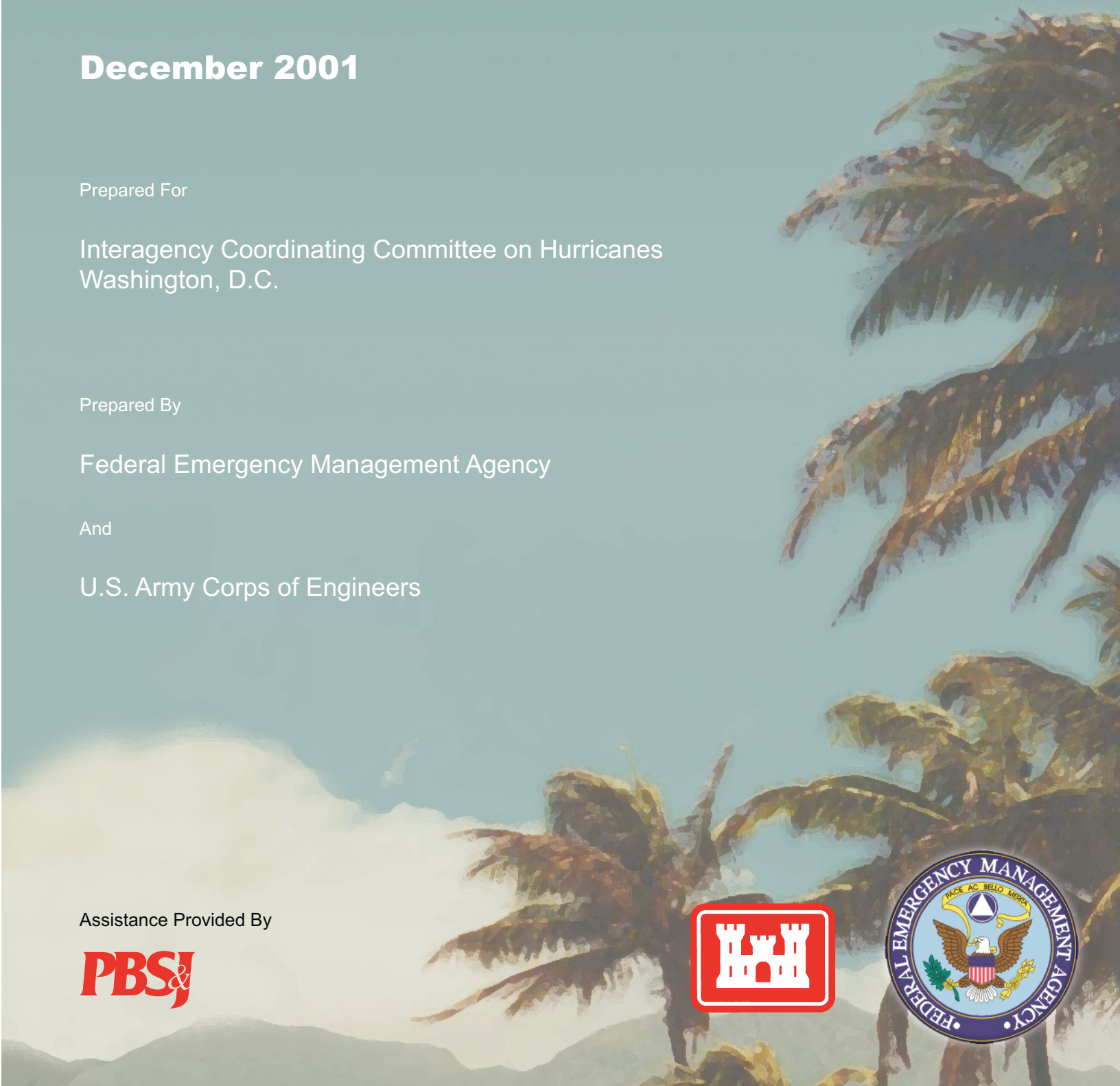
Interagency Coordinating Committee on Hurricanes
Washington, D.C.

Prepared By

Federal Emergency Management Agency

And

U.S. Army Corps of Engineers



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Executive Summary

With the recent onslaught of major hurricanes directly impacting Puerto Rico, the U.S. Virgin Islands, Guam, Hawaii and other insular United States territories, the need for the best technical data available for hurricane preparedness is evident. Hurricane Lenny in 1999, Hurricane Georges in 1998, Hurricane Paka in 1997, Hurricane Marilyn in 1995, Hurricane Iniki in 1992, and Typhoon Tusi in 1991, have underscored the fact that major hurricane vulnerability and evacuation issues face U.S. island communities just as much as the Florida peninsula, the outer banks of North Carolina, or the northern gulf coast. Although some hurricane evacuation study work has been undertaken for these island communities, much work needs to be continued and reinforced. The needs are immediate as experts indicate that we are entering a period of more hurricanes and more intense hurricanes.

Hurricane evacuation studies conducted in some insular communities, both in the Atlantic and Pacific, have generally followed the guidelines developed for mainland studies as no specific written guidance exists that specifies what additional or different analyses are needed for an island environment. As we move into an aggressive period of conducting studies for island communities, the development of additional guidance is now required. This guidance must recognize the unique characteristics of islands.

The Island Task Force meetings held in San Francisco in July of 1998, in Honolulu in April of 1999, in St. Thomas, USVI in December 1999, and Honolulu/Fort Shafter in July 2001 have been well attended by agencies invited to participate. Prioritized recommendations that have come out of these meetings include:

Recommendations

Wind, Waves, Hazards, and Vulnerability Issues

Highest Priority:

Fund and emphasize the expeditious collection of perishable high water mark and debris line data after storm event. Use data collection guidelines developed by USGS.

Fund and emphasize the measuring of accurate terrain elevations and water depths around islands. (This should include the areas between -100 ft. and 40 ft.) It is recommended that these data be incorporated into DEMs and that standardized formats be used.

Instrument an area with wave, wave direction, and water level gauges for intense observation of hurricane waves at the shoreline; initiate pilot study to investigate the effects of storm surge elevated water levels on waves; also instrument an area of mountain terrain to get better terrain-enhanced wind observations.

Other:

Coordinate / enhance USGS efforts to determine mudslide potential areas and depict them in evacuation zone delineations for island studies.

Gather wind engineering research and expertise to further analyze potential island wind effects on various types of structures. Identify areas for further research.

Gather tropical meteorology expertise addressing the forecasting of rainfall amounts and use of available tools such as advanced radar.

Expand the tsunami research program to include all of the Caribbean.

Show 100-year floodplain areas on surge atlas sheets like Jacksonville District has done in parts of Puerto Rico.

Public Shelter Issues

Highest Priority:

Provide island communities with a shelter assessment tool which would at least qualitatively and preferably quantitatively evaluate structural integrity of public shelters. Develop local skills for evaluating shelters.

Develop shelter management training plans for the island communities focusing on the needs of multiculture homeless, aged, and physically challenged populations.

Develop shelter plans which where appropriate incorporate "shelter districts" in order to minimize shelter congestion.

Other:

Recognize the importance of realistic public shelter demand estimates in island HES products.

Develop guidance for island communities to shelter tourists who are stranded on an island for a particular storm threat.

Compare shelter locations to freshwater floodprone areas, potential rockslide/mudslide areas, high wind acceleration areas, storm surge and tsunami envelopes, and man-made hazards.

Look at innovative, non-traditional sheltering resources on each island that could provide some last resort protection to evacuees.

Cultural, Behavioral, and Special Population Issues

Highest Priority:

Conduct HES behavioral analyses so that telephone interviews are supplemented by person-to-person interview techniques and adapted to various population groups, form task force to assist with developing survey questions.

Have locals review survey instruments for "local culture" screening; where possible use locals for interview contacts.

Develop multilingual public education programs regarding hurricane preparedness.

Other:

Use post-storm evacuation assessments as a means to accomplish behavioral studies for permanent island residents and tourists.

Conduct/gather studies which help better understand customs, protocol, values, decision-making processes and special needs accommodations.

Transportation Issues

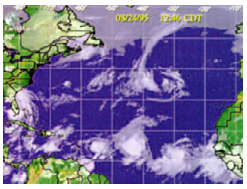
Highest Priority:

Provide mass management tool so that locals can vary participation rates and public shelter usage percentages as well as other model inputs to see effects on evacuation people, vehicle, and traffic statistics.

Other:

Encourage departments of transportation to implement fully operational traffic counters for real-time traffic evacuation counts (e.g. Florida Keys).

Complete GIS based transportation analyses for remainder of Puerto Rico and Hawaiian Islands.



Evacuation Decision Making Tools and Training

Highest Priority:

Continue developing a western Pacific historical storms/real time download component to HURREVAC and provide training. Include American Samoa incorporating the first area in HURREVAC south of the equator.

Work with EMI to develop island specific hurricane preparedness training tools such as videos, CDs, field courses and NHC courses as appropriate.

Other:

Provide HURWIN95 (new Windows based HURREVAC) to all U.S. Caribbean emergency management officials and provide training in Puerto Rico and the U.S.Virgin Islands. (Accomplished Summer 1999)

Develop a central Pacific historical storms/real time download component to HURWIN95 and provide the model and training to the islands immediately. (Accomplished June 2000)

Infrastructure, Communications, Mitigation, Coordination with Response and Recovery

Highest Priority:

The HES should be a way to help document and organize the hurricane readiness response and recovery (RR&R) and the mitigation (MT) work already done by the various jurisdiction agencies.

The HES should include a Contingency Plan component, including a "Time Phased Force Deployment" plan in coordination with FEMA.

Other:

The HES should make an effort to include local subject matter experts and help build local capability.

The HES should lay out the non-FEMA assistance available for RR&R and for MT, similar to efforts made in DFOs to coordinate broad federal efforts.

The HES should lay out potential mitigation projects and activities; make recommendations to address potential bottlenecks and problems identified in HES; and should be developed in conjunction with the jurisdiction's mitigation plan.

Future Study Organization

High Priority:

Develop technical guidelines for island hurricane preparedness studies.

Develop a mass management tool in FY 2002 for all U.S. islands which have not had an HES developed to date.

ISLANDS TASK FORCE REPORT

A Briefing on Hurricane Evacuation Study Needs in the United States Island Communities

I. Introduction

With the recent onslaught of major hurricanes directly impacting Puerto Rico, the U.S. Virgin Islands, Guam, Hawaii and other insular United States territories, the need for the best technical data available for hurricane preparedness is evident. Hurricane Lenny in 1999, Hurricane Georges in 1998, Hurricane Paka in 1997, Hurricane Marilyn in 1995, Hurricane Iniki in 1992, and Typhoon Tusi in 1991, have underscored the fact that major hurricane vulnerability and evacuation issues face U.S. island communities just as much as the Florida peninsula, the outer banks of North Carolina, or the northern gulf coast. Although some hurricane evacuation study work has been undertaken for these island communities, much work needs to be continued and reinforced. The needs are immediate as experts indicate that we are entering a period of more hurricanes and more intense hurricanes.

Hurricane evacuation studies conducted in an insular community, both in the Atlantic and Pacific, have generally followed the guidelines developed for mainland studies since no specific written guidance exists that specifies what additional or different analyses are needed for an island environment. As we move into an aggressive period of conducting studies for island communities, the development of additional guidance is now required that recognizes the unique characteristics of islands.

FEMA, the lead Federal agency responsible for hurricane planning and preparedness in the United States and its territories, is responsible for providing financial and technical assistance to state and local governments to assist in the planning for and the immediate response to an approaching hurricane or tropical storm. One of the major elements of FEMA's Hurricane Program is the Hurricane Evacuation Study (HES). These studies are normally accomplished as a cooperative effort between FEMA, the state, the National Weather Service and the U.S. Army Corps of Engineers. The Corps serves as the study manager for most of these study

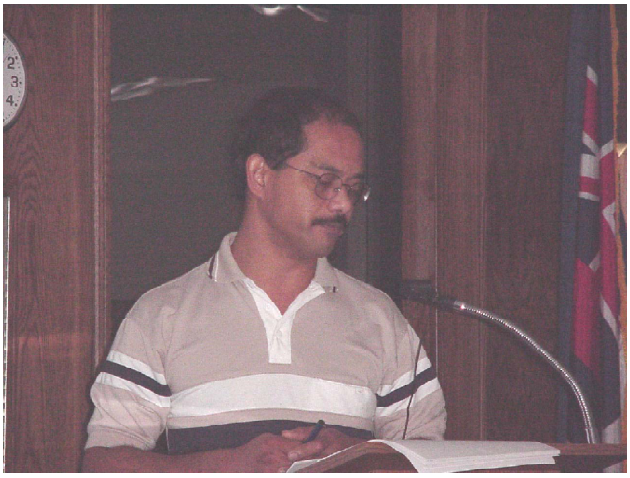
efforts. Under the auspices of the Interagency Coordinating Committee on Hurricanes (ICCOH, chaired by FEMA, with involvement from all federal agencies and national groups such as the Red Cross who have a direct interest in hurricanes) the Islands Task Force has been formed to develop recommendations for specific guidance and procedures to be utilized in the preparation of HESs in island environments. Mr. Allan McDuffie from the Wilmington District of the Corps of Engineers and William Massey from FEMA, Region IV co-chair this Task Force. The inaugural meeting of the Task Force was held in San Francisco, California, on July 9-10, 1998. Representatives of Federal, State and local emergency management agencies from island and mainland coastal locations and select private consultants participated in this session. A second meeting was held in Honolulu, Hawaii on April 12-13, 1999, and a third meeting was held on St. Thomas in the U.S. Virgin Islands on December 1-2, 1999. In addition, interviews with local island emergency management officials have been conducted in Puerto Rico, the U.S. Virgin Islands, and the Florida Keys as a part of the post-Georges and post-Marilyn hurricane evacuation assessments, in Guam as a part of the post-Paka hurricane evacuation assessment, and in each county of Hawaii in conjunction with the second Island Task Force meeting. Interviews with emergency management officials in American Samoa, Guam and CNMI were held in early summer 2001 in preparation for the Island Task Force's final meeting which was held on July 24-25, 2001. Representative scenes from the July 2001 ITF wrap-up meeting are provided on the following pages.

This briefing summarizes the organization and goals of the Island Task Force, the unique island issues related to Hurricane Evacuation Study (HES) technical components and recommendations for future study efforts and technical components.

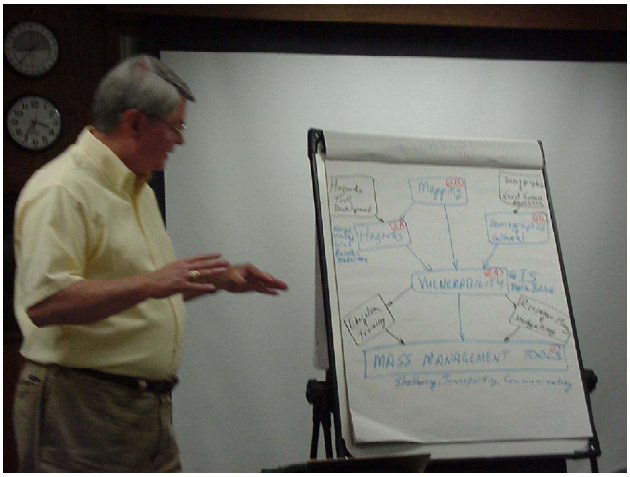
Representative Scenes From ITF Wrap-Up Meeting - July 2001

Representative Scenes From ITF Wrap-Up Meeting - July 2001 (continued)

Representative Scenes From ITF Wrap-Up Meeting - July 2001 (continued)



Representative Scenes From ITF Wrap-Up Meeting - July 2001 (continued)



II. Task Force Participation, Organization And Goals

The Island Task Force meetings held in San Francisco in July of 1998, Honolulu in April of 1999, St. Thomas in December of 1999, and Honolulu in July 2001, have been well attended by agencies invited to participate. Appendix A provides a list of attendees present at each meeting. Agencies that are currently a part of the Island Task Force include:

- FEMA Headquarters; Regions II, IV, and IX, Pacific Area Office, Caribbean Area Office
- U.S. Army Corps of Engineers; Headquarters, Pacific Ocean Division, South Atlantic Division, Honolulu District, Jacksonville District, Wilmington District, and the Coastal and Hydraulics Laboratory
- NOAA/National Weather Service; Headquarters, Pacific Region, Honolulu Office, National Hurricane Center
- Hawaii, State Civil Defense
- Guam Civil Defense
- VITEMA (Virgin Islands Territorial Emergency Management Agency)
- Puerto Rico Civil Defense
- American Samoa Civil Defense
- CNMI Civil Defense
- Monroe County, Florida Emergency Management

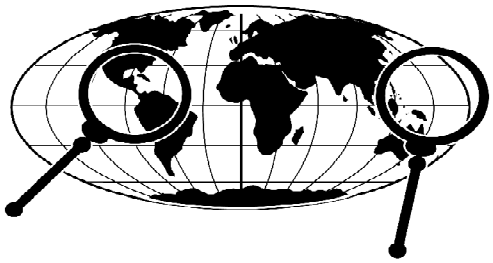
<u>Advisory Consultants</u>

- Hazards Management Group
- Post, Buckley, Schuh & Jernigan, Inc.
- University of Puerto Rico
- Greenehorne and O'Mara, Inc.

At the inaugural meeting of the task force in San Francisco current HES procedures and guidance were discussed and key differences in island and mainland HES issues identified. Four working groups were formed to investigate and collect data on specific issues. The groups were divided into the following subject areas:

Working Group #1 – Study Needs/Management

This group was assigned the following issues:

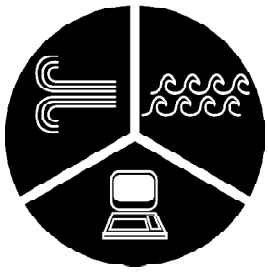


- Post Paka-Guam
- Western Pacific Issues
- Study Management
- 98 Season storm assessments
- Historical data and reports
- Plan Of Study (POS) for future studies
- Training needs for emergency managers

Co-Chairs: Milton Yoshimoto of COE, Honolulu District and Shelley Trulock, COE, Jacksonville

Working Group #2 – Wind, Waves, Technological Advances

This group was assigned the following issues:



- Define wind analysis
- Water analysis including waves
- Forecast Utilization (including use of probabilities)
- Technological advances
- Evaluation/Forecasting

Co-Chairs: Dr. Wilson Shaffer, NWS, Silver Springs, Maryland and Dr. Andrew Garcia, COE, Coastal and Hydraulics Laboratory

Working Group #3 – Culture, Behavioral, Sheltering, Special Populations

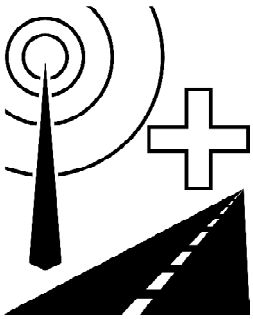
This group was assigned the following issues:

- Culture/customs
- Boat dwellers
- Tourists
- Military
- Public Education
- Behavioral Issues

Co-Chairs: Mel Nishihara, Hawaii Civil Defense (retired), and Billy Wagner, Monroe County, Florida

Working Group #4 – Infrastructure, Communications, Mitigation, Coordination with Response and Recovery

This group was assigned the following issues:



- Communications
- Shelters
- Mitigation issues
- R&R Coordination
- Infrastructure

Co-Chairs: Marie Gonzales, FEMA Caribbean Area Office, and David Kennard, FEMA Region IX

Working Groups 1 and 2 accomplished some important ground work and reported activities to date back to the second Island Task Force meeting in Honolulu. Working Groups 3 and 4 were initiated at the third meeting in St. Thomas. (A meeting had been scheduled in Atlanta during December, 1998 to activate Working Groups 3 and 4, but due to the very active 1998 hurricane season, the meeting was not held.) Working Groups 3 and 4 reported their activities, findings, and recommendations to the Island Task Force meeting in Honolulu during July 2001. Each working group prioritized their recommendations at the July 2001 meeting and those results have been incorporated into this report.

III. Island Hurricane Preparedness Issues

Wind, Waves, Hazards and Vulnerability Issues

Through interviews with local emergency management (EM) representatives from Puerto Rico, the U.S. Virgin Islands, Guam, and Hawaii as well as technical work accomplished by the "Winds, Waves and Water Levels Working Group", a number of unique hazards issues have been identified for the unique island environment. The working group (chaired by Dr. Wilson Shaffer of the NWS and Dr. Andrew Garcia of the COE) met several times in early 1999 to organize data and discuss issues regarding storm tracks/intensities, wind analyses and forecasts, storm surge, waves, rainfall, mudslides and tsunamis. The following is a listing of major facts and issues identified to date:

Tropical Cyclone Position and Intensity Forecasts – while average track errors have steadily lessened over the years (see Appendix B) average track error is still approximately 89 nautical miles at 24 hours out and average intensity error is 10 knots at 24 hours out. Although the figure in Appendix B is for the Atlantic hurricane basin, the error statistics are very similar for the Central Pacific basin. Some further improvements may result from the GFDL model and Gulfstream aircraft sounding strategy. Given the small width and depth of most island landmasses, even small errors in track and intensity have profound effects on decision making and response.

Winds in Complex Terrain – the typical island environment contains high mountainous terrain adjacent to a narrow coastal plain. Downslope and upslope wind acceleration and maximum winds at 200 to 300 feet above MSL (results shown from new GPS dropwindsondes) both create unusually harsh wind effects on island structures due to hurricanes. Little hard data exists and numerical modeling is unlikely to produce results on the required scales. Wind tunnel data are useful but expensive and hard to simulate for the real world island environment. Inferential data such as Fujita's wind field following Iniki and post-storm field reviews have shown how critical this issue is.

Storm Surge – various models are now available including SLOSH and ADCIRC; however, overland surge flooding is generally not a major issue for most islands. The Maximum of Maximums (MOM) concept appears to be a good way of dealing with track and intensity forecast errors. Some areas of Hawaii use a "model" and "worst case" approach regarding anticipated surge. The U.S. Virgin Islands and Puerto Rico have been mapped for storm surge effects but major portions of the Pacific including parts of Hawaii have not been mapped. Bathymetric data from SHOALS (LIDAR technology) may enhance mapping efforts. Islands need more than just expected tsunami storm surge data and corresponding evacuation areas must be hurricane specific. Most Pacific islands have a tsunami evacuation zone and are using it for hurricane threats. There is also a Caribbean tsunami problem that needs more recognition and research.

Waves – a huge coastal problem for most islands due to deep waters offshore. Wave runup and setup equations have been derived from wave tank experiments which provide some indication of problems in "real world" situations. Some work has been done for Hawaii. More information is needed about wind modified waves at the coastline and the effects of coral reefs. Data from strategically placed buoys shows promise and SHOALS data will prove invaluable for modeling advances.

Rainfall and Mudslides – in the Caribbean most intense rainfall events are caused by tropical systems. Hurricane Georges in Puerto Rico and Mitch in Honduras highlighted this critical vulnerability to both flooding and landslides. In Hawaii, highest rainfall is due usually to Kona storms, not tropical cyclones. However, a slow-moving tropical cyclone could produce massive amounts of rainfall. In the Caribbean and Pacific, studies must recognize 100-year floodplain areas. USGS has identified some mudslide-prone areas for limited portions of Puerto Rico and this should be recognized in studies. Dam breaks can aggravate flooding/mudslide problems. Forecasting rainfall amounts is extremely difficult. Forecast rules of thumb for flat terrain do not work in island communities and rainfall is independent of hurricane category.

Recommendations

Highest Priority:

Fund and emphasize the expeditious collection of perishable high water mark and debris line data after storm event. Use data collection guidelines developed by USGS.

Fund and emphasize the measuring of accurate terrain elevations and water depths around islands. (This should include the areas between -100 ft. and 40 ft.) It is recommended that these data be incorporated into DEMs and that standardized formats be used.

Instrument an area with wave, wave direction, and water level gauges for intense observation of hurricane waves at the shoreline; initiate pilot study to investigate the effects of storm surge elevated water levels on waves; also instrument an area of mountain terrain to get better terrain-enhanced wind observations.

Other:

Coordinate / enhance USGS efforts to determine mudslide potential areas and depict them in evacuation zone delineations for island studies.

Gather wind engineering research and expertise to further analyze potential island wind effects on various types of structures. Identify areas for further research.

Gather tropical meteorology expertise addressing the forecasting of rainfall amounts and use of available tools such as advanced radar.

Expand the tsunami research program to include all of the Caribbean.

Show 100-year floodplain areas on surge atlas sheets like Jacksonville District has done in parts of Puerto Rico.

Public Shelter Issues

Interviews conducted in the Caribbean after Hurricane Georges, in Guam after Paka, and in the Hawaiian Islands as a part of the Island Task Force Meetings revealed several important public shelter issues for island environments. The greatest concern was the structural integrity of schools and other public buildings used as public shelters. Officials in Puerto Rico and the U.S. Virgin Islands requested assistance in evaluating public shelters for structural integrity even if the evaluation could only be a qualitative assessment. (This assistance was provided by FEMA using the private consultant Greenehorne and O'Mara. The firm analyzed several shelters in the U.S. Virgin Islands and found the need for significant strengthening of structures to withstand sustained major hurricane force winds.) Officials in Guam would also like a structural analysis of schools used for public sheltering. Given the fact that this is one of the few destinations people can go to on an island, the needs are critical.

Excellent progress has already been made in Hawaii to evaluate public shelters. State of Hawaii Civil Defense has a set of shelter criteria used for identifying and evaluating shelters. Shelters on the "Big Island" of Hawaii have been reviewed by structural engineers. Maui Civil Defense has identified schools needing retrofitting to better withstand storms. Oahu Civil Defense has actually examined hotels in the Waikiki area suitable to be used as public shelters and has designated them as such thereby releasing hotel management from liability concerns. The local convention center has also been identified as a public shelter with the ability to house some 30,000 evacuees.

Recommendations

Highest Priority:

Provide island communities with a shelter assessment tool which would at least qualitatively and preferably quantitatively evaluate structural integrity of public shelters. Develop local skills for evaluating shelters.

Develop shelter management training plans for the island communities focusing on the needs of multiculture homeless, aged, and physically challenged populations.

Develop shelter plans which where appropriate incorporate "shelter districts" in order to minimize shelter congestion.

Other:

Recognize the importance of realistic public shelter demand estimates in island HES products.

Develop guidance for island communities to shelter tourists who are stranded on an island for a particular storm threat.

Compare shelter locations to freshwater floodprone areas, potential rockslide / mudslide areas, high wind acceleration areas, storm surge and tsunami envelopes, and man-made hazards.

Look at innovative, non-traditional sheltering resources on each island that could provide some last resort protection to evacuees.

Culture, Behavioral, and Special Population Issues

Very limited behavioral analyses have been accomplished for the hurricane evacuation studies conducted to date in the island communities. Due to many unique cultural and linguistic variations even on the same island, behavioral analyses needs to be conducted more extensively and focused on different island subcultures. PowerPoint presentations to the July 2001 ITF by emergency management representatives of the U.S. Virgin Islands, Puerto Rico, Guam, CNMI, and American Samoa vividly showed the myriad of cultural differences throughout the U.S. island environments. These differences must be handled in future behavioral studies.

Areas of behavioral analysis that need further focus in the island environment include:

- Method of data collection – telephone interviews must be supplemented by door-to-door or small group interactive approaches; interviewers should be locals, if possible.
- Participation rates – more data are needed to determine what percent of different groups will leave their dwellings for various storm threats; stratification by type of housing unit may be helpful.
- Public shelter usage – since destinations are limited in an island environment, the percent expected to go to public shelter from different population subgroups is very important to predict for various storm scenarios.
- Vehicle ownership and usage – vehicle ownership is quite low in some of the islands; the percent of evacuees relying on public transit versus private auto is important to predict.
- Tourist behavioral patterns.
- Special population evacuation behavior (homeless, aged, physically challenged).

A humorous but vivid illustration of the importance of tailoring a survey instrument to the language and local customs of a locality surfaced in Puerto Rico during a Spanish translation of an HES study element. Apparently an incorrect Spanish translation of the word for "evacuation" meant "to rid oneself of waste" as used in the Puerto Rican dialect of Spanish. Therefore a local Spanish word had to be identified which would mean "to leave one's residence to seek safe shelter" and which would be understood in the study area.

Recommendations

Highest Priority:

Conduct HES behavioral analyses so that telephone interviews are supplemented by person-to-person interview techniques and adapted to various population groups; form task force to assist with developing survey questions.

Have locals review survey instruments for "local culture" screening; where possible use locals for interview contacts.

Develop multilingual public education programs regarding hurricane preparedness.

Other:

Use post-storm evacuation assessments as a means to accomplish behavioral studies for permanent island residents and tourists.

Conduct / gather studies which help better understand customs, protocol, values, decision-making processes and special needs accommodations.

Interview boat dwellers as to anticipated protective action behavior.

Transportation Issues

Just like behavioral analyses, very few HES transportation analyses have been conducted for island environments. Work accomplished to date has focused on the island of Oahu in Hawaii (3 separate studies), St. Croix, St. Thomas (in the U.S. Virgin Islands), and a few small areas of Puerto Rico. Typical study components include:

- Translation of surge vulnerable areas/wind (only) vulnerable areas into evacuation zones/areas.
- Development of evacuating population, vehicles, and public shelter demand by zone/island subarea
- Identification of evacuation route characteristics and existing traffic control
- Routing of evacuees to probable destinations
- Identification of key evacuation congestion areas/controlling bottlenecks
- Calculation of evacuation clearance times
- Traffic control recommendations

Unlike mainland HES efforts, the calculation of evacuation clearance times is not as complex or difficult to perform. For some island locations, low auto ownership, modest surge areas, and limited road networks make this element an important but much less expensive task to accomplish for island studies. Some of the unique issues and elements of transportation analyses conducted for island HES efforts include:

- Storm direction (not just intensity) built into evacuation concept
- Vehicle ownership and usage (lower than mainland studies)
- Participation of wind vulnerable/substandard housing units
- Tourist presence and evacuation participation/effect of airlines pulling out early
- Destinations – emphasis on public shelters, relatives' homes, military bases, and vertical refuge
- Zone to zone "paths" simplified
- Clearance times typically a function of behavioral response rates and 2 or 3 bottlenecks' flow
- Institutional EM environment somewhat different
- Need for public transportation

Clearance times calculated in the studies have compared favorably to post-storm evacuation assessment identified actual clearance times. Implementation of GIS in transportation analyses (such as that recently conducted for St. Thomas) seems to be well worth the slight increase in project cost. Future studies should provide an abbreviated version of the transportation model (similar to recent mainland studies) so that some local EMS can adjust behavioral, socioeconomic, and roadway assumptions to see effects on evacuating population, public shelter demand, traffic congestion, and expected clearance times.

Recommendations

Highest Priority:

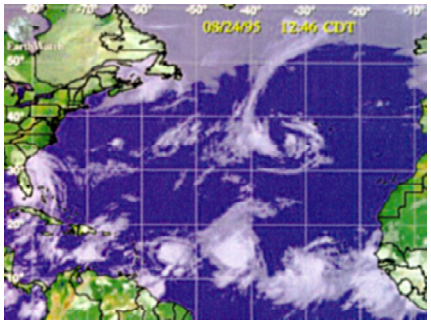
Provide a mass management tool so that locals can vary participation rates and public shelter usage percentages as well as other model inputs to see effects on the number of people, vehicle, and other evacuee statistics.

Other:

Encourage departments of transportation to implement fully operational traffic counters for real-time traffic evacuation counts (e.g. Florida Keys).

Complete GIS-based transportation analyses for remainder of Puerto Rico and Hawaiian Islands.

IV. Evacuation Decision Making Tools and Training



Post-storm interviews in the Caribbean and Guam as well as interviews with local county officials in Hawaii have shown a lack of product availability, education, and development when it comes to HES decision making tools. HURREVAC is not widely known about nor were some of the commercially available tracking products present in most emergency operating centers as recently as 1999. The U.S. Virgin Islands have worked with HURREVAC the most of the island communities but until Summer of 1999 were using the older "DOS" version. Some municipalities in Puerto Rico did not have computer hardware available for emergency management to run such programs even if they had been available during Georges.

When the new Windows version of HURREVAC has been demonstrated, many of the island officials have shown great interest in obtaining it and being trained in its use. The HURREVAC web page now incorporates a central Pacific storm screen which is fully functional for Pacific users. The program was used by Hawaii as Daniel approached the islands in 2000. Island communities in the Caribbean should be able to fully use the new program as is, assuming appropriate/basic computer hardware is available. All participants in the July 2001 ITF meeting were trained on the latest HURREVAC program.

Recommendations

Highest Priority:

Develop a western Pacific historical storms / real time download component to HURREVAC and provide training. Include American Samoa incorporating the first area in HURREVAC south of the equator. (Western Pacific accomplished July 2001)

Work with EMI to develop island specific hurricane preparedness training tools such as videos, CDs, field courses and NHC courses as appropriate.

Other:

Provide HURWIN95 (new Windows based HURREVAC) to all U.S. Caribbean emergency management officials and provide training in Puerto Rico and the U.S.Virgin Islands. (Accomplished Summer 1999)

Develop a central Pacific historical storms / real time download component to HURWIN95 and provide the model and training to the islands immediately. (Accomplished June 2000)

V. Infrastructure, Communications, Mitigation, Coordination with Response and Recovery

To go beyond the normal HES(Hurricane Evacuation Study) technical tasks and products, the ITF considered the findings and recommendations of Working Group #4 with great interest. Their charge was to look at miscellaneous hurricane preparedness issues dealing with infrastructure, communications, mitigation, and coordination with response and recovery. Since US island communities (particularly those in the western Pacific) are geographically far away from major recovery resources, the need for contingency planning and better deployment of assistance is critical.

Since no data had been collected by the ITF for the Pacific regarding these issues, a series of meetings was held in May 2001. Working group representatives met with Guam Office of Civil Defense officials who in turn met with RAC (Response Activity Coordinator) and Guam government officials to identify the key needs and issues. A similar meeting was conducted by Northern Mariana Island EMO officials who followed up with Saipan, Tinian, Rota, and NMI leaders. Finally, working group representatives met with American Samoa TEMCO (Territorial Emergency Management Coordinating Office) officials and went through a similar process.

Recommendations were then formulated and prioritized as follows.

Recommendations

Highest Priority:

The HES should be a way to help document and organize the hurricane readiness response and recovery (RR&R) and the mitigation (MT) work already done by the various jurisdiction agencies.

The HES should include a Contingency Plan component, including a "Time Phased Force Deployment" plan in coordination with FEMA.

Other:

The HES should make an effort to include local subject matter experts and help build local capability.

The HES should lay out the non-FEMA assistance available for RR&R and for MT, similar to efforts made in DFOs to coordinate broad federal efforts.

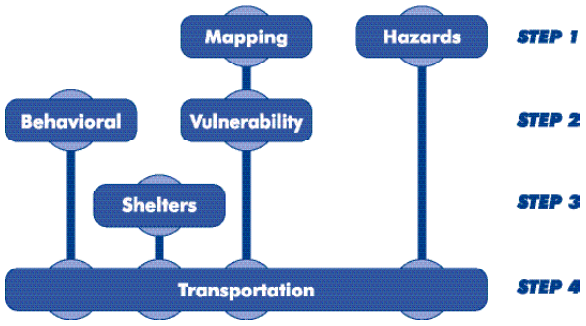
The HES should lay out potential mitigation projects and activities; make recommendations to address potential bottlenecks and problems identified in HES; and should be developed in conjunction with the jurisdiction's mitigation plan.

VI. Future Study Organization

One of the most significant outcomes of the July 2001 ITF meeting is the strong recognition of the need for a more streamlined and specific study process for island environments. In that light, the U.S. Army Corps of Engineers will be developing new technical guidelines for hurricane evacuation studies performed for the island communities. Recognizing the limited funding available through the HES program, the critical study needs of the islands, and the need to place greater emphasis on certain technical components (and less emphasis on others), a new study process was proposed for implementation in federal fiscal year 2002.

The traditional mainland study process consists of four steps starting with an intense and somewhat expensive hazards and mapping effort. The studies typically move into a behavioral and vulnerability analysis and then a shelter analysis. Each study component is geared to feed into a final step, a massive transportation analysis where the emphasis is on clearance times and evacuation timing (velocity management).

Traditional HES Process - Mainland



In year 2002, it has been proposed that the study process be somewhat reversed with the transportation analysis being replaced with the development of a "mass management tool". The mass management tool will inventory and marry together sheltering, transportation facilities and communications resources already present on each island. The level of effort will be such that every island that previously has had no HES effort, will receive significant attention and expertise within nine to twelve months. As mapping, hazards, cultural/behavioral and GIS databases become available, they will be used to refine the mass management tool. The figure at right depicts a possible new approach for island communities.

New HES Process - Island Communities

Recommendations

High Priority:

Develop technical guidelines for island hurricane preparedness studies.

Develop a mass management tool in FY 2002 for all U.S. islands which have not had an HES developed to date.

APPENDIX A

Island Task Force Meeting Attendees

Island Task Force Meeting
San Francisco, California
July 9-10, 1998

NAME	ORGANIZATION	PHONE
Bill Massey	FEMA, Region IV-Atlanta, GA bill.massey@fema.gov	770-220-5430
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Island Task Force Meeting
Honolulu, Hawaii
April 12, 1999

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Island Task Force Meeting
St. Thomas, USVI
December 1-2, 1999

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Island Task Force Meeting
St. Thomas, USVI
December 1-2, 1999

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Island Task Force Meeting
Ft.Shafter, Hawaii
July 24-25, 2001

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Island Task Force Meeting
Ft.Shafter, Hawaii
July 24-25, 2001

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Island Task Force Meeting
Ft.Shafter, Hawaii
July 24-25, 2001

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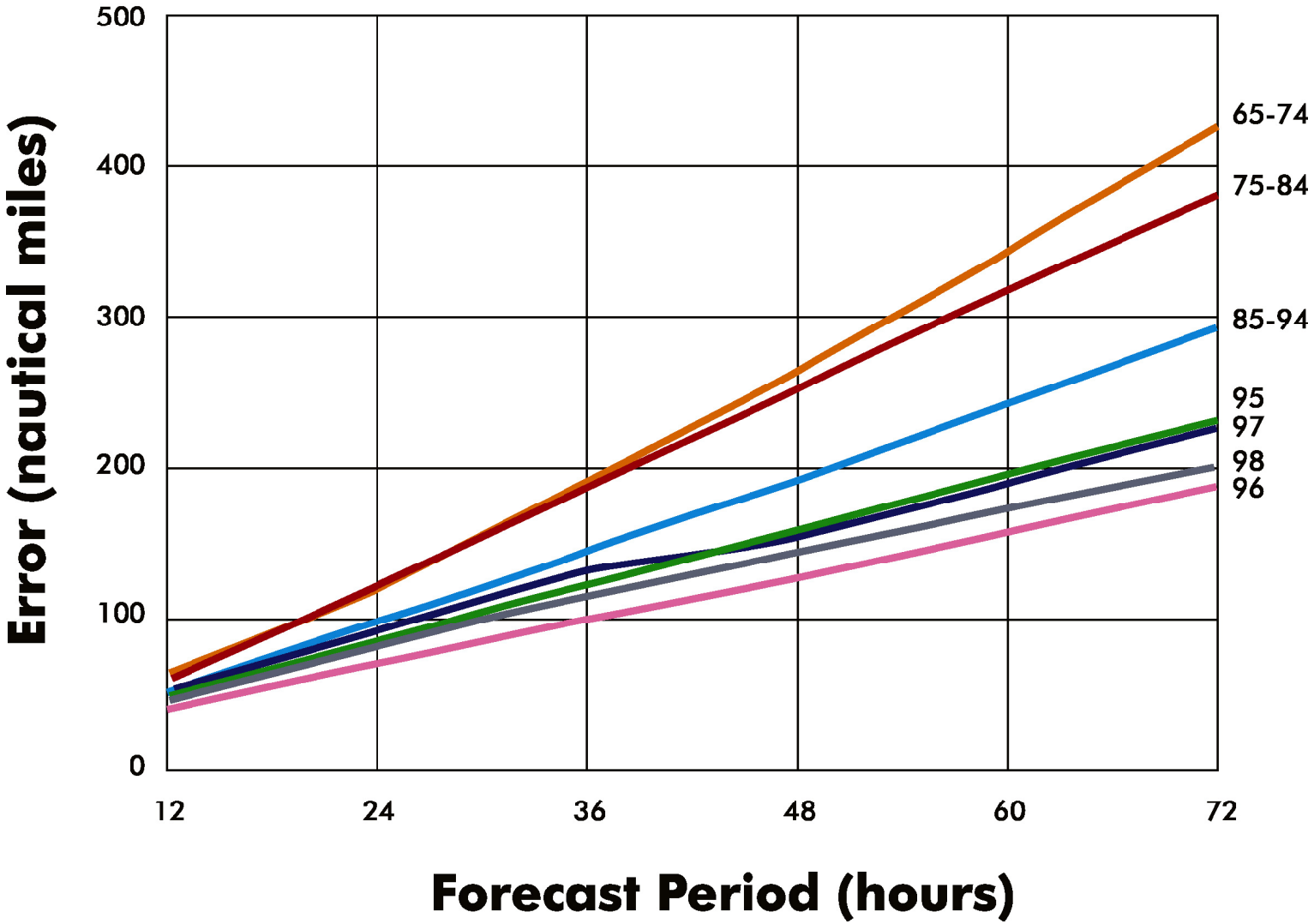
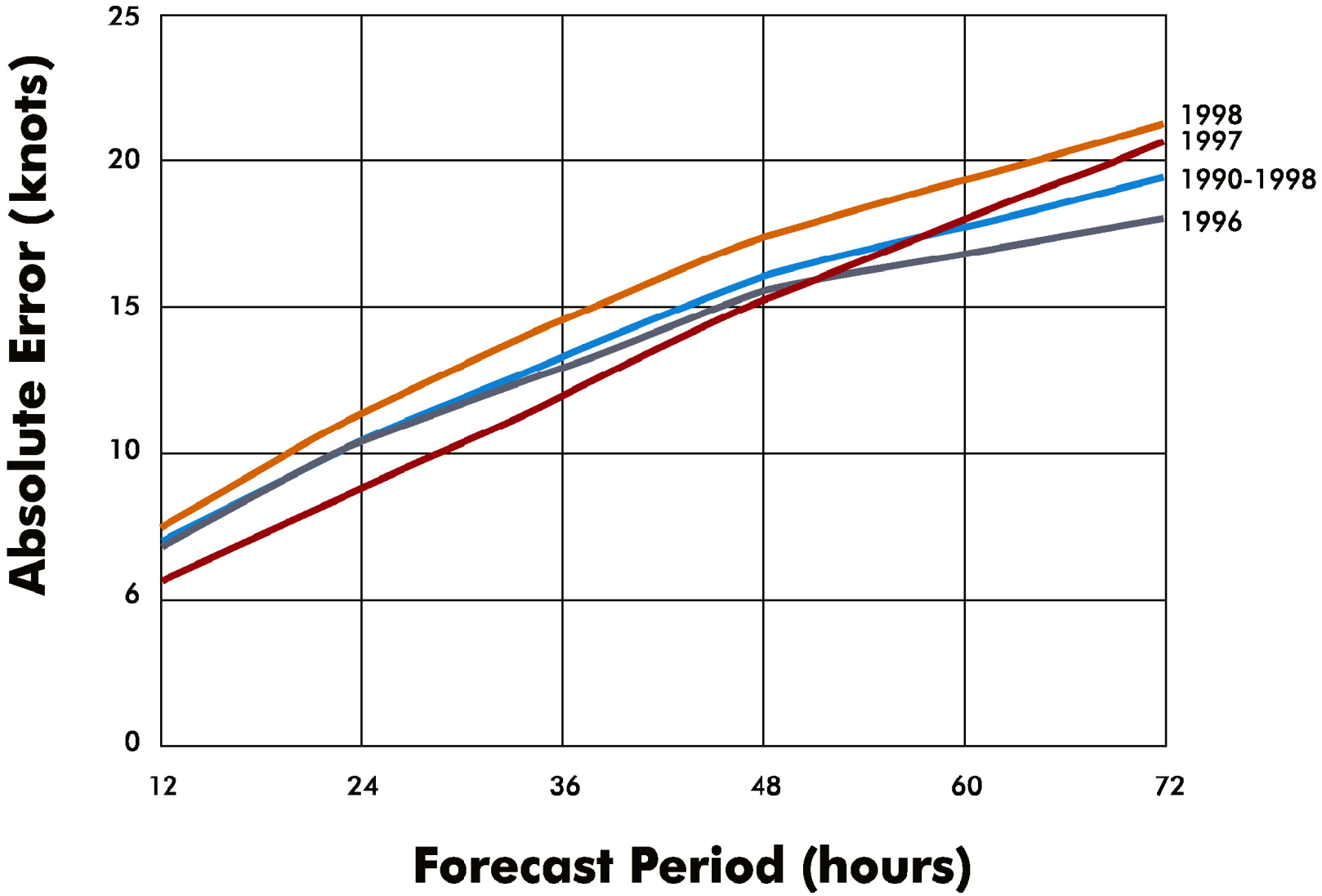
APPENDIX B

NHC Atlantic Track and Intensity Forecast Error Improvement/State of the Art

National Hurricane Center
Atlantic Track Forecast Errors

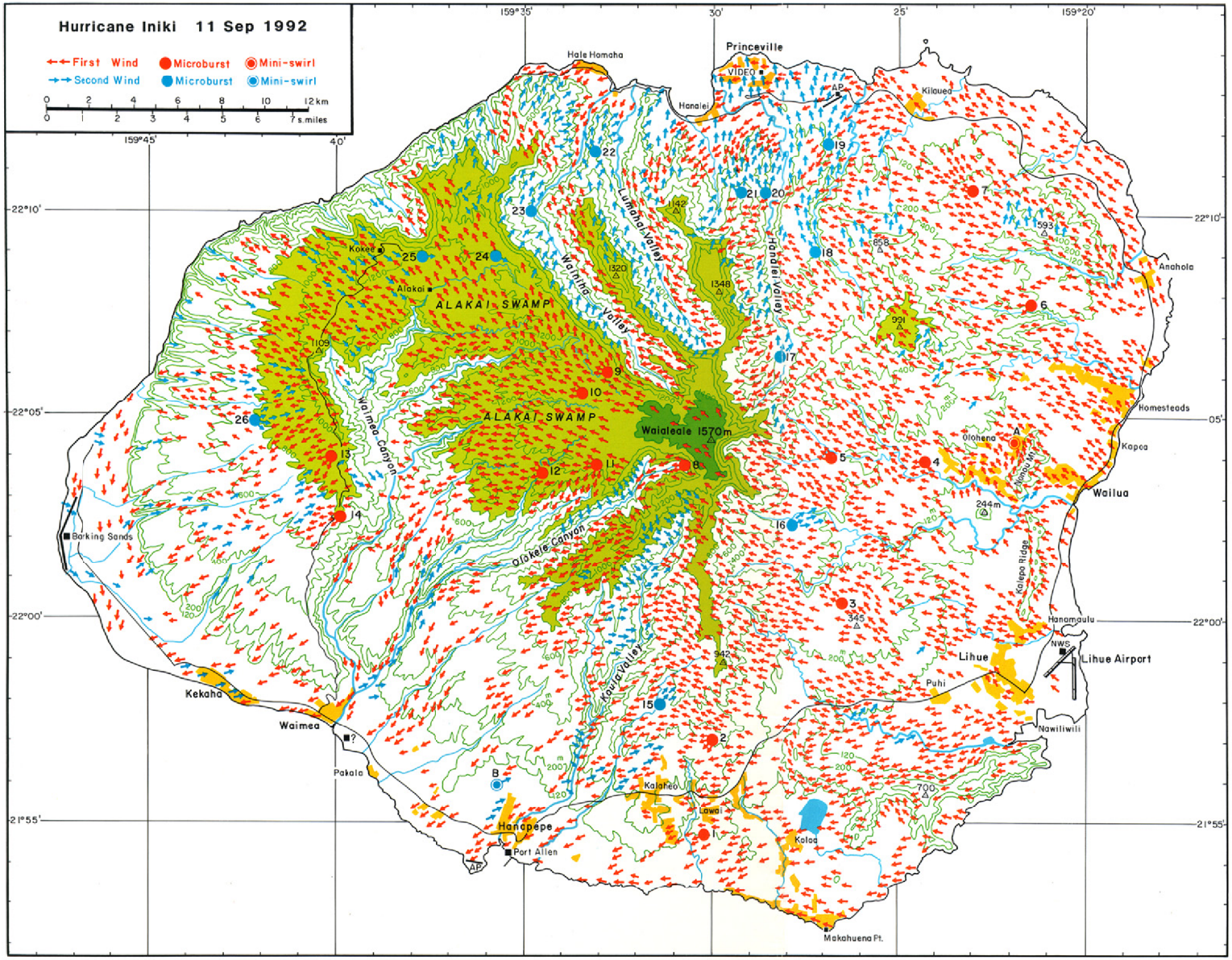


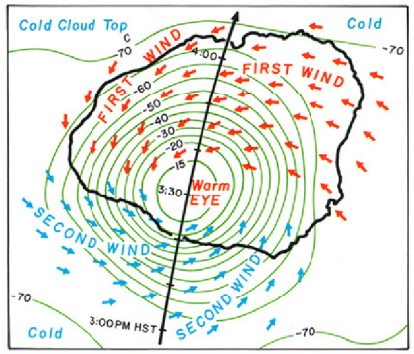
National Hurricane Center
Atlantic Official Intensity Forecast Errors



APPENDIX C

Kauai Hurricane Iniki Wind Field Map

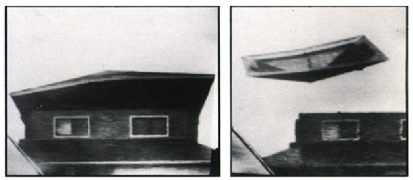




Hurricane-top temperatures measured by GOES-7 satellite suggest that Iniki's eye passed across the center of Kauai in the north-northeasterly direction. Cloud-top isotherms in the above map depict the warm, circular eye at 3:30 p.m. HST on 11 September 1992.

The damaging wind on the front side of the eye (first wind) either reversed or gradually changed into the back-side wind (second wind). The damage map on the left shows the direction of the first wind in red and that of the second wind in blue. In mountain areas, the downslope wind was found more damaging than the upslope wind.

Microburst (small downburst) has been known to endanger aircraft during landing and/or takeoff operations. Unexpectedly, 26 microbursts have been found in Kauai in the wake of Iniki. A video taken by Mr. Dean Marshall from San Francisco shows the scene of a roof at Princeville being blown off by the southerly wind induced by Microburst No. 20 shown in the damage map.



In addition, two mini-swirls (not tornadoes) were found in Kauai. The violent whirlwind, first identified in south Florida after hurricane Andrew of 24 August 1992, could induce a peak wind of 200 mph within a very small area. Iniki was a very complicated storm accompanied by both mini-swirls and microbursts.

Acknowledgements are due to Duane Stiegler for aerial photography, Jim Partacz for mapping and photography, and Jaime Tecson for laboratory assistance. Aerial color and infrared pictures were provided by Air Survey Hawaii. Aerial survey and analysis were supported by NOAA/ National Weather Service under Grant 40AANW204612 and Office of Naval Research under Grant N00014-91-J1136. The publication of this map was supported by the University of Chicago under Fund 2-64613.

The research leading to the publication of this damage map was performed at the University of Chicago under the direction of T. Theodore Fujita, Professor Emeritus.