U.S. Army Corps
of Engineers
Coastal and Hydraulics Laboratory

Proceedings of the 69th Meeting of the Coastal Engineering Research Board

14-16 April 1999 (Honolulu, HI)

(Includes Proceedings of the 68th Meeting of the CERB)

Hosted by: U.S. Army Engineer Division, Pacific Ocean
U.S. Army Engineer District, Honolulu

Prepared for Headquarters, U.S. Army Corps of Engineers

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Preface

The Proceedings of the 68th (Appendix C) and 69th Meeting of the Coastal Engineering Research Board (CERB) were prepared for the Office, Chief of Engineers, by the U.S. Army Engineer Waterways Experiment Station's (WES's) Coastal and Hydraulics Laboratory (CHL). These proceedings provide a record of the papers presented, the questions and comments in response to them, and the interaction among program participants and the CERB.

The 69th meeting was hosted by the U.S. Army Engineer Division, Pacific Ocean (POD), under the direction of BG Carl A. Strock, Commander, and the U.S. Army Engineer District, Honolulu (HED), under the direction of COL Wally Z. Walters, Commander.

Acknowledgments are extended to the following from POD: Mr. John G. Emmerson for coordination and 1Lt Kevin Golinghorst for logistical support, and from HED: Mr. Stanley J. Boc for overall coordination of the meeting and field trip; Ms. Jasmina Dobinchick for pre-meeting support; and Mses. Joanne Hasegawa and Karen Tomayasu, who assisted with registration and onsite support. Thanks are also extended to all speakers; to Ms. Sharon L. Hanks of WES's CHL, for overall coordination and assistance in the setup of the meeting and the assembly of the information for this publication; Mr. Doyle Jones of WES's CHL for placing proceedings on the Internet; and Mr. Bill Mullen of WES's Information Technology Laboratory for editing these proceedings. Thanks are extended also to Ms. Susan C. Soderberg, Pro/Tech Reporting Services, for taking verbatim dictation of the meeting.

These proceedings were reviewed and edited for technical accuracy by Dr. James R. Houston, Director, WES's CHL, and Mr. Thomas W. Richardson, Acting Assistant Director, WES's CHL. COL Robin R. Cababa, Executive Secretary of the Board, provided additional review.

The document is approved for publication in accordance with Public Law 166, 79th Congress, approved 31 July 1945, as supplemented by Public Law 172, 88th Congress, approved 7 November 1963.

RUSSELL L. FUHRMAN
Major General, U.S. Army
President, Coastal Engineering Research Board

Agenda

THEME: MILITARY APPLICATIONS OF COASTAL ENGINEERING

Tuesday, 13 April 1999

1830 - 1930 Registration

Wednesday, 14 April 1999

0730 - 0830 Registration

0830 - 0835 Opening Remarks
MG Russell L. Fuhrman

0835 - 0845 Welcome and Introduction
BG Carl A. Strock, Pacific Ocean Division (POD) and
LTC Wally Z. Walters, Honolulu Engineer District (HED)

0845 - 0945 **Old Business**

0845-0910 Systems Approach to Regional Sediment Management
BG J. Richard Capka, South Atlantic Division

0910-0925 Partnering Update
Mr. Charles B. Chesnutt, Headquarters, U.S. Army Corps of Engineers (HQUSACE)

0925-0945 Hurricane Evaluation Report Study of North Carolina Beaches
Mr. James T. Jarrett, Wilmington District

0945 - 1515 **Military Customer Needs and R&D Related to Military Applications of Coastal Engineering**

0945-1015 Examples of Past Contributions
Professor Robert L. Wiegel, University of California

1015 - 1030 Break

1030-1115 Rapidly Installed Breakwater System/Logistics-Over-the-Shore
Dr. Donald T. Resio, U.S. Army Engineer Waterways Experiment Station (WES)

1115-1145 Operations and Research Needs
Rear Admiral Kenneth E. Barbor, Naval Meteorology and Oceanography Command

1145-1215 Office of Naval Research and Waterways Experiment Station Collaborations at the Field Research Facility 1990-99
Dr. C. Linwood Vincent, WES

1215 - 1345 Lunch (Imperial Suite) (Pacific Command Strategy)
MAJ Jeffrey S. Lavallee, Headquarters, Pacific Command

1345-1415 Military Applications of Civil Works Modeling Capabilities
Dr. James R. Houston, WES

1415-1445 Military Applications of Airborne Lidar Bathymetry
Mr. W. Jeffrey Lillycrop, WES

1445-1515 Naval LOTS Program
Mr. Theodore G. Vaughters, Naval Surface Warfare Center

1515 - 1530 Break

1530 - 1600 Iwakuni Runway Relocation
Mr. Andrew Constantaras, POD

1600 - 1630 Alaska District Coastal Projects
Mr. Kenneth J. Eisses, Alaska District

1630 Adjourn for the day

1800 Social (Ilikai Hotel)

Thursday, 15 April 1999

0900 - 0905 Opening Remarks
MG Fuhrman

0905 - 0935 Summary of Marine Board Study on Coastal Engineering Research and Education Needs
Professor Robert A. Dalrymple, University of Delaware

0935 - 1000 Honolulu Engineer District Coastal Navigation Program
Mr. Stanley J. Boc, Jr., HED

1000 - 1025 Future Direction of Corps' Shore Protection Program
Mr. Chesnutt

1025 - 1035 New Directions in Coastal Research Needs
Mr. Orville T. Magoon, Coastal Zone Foundation

1035 - 1045 Field Trip Overview

1045 - 1400 Adjourn for Executive Session (Working Lunch)

1430 - 1715 Field Trip
Travel to Kaneohe Marine Corps Base
Marine Corps Beach Invasion Demonstration
Return to Hotel

Friday, 16 April 1999

0900 - 0905 Opening Remarks
BG J. Richard Capka

0905 - 0930 Island Harbors
Mr. Frederick Nunes, State of Hawaii Harbors Division

0930 - 1015 The Influence of Geology, Demographics, and History on U.S. Army Corps of Engineers Coastal Projects
Mr. Chesnutt

1015 - 1030 Break

1030 - 1055 Hurricane Evacuation Studies
Ms. Helen Stupplebeen, HED

1055 - 1115 Disaster Related Issues on the Islands
Mr. Melvin Nishihara, Hawaii Civil Defense

1115 - 1145 Public Comment

1145 - 1200 Comments by Members of the Board
Board

1200 Adjourn

Attendees

Board Members
MG Russell L. Fuhrman
BG J. Richard Capka
COL(P) Peter T. Madsen
Dr. Robert G. Dean
Dr. Billy L. Edge

Headquarters, U.S. Army Corps of Engineers
Mr. Charles B. Chesnutt, CECW-PF
Mr. Peter C. Luisa, CECW-BW
MAJ Scott Schutzmeister, CECW-ZA

Great Lakes and Ohio River Division
Mr. Ronald L. Erickson, CELRE-EP-DC

Mississippi Valley Division
Mr. Adrian J. Combe, Jr., CEMVN-ED-HC

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Mr. Andrew C. Petallides, CENAD-ET-E
Mr. Ronald G. Vann, CENAO-EN-C
Ms. Susan S. Lucas, CENAP-PL-PC

Pacific Ocean Division
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Mr. Louis Carr, CEPOD-ET
Mr. Andrew Constantaras, CEPOD-ET-E
Mr. John G. Emmerson, CEPOD-ET-C
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Mr. James L. Bersson, CEPOH-CO
Mr. Stanley J. Boc, CEPOH-ED-CP
Mr. Benton Ching, CEPOH-ED-CD
Mr. James Hatashima, CEPOH-ED-CP
Mr. Ray H. Jyo, CEPOH-PP
Mr. Paul Mizue, CEPOH-ED-C
Mr. James Pennaz, CEPOH-ED-CD
Mr. Samuel Song, CEPOH-EN-L
Ms. Helen Stupplebeen, CEPOH-ED-CF
Mr. Kenneth J. Eisses, CEPOA-EN-CW-HH

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Ms. Mary H. Whittington, CESAM-OP-J
Mr. F. Wade Seyle, Jr., CESAS-EN-HC
Mr. James T. Jarrett, CESAW-TS-EC
Mr. Allan E. McDuffie, CESAW

South Pacific Division
Mr. George W. Domurat, CESPD-ET-C

Southwestern Division
Mr. Herbie A. Maurer, CESWG-CO-M

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COL Robin R. Cababa, CEWES-ZB
Ms. Sharon L. Hanks, CEWES-CV-Y
Dr. James R. Houston, CEWES-CV-Z
Mr. W. Jeffrey Lillycrop, CEWES-CC-S
Dr. Donald T. Resio, CEWES-CV-CS
Mr. Thomas W. Richardson, CEWES-CC
Dr. C. Linwood Vincent, CEWES-CV-CH

Guest Participants
RADM Kenneth E. Barbor, Chief, Naval Meteorology and Oceanography Command, Stennis Space Center, MS
Professor Robert A. Dalrymple, University of Delaware, Newark, DE
MAJ Jeffrey S. Lavallee, Headquarters, Pacific Command, Camp Smith, HI
Mr. Orville T. Magoon, Coastal Zone Foundation,
Middletown, CA
Mr. Melvin Nishihara, Hawaii Civil Defense, Honolulu, HI
Mr. Frederick S. Nunes, Department of Transportation, Harbors Division, Honolulu, HI
Mr. Theodore G. Vaughters, Naval Surface Warfare Center, West Bethesda, MD
Professor Robert L. Wiegel, University of California, Berkeley, CA

Guests

Mr. Warren Bucher, OCEANIT Coastal Corporation, Honolulu, HI

COL Patrick Dunkle, Headquarters, Pacific Command, Camp Smith, HI

Mr. J. Michael Hemsley, National Data Buoy Center, Stennis Space Center, MS

CDR Larry Jaeger, U.S. Coast Guard, Honolulu, HI

Dr. Hans J. Krock, University of Hawaii, Honolulu, HI

Mr. Carter Luke, Department Transportation, Harbors Division, Honolulu, HI

Mr. Bernard Marcos, Headquarters, Pacific, Air Force, Hickam Air Force Base, HI

Ms. Barbara R. Moore, U.S. Army, Pacific, Fort Shafter, HI

Dr. Edward K. Noda, Edward K. Noda and Associates, Inc., Honolulu, HI

LT John A. Okon, Naval Meteorology and Oceanography Command, Stennis Space Center, MS

Mr. Joseph D. Reed, Oahu Civil Defense Agency, Honolulu, HI

Mr. Scott P. Sullivan, Sea Engineering, Inc., Waimanalo, HI

Mr. Stan Yasumoto, Pacific Command, Air Force, Hickam Air Force Base, HI

Court Reporter

Ms. Susan C. Soderberg, Pro/Tech Court Reporting

Proceedings of the 69th Meeting of the Coastal Engineering Research Board

Introduction

The 69th meeting of the Coastal Engineering Research Board (CERB) was held at The Ilikai Hotel in Honolulu, HI, on 14-16 April 1999. It was hosted by the U.S. Army Engineer Division, Pacific Ocean, under the direction of BG Carl A. Strock, Commander, and the U.S. Army Engineer District, Honolulu, under the direction of LTC Wally Z. Walters, Commander.

The Beach Erosion Board (BEB), forerunner of the CERB, was formed by the Corps in 1930 to study beach erosion problems. In 1963, Public Law 88-172 dissolved the BEB by establishing the CERB as an advisory board to the Corps and designating a new organization, the Coastal Engineering Research Center, now the U.S. Army Engineer Waterways Experiment Station's (WES's) Coastal and Hydraulics Laboratory (CHL), as the research arm of the Corps. The CERB functions to review programs relating to coastal engineering research and development and to recommend areas for particular emphasis or suggest new topics for study. The Board meets twice a year to do the following:

a. Disseminate information of general interest to Corps coastal Districts or Divisions.

b. Obtain reports on coastal engineering projects in the host (local) District or Division; receive requests for research needs.

c. Provide an opportunity for state and private institutions and organizations to report on local coastal research needs, coastal studies, and new coastal engineering techniques.

d. Provide a general forum for public inquiry.

e. Provide recommendations for coastal engineering research and development.

Presentations during the 69th CERB meeting dealt with military applications of coastal engineering. Documented in these proceedings are summaries of presentations made at the meeting, discussions following these presentations, and recommendations by the Board. Documentation and verbatim transcripts of the 69th meeting are on file at WES's CHL.

Also, Appendix C is the documentation of the 68th CERB meeting, which includes the Executive Session and visits to the U.S. Army Engineer District, Wilmington, and the U.S. Army Engineer District, Norfolk.

Membership

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Welcome and Introduction

MG Russell L. Fuhrman welcomed attendees to the Coastal Engineering Research Board (CERB) meeting and to the "Aloha" state. He introduced Board members Dr. Robert G. Dean from the University of Florida; Dr. Billy L. Edge from Texas A&M University; BG J. Richard Capka, Commander of the South Atlantic Division; and COL(P) Peter T. Madsen, Commander of the South Pacific Division. He noted the absence of Dr. Richard W. Sternberg of the University of Washington and MG Jerry L. Sinn, Commander of the North Atlantic Division, due to scheduling conflicts. MG Fuhrman introduced special guests, former CERB members Professor Robert L. Wiegel from the University of California and Dr. Edward K. Noda from Edward K. Noda and Associates, Inc., and RADM Kenneth E. Barbor, Chief of the Naval Meteorology and Oceanographic Command.

MG Fuhrman acknowledged a letter from U.S. Senator Daniel Inouye, senior senator from Hawaii, who was invited to address the Board, but was unable to do so. The letter states "…congratulations for what we have done in the past and the importance of coastal engineering to the Nation and the state of Hawaii." Senator Inouye wishes us well in our deliberations.

BG Carl A. Strock and LTC Wally Z. Walters also welcomed the CERB and attendees. They acknowledged the presence of the Navy, Coast Guard, Marines, and Air Force.

BG Strock noted that the theme of the meeting is appropriate since the Pacific area is a maritime theatre, and the program covers scientific aspects of what they do as well as the practical military application.

LTC Walters noted that the basic problems they are encountering in the coastal engineering arena are getting harder and harder to implement as ecological, political, and social pressures are closing in, and he welcomed the results of the meeting.

Systems Approach to Regional Sediment Management

BG J. Richard Capka
Commander
U.S. Army Engineer Division, South Atlantic
Atlanta, GA

My presentation will update the Coastal Engineering Research Board (CERB) on the activities and proceedings of the Regional Sediment Management Committee established by MG Russell L. Fuhrman at the 67th CERB meeting on 14 May 1998 in Fort Lauderdale, FL. The objective of the committee is to promote effective and efficient sand management on a regional basis. Our goal is to keep more sand in the littoral system. Members of my committee include the three civilian CERB members.

Previous Proceedings

My committee met in Atlanta, GA, on 25 September 1998 to review regional sediment management objectives and demonstration proposals for selected regional locations and to identify characteristics of an effective sediment management demonstration. Potential demonstration project locations include: the northern Gulf coast, the northeast coast of Florida, the southern North Carolina coast, and the southern coast of California (Orange County, upper San Diego County).

I reported to the CERB at its 68th meeting 15 October 1998 in Norfolk, VA, and received direction from the Board to:

a. Get on with it.

b. Downselect and focus.

c. Look at the candidates.

d. Identify Federal funding needs and sources and cost-sharing partners.

e. Seek buy in from other agencies.

In response to these instructions, my Mobile District office convened a workshop on regional sediment management for the north Gulf of Mexico location on 9 February 1999. Federal, state, and private partners presented their coastal management capabilities and concerns. Workshop participants identified management objectives for the area and project components. An interagency working group is detailing the demonstration, and a management group is meeting with all other area stakeholders.

My committee met 25 March 1999 at Kill Devil Hills, NC, to hear a report on the Mobile District workshop and to consider other regional sediment management proposals. We discussed the tools that are available to us now and challenging policy issues.

My report to the CERB will:

a. Define existing problems, frustrations, and issues that will be addressed by the demonstration projects.

b. Describe why we are recommending particular regions.

c. Identify components that a demonstration program must have.

d. Identify the data to be collected.

e. Suggest what we can learn that is transferable to other regions.

f. Identify the deliverables and the time line for the demonstration program.

g. Describe our resourcing plan.

h. State what we need from the CERB today.

Discussion

Dr. Robert G. Dean underscored BG Capka's statement about the sediment being a valuable natural resource. He has seen several areas where there is an interest in cutting inlets. We apply much greater requirements for the construction and excavation of those inlets than we do for the inlets that are present. In Florida, the need for regional sediment management is great. The states of Florida and South Carolina have statutes that address this problem. *Dr. Dean* mentioned that the American Society of Civil Engineers has a policy that endorses this concept in general and recommends bypassing good-quality littoral material. Regional sediment management is a trend in coastal engineering, and the demonstration projects will have a good impact in furthering that trend.

Mr. J. Michael Hemsley, Chief of Operations for the National Data Buoy Center, stated that the Gulf of Mexico demonstration project could take advantage of several things that are happening in that area. Waves are a critical factor when watching where sediment goes. The National Data Buoy Center is in the business of measuring these waves. South of Mobile and Pensacola, the Minerals Management Service is gathering wave and circulation data from nondirectional buoys, and *Mr. Hemsley* feels that this would be of interest to the people involved in the demonstration. *Mr. Hemsley* stated that the Weather Service and the National Data Buoy Center are proposing an expansion of their data collection network. If that happens, there would be considerable data collected at no expense to the U.S. Army Corps of Engineers. There would be a good opportunity for some synergy between the Weather Service and the Corps on acquiring directional waves in those areas.

Mr. Orville T. Magoon added that there is a tremendous amount of work on this problem in foreign nations and the Corps might consider the published literature in these areas. *Mr. Magoon* also mentioned that consideration be given to Southern California for a demonstration site.

BG Capka added that there is a lot of interest right now among the congressional delegations from the coastal states, and there is some movement to add some language to the authorization bill to include funding for these kinds of things.

Mr. Charles B. Chesnutt stated that a workshop was being planned in Herndon, VA, to include the U.S. Geological Survey, the Minerals Management Service, and NESDIS, the data base management people with the National Oceanographic and Atmospheric Administration, to work together to support these kinds of demonstration programs.

Mr. Chesnutt also mentioned that there has only been one public meeting held by the Mobile District concerning the demonstration project. As a result, geological surveys from Mississippi, Alabama, and Florida have agreed to form a research consortium to support the data collection and analysis that will allow us greater ease in managing the sediment in that region.

Partnering Update

Charles B. Chesnut
Planning Division
Headquarters, U.S. Army Corps of Engineers
Washington, DC

Prior to the 67th Coastal Engineering Research Board meeting in Fort Lauderdale, FL, in May 1998, a workshop was conducted to see how the U.S. Army Corps of Engineers and private industry can work together to increase the U.S. share of work in overseas markets. The workshop identified a number of obstacles that were hampering the ability of the Corps to support private industry.

In September, Mr. Donald Kisicki, Chief of the International and Interagency Office, began working with the American Engineers Council and Mr. Henry Michel, President Emeritus of Parsons, Brinkerhoff, Douglas, and Quade, to overcome some of the obstacles. In October, the committee met again with a larger group of consulting firms. Two past Corps employees, GEN Norman Delbridge and COL Sidney Vogel, provided good moderation/mediation roles because of their past experience. The committee broke into four subgroups, and met in January and February. Other agencies involved were the Tennessee Valley Authority, the Federal Highway Administration, the Association of General Contractors, and the Dredging Contractors of America.

Sample issues of concern were:

a. Liability and risk sharing. Private industry wants the Corps to share in liability.

b. Lack of Corps funds. An appropriation of $3 million is proposed to support efforts of private industry and is being proposed and reflected in the Technical Assistance Program.

c. Effective marketing.

Much interest has evolved and has already paid off in overseas work. Firms that had never worked with the Corps are expressing interest and have already begun a significant networking effort with private industry and sharing information among Corps offices to pursue these opportunities.

Discussion

Dr. Dean asked if the effort we are undertaking is to even the playing field with consulting firms in other countries. *Mr. Chesnutt* answered, "Yes." National laboratories, such as the Danish Hydraulic Institute in Denmark, the Delft Laboratory in The Netherlands, and the Wallingford Lab in England subsidize the work of European firms seeking work in the developing countries. We cannot subsidize U.S. firms, but the Technical Assistance Program allows our laboratories as well as our District offices to support the work of U.S. firms now.

Dr. Dean commented that in Holland this program even goes to the educational side. They have courses in coastal and hydraulic engineering that provide them with an entree into the other countries as well. *Mr. Chesnutt* agreed and added that that is another area we want to pursue, and in fact, the last class of the Coastal Engineering Education Program had a student from Spain. He stated that we need to educate some of the engineers in developing countries so they will turn to us for support.

Dr. Billy L. Edge commented that neither the Corps nor the universities are in a position to offer the subsidies to those students who would be coming from the developing countries. He said that it would appear that someone like the State Department or other Federal entity that is interested in promoting this kind of international commerce would be a likely source of funding. *Mr. Chesnutt* added that this is an area that needs to be addressed.

Hurricane Evaluation Report
Study of North Carolina Beaches
(April 1999 Status)

James T. Jarrett
Chief, Coastal, Hydrology, and Hydraulics Section
U.S. Army Engineer District, Wilmington
Wilmington, NC

The southeastern coast of North Carolina was severely impacted by two hurricanes in the summer of 1996, Hurricane Bertha on 12-13 July and Hurricane Fran on 5-6 September. Bertha was a category 3 hurricane, but reduced in strength to a strong category 2 hurricane at the time of landfall. Fran maintained a category 3 status through landfall with estimated wind speeds in excess of 115 mph. The eyes of both storms passed over the coastal area extending from Cape Fear to Topsail Island. Storm still-water levels associated with Bertha were not extraordinary; however, still-water levels surveyed following Hurricane Fran ranged from a high of 15.5 ft above National Geodetic Vertical Datum (NGVD) at the south end of Kure Beach to around 9.5 ft above NGVD along the north end of Topsail Island. Prior to Hurricane Fran, the historic maximum still-water level in this area of the North Carolina coast was around 10.5 ft above NGVD and was associated with Hurricane Hazel, which hit the area in October 1954. The maximum still-water level measured at Kure Beach was believed to include some wave setup effects as the majority of the still-water marks surveyed in Kure Beach ranged between 11.5 ft and 12.5 ft above NGVD. Similar still-water levels were measured in Carolina Beach, which lies immediately north and adjacent to Kure Beach, and along Wrightsville Beach, which is located approximately 10 miles northeast of Carolina Beach. Still-water levels along Topsail Island, which is a 22-mile-long island located from the town of Topsail Beach on the south end of the island to the town of North Topsail Beach on the north end of the island, ranged from 9.5 ft to 10.5 ft above NGVD.

The shoreline impacted by both of these storms contain two of the oldest coastal storm damage reduction projects constructed by the U.S. Army Corps of Engineers (USACE), namely, the Carolina Beach and Wrightsville Beach projects. Both of these two projects, which consist of beach fills shaped in the form of a 25-ft-wide dune at elevation 13.5 ft above NGVD fronted by 50-ft-wide storm berms at elevation 10.5 ft above NGVD, were initially constructed in 1965 and have been maintained through a program of periodic nourishment. Following the passage of these two storms, particularly Hurricane Fran, visual inspections of the impacted coastal areas revealed that the beach communities protected by the beach-fill projects experienced considerably less damage to oceanfront development than their unprotected neighbors. Noting the difference in damage levels for protected and unprotected beach

communities, Headquarters, USACE, Civil Works Policy Division and the USACE Institute of Water Resources initiated a cooperative effort to document the beneficial effects of the two Corps projects. Funds to initiate this effort were made available late in FY 96; however, FY 97 funds could not be found and the study effort was suspended. Additional funding for the study was obtained late in FY 98, and the effort was renewed.

The primary goal of the study is to document the difference in damage to oceanfront development between the protected and unprotected beach communities by using actual damage quantities. To assure that the observed differences in damage level were not associated with difference in storm intensities or differences in the geologic makeup to the affected areas, the study includes the evaluation of wind patterns and strengths along the affected area, the reconstruction of the storms through numerical modeling, and a general evaluation of the geology between Cape Fear and North Topsail Beach.

The documentation of the difference in damage between the protected and unprotected beaches is being based primarily on the analysis of damage claims filed with the Federal Flood Insurance Program, which is administered by the Federal Emergency Management Agency (FEMA), and comparative analysis of poststorm photographs. The storm modeling will focus on hindcasting storm conditions along the area and will include still-water levels, winds, wave conditions, and storm duration. The results of the modeling effort will be compared to documented storm still-water levels obtained through extensive high-watermark surveys and observed wind conditions. The geology of the impacted area is being developed by geologists at the University of North Carolina at Wilmington.

The preliminary outline of the report includes:

a. Preface, Acknowledgments, Table of Contents

b. Executive Summary

c. Chapter 1 – Introduction

d. Chapter 2 – Project Descriptions

e. Chapter 3 – Economics

f. Chapter 4 – Physical Setting

g. Chapter 5 – Findings and Conclusions

h. Appendices

Progress to date includes drafts of Chapters 1 and 2, and Sections A (Geologic) and C (Onshore Winds) of Chapter 4. Numerical modeling of Hurricanes Bertha and Fran has also been completed. Work on the assessment of damages from the FEMA data is continuing. A draft of the report should be available by midsummer.

Discussion

BG Capka asked if we pulled in any data from Hurricane Bonnie to corroborate what we found with Hurricane Fran? *Mr. Jarrett* stated that Bonnie came in about 6 months after the Kure Beach Project was complete. The District performed some poststorm profiles, and the beach performed quite well. They had taken some high-water measurements after Fran. Bonnie produced storm surges 2 to 3 ft below what Fran created. The project worked so well that the District did not collect any real detailed damage data because there weren't any.

Dr. Dean asked Mr. Jarrett to comment on the fact that initially they hoped to address the economics of the beach nourishment projects and thereby provide more solid basis for justifying such projects. *Mr. Jarrett* stated that they had all the Federal Emergency Management Agency (FEMA) data, but it was difficult to discern what was oceanfront. There is a difference in damage due to ocean surge and to the waves and also erosion. With the FEMA data, they are trying to pull out the oceanfront structures to get that comparison. The Institute for Water Resources has that data, can pull it out, and get a direct comparison of damage per mile for each community.

Dr. Dean asked if the impact to the beach nourishment projects that were in place in 1996 were documented and will a report be written? *Mr. Jarrett* stated that the District prepared P.L. 99, which gives the Corps authority to go back and repair flood protection projects that were damaged by significant storms, reports for Wrightsville and Carolina beaches following Hurricane Fran. Reports were not written for Bonnie or Bertha because the damage level was nonexistent to the beaches.

COL(P) Peter T. Madsen asked Mr. Jarrett if he saw this maturing to the point where a correlation between storm size if a community predicts damage and the beach cushion they want to put in front of themselves for protection? *Mr. Jarrett* stated that they are moving toward a risk and uncertainty type of analysis and developing the so-called National Economic Development Plan. Level of protection is not a good term to use. They are trying to optimize the difference in the costs of the projects and the benefits projected.

Military Applications of Coastal Engineering
Examples of Past Contributions

Robert L. Wiegel
Professor Emeritus
Civil and Environmental Engineering Department
University of California
Berkeley, CA

Introduction

Maritime ports and harbors in the Zone of the Interior (ZI) are needed for nearly every overseas military operation, but they will not be included here. We know that coastal engineering is required and integral in their design, construction, operation, and maintenance. For a major invasion and subsequent projected warfare operation, seized ports (such as Cherbourg, France, during World War II) must be repaired, modified, and dredged (e.g., Buck 1948) utilizing ocean engineering similar to that for ZI ports. Some past contributions to the "far shore" aspects of amphibious operations (seizure or invasion) will be described, together with some things learned from them, expanding our knowledge of coastal engineering, which subsequently have proved to be useful for military and civilian applications.

(With more than 50 years in the field of coastal engineering I consider operations and construction on the shore, in the surf, and in the nearshore to be a part of it, as well as design and research.)

Amphibious military operations are not new. In his *The Histories*, Herodotus (pp 518-520) describes in detail the construction and use of the floating causeway (or bridge) across the Hellespont (the Dardanelles) by Xerxes in 480 BC, its destruction by a great storm, and its replacement. Alexander also crossed the Hellespont, unopposed, from Sestos to Abydos, in 334 BC, but by ship - using 160 triremes (galley with three banks of oars) and a large number of merchant vessels to transport mounted troops and most of the infantry (*The Campaigns of Alexander* by Arrian, p. 66).

One of the first amphibious operations in America was the 49-day siege of the French Fortress of Louisburg on Cape Breton Island (in what is now Nova Scotia, Canada) in 1745 (Buzzaird 1947). This was a successful joint Anglo-American "large-scale commando scheme," by New England colonists and the British Navy. Richard Gridley was the chief bombardier and captain of artillery, as well as the chief engineer of the operation. What is considered to be the first map made and published in America was Gridley's "Plan of the City and Fortifications of Louisburg" (surveys made in 1745) that shows the harbor (with soundings), some coastal features, the landing site, encampment site, the British Fleet and Transport anchorage, and battery locations installed for the siege. (Gridley became the first chief of engineers of the "Grand Army" in 1775, shortly after George Washington was appointed commander-in-chief.)

Many amphibious operations were made during WW II in North Africa, Italy, France and the Pacific involving Army Engineer Special Brigades, Marine Corps, and Navy Amphibious Forces (e.g., Anon. 1946; Heavey 1946, 1947; Isely and Crowl 1951; Thompson 1997-1998), and some in the Korean War; and there were coastal engineering applications in port construction in Vietnam. Examples are given of the use overseas of coastal engineering in these conflicts; the great variety of site conditions is evident. Operations over beachheads are in shallow water, as are most harbors. Waves are a major factor in the behavior of landing craft, amphibian vehicles, pontoon causeways, pierheads, etc., but at the start of WW II, little was known quantitatively about waves in shallow water. Studies had been made of waves and coastal structures by U.S. Army Corps of Engineers (USACE) personnel in the 1880s, 1890s, and early 1900s. Probably the first book in the United States on waves and their effects on coastal structures was *Wave Action in Relation to Engineering Structures* by Captain D. D. Gaillard, CE (1904). He was interested in measuring wave-induced forces and the characteristics of shallow-water waves, and stated, "As a rule, an engineering structure subject to wave action is exposed only to the attack of shallow water waves; yet strange as it may seem, the number of recorded measurements of waves of this class is insignificant when compared with that of deep-water waves." Yet, there was little known about this at the start of WW II. Then, major advances were made in the combined engineering and science of coastal processes, and in the measurement and understanding of environmental conditions. We learned more about their effects on beaches, structures, and operations. Our analysis capabilities and use of hydraulic models were improved. Most, if not all of the processes are nonlinear, very difficult to analyze, and we still have much to learn. Fortunately, some of the processes could be treated by linearization to obtain useful approximations, but this is not the case for others.

There is now routine use of the coastal engineering and science developed during WW II, and its great expansion since; see *History of Coastal Engineering in the USA* by Wiegel and Saville, Jr. (1996) for details.

Amphibious Operations, WW II

For an "over-the-beach" assault, details must be acquired of coastal type (for world maps delineating coastal type, see McGill 1959; Putnam et al. 1960), beach configuration and morphodynamics (large scale, and small scale such as beach cusps and nearshore runnels) and profiles (subaerial and nearshore - bars and troughs especially - including changes), wave conditions (offshore sea and swell, breakers and surf), tides, beach material, beach trafficability, nearshore and offshore bottom holding capacity for moorings and anchored ships. As some of these are dynamic, forecasts of changes are needed. At the start of WW II, many charts were available to show areas safe for deep sea navigation (e.g., U.S. Navy Hydrographic Office charts and British Admiralty charts), and there were large numbers of maps with details of land topography, but practically nothing of the shore, showing where or how assault troops and supplies could best be landed on hostile shores (National Research Council (NRC), Committee on Amphibious Operations 1951). For example, at the assault landing on Sicily, 10 July

1943: "Buffeted by high winds and high surf, the heavily laden troop and tank craft....only to run aground yards offshore on the gently sloping beaches of the Italian island fortress (Combs 1944)." This was overcome in time by the use of Seabee "pontoon strings."

The types of military intelligence information required for amphibious assaults are listed in a report of the NRC Committee on Amphibious Operations (1951, p. 15) and given herein as Appendix 1. A great amount of information of this type was collected and evaluated by the U.S. Navy Hydrographic Office (Bates and Fleming 1947). Tidal information was available from the U.S. Coast and Geodetic Survey and the British Admiralty. (However, some operations were at places where little information was available, such as Tarawa Atoll, Thompson 1996-1997, p. 16.) To make use of this information, processes must be understood (wave refraction, wave diffraction, wave shoaling, surf beats, wave runup and drawdown on the beach face, wave-induced littoral currents (U.S. Navy, COMINCH, 1945; for some field studies made during WW II, see O'Brien and Johnson 1947). Then this information must be applied to the calculation of wave-induced forces on structures (breakwaters, pontoon causeways (Navy term pontoon; Army term, ponton), docks, landing craft), the generation of littoral currents (alongshore currents and rip currents) and estimates of their effects on equipment (broaching of craft and amphibian vehicles) and sand transport (for example, relationship between bar depths and wave conditions, (Keulegan 1945); estimates of effects of changing bottom bathymetry on minefields, obstacles, pipelines). (For more details, see, e.g., the *Manual on Amphibious Oceanography* (University of California, Berkeley, Institute of Engineering Research 1952).)

Wave conditions at a landing beach are of prime importance, and details of wave climate are essential. Wave forecasting techniques were developed in America and in the United Kingdom and used in planning and in operations (for the American procedure, see U.S. Navy Hydrographic Office 1943, 1944; Seiwell 1947; Bates 1949; Wiegel and Saville, Jr. 1996; Thompson 1996-1997). Military officers were trained in meteorology (aerology - Navy term) at the University of California, Los Angeles, and a few in specialized wave and surf forecasting, a 6-week program at the Scripps Institution of Oceanography of the University of California taught by H.U. Sverdrup and Walter H. Munk (Bates 1949; Thompson 1996-1997). According to Thompson (p. 13):

> "We learned how to forecast the dimensions of waves in the wind area where they are generated, how to forecast the dimensions and arrival time of swell at any location distant from the generating waves, and how to forecast breaker heights in the surf zone after waves have traveled from deep water offshore to the beach. The latter process involved the construction of wave-refraction diagrams that show how wave energy is amplified or diminished along the shore because of the nearshore bottom topography (see Johnson, O'Brien, and Isaacs 1948 - RLW)."

The fact that waves behave differently for various bottom conditions was learned by experience. As an example, Warren Thompson, U.S. Navy beach and wave observer/forecaster, commented (1986-1987,

p. 22) that while on a low altitude reconnaissance flight over Peleliu, Palau Islands, on 13 Sept. 1944, D-2:

> "Almost immediately I made the disconcerting observation that the incoming swell did not behave according to the wave forecasting rules I had been taught, which apply to waves shoaling over a gently sloping sea bottom. Instead, here the waves arrived abruptly at the reef from deep water, broke over the outer margin losing energy in the process, then reformed and traversed the shallow 300-500-yard-wide reef and broke a second time on the beach as smaller and much shorter waves having periods of one or two seconds....I handled this problem by using my forecasted waves only as a rough guide of what to expect, and relied primarily on my visual wave estimates and my judgment of the ability of amphibious vehicles to cross the outer reef margin and transit the reef to the beach."

We are familiar now with the term "significant wave height," and it is related to the variance of wave spectra. Why is it significant, and where and how did it originate? Charles C. Bates (1949, p. 550) states:

> "It was also necessary to determine how the height values extracted from generation graphs might be compared to observation which reported both average and maximum wave heights, particularly since the maximum height reported was often double that of the average height. It appeared that small craft operation was concerned neither with the occasional maximum wave nor with the average value, which is considerably depressed by the many small waves present in a wave train. However, a value half way between the average and maximum height appeared to be highly useful. This value, termed the "Predicted Height," was used for purposes of comparison. The value falls amazingly close the "Significant Wave Height" defined by Sverdrup and Munk about a year later."

A word of advice by BG William F. Heavey, who was Commander of the 2d Engineer Special Brigade during WW II (May 1946):

> "It must be remembered, however, that no two beach operations are ever the same. Tide, surf, enemy opposition, and obstacles vary in every case so that accurate comparisons of any two operations are impracticable."

Although coastal processes are general, their mix and environmental conditions are site specific, and inadequate knowledge of them for a landing beach can result in great difficulties, sometimes disastrous. For example, the commando assault of Dieppe, France, on 18-19 August 1942 (Anon. 1943, p. 136):

> "The fire on the beaches, however, as soon as they set foot on them, proved to be as fierce as ever. Some found cover behind stranded tanks, others in folds of the shingle.... A strong westerly set of the tide had taken more than half of them to the west of the Casino where they eventually got ashore, not on the main beach but on a small stretch of shingle and rock beneath high,

> unscalable cliffs. There they were cut off, for they had no room to deploy.... They eventually surrendered about noon, after more than a hundred had been wounded."

In addition to characteristics, processes, forcings, etc., we need to learn more about the probabilities of occurrences of storms (joint intensity and duration) and the resulting waves and currents - a part of the risk analysis of an operation. Perhaps there is no better example of why than the storm of 19-23 June 1944 along the coast of Normandy, a rare but normal storm (Seiwell (1947) - see Appendix 2 herein); there was great damage to craft and ships, and operations were very difficult. Eisenhower (1948, pp 238 and 261) wrote:

> "Construction of the great artificial harbors engaged the services of thousands of men and added indescribable congestion to already crowded ports and harbors." "The mulberry (an artificial harbor - RLW; see Manning (1944); Jellett (1948)) at Omaha Beach in the American sector suffered damage beyond repair. Great numbers of ships and small vessels were grounded or hurled onto the beach... On the day of the storm's ending I flew from one end of our beach line to the other and counted more than 300 wrecked vessels above small-boat size, some so badly damaged they could not be salvaged.... There was no sight in the war that so impressed me with the industrial might of America as the wreckage on the landing beaches. To any other nation the disaster would have been almost decisive;..."

In his discussion of the Mulberry harbors (Institution of Civil Engineers 1948, p. 443), D.H. Little states:

> "…at the end of that storm Mulberry A (at St. Laurent, "Omaha Beach" - RLW) ...was written off as a complete loss, and 50 percent of Mulberry B (at Arromanches - RLW) was lost..."

Jellett (1948, p. 304): said:

> "The break-up of the St. Laurent harbour in the gale of June 19 to 22 and its subsequent abandonment allowed the concentration of all resources at Arromanches."

More details of this storm and the damage to the harbor components are given in Appendix 2.

The Mulberry harbor was of two parts. The portion closer to shore, in shallower water, had breakwaters consisting of reinforced concrete vertical wall caissons (code name "Phoenix") and sunken ships (referred to as "blockships" by the British). These were towed across the English Channel to the site, positioned, and sunk to the bottom. Inside the sheltered region were pierheads and flexible mile-long pontoon supported flexible bridges (causeways - code name "Whales"). Seaward of these breakwaters were the floating breakwaters ("Barbomdon"), over two miles long, providing a larger area of sheltered space and deeper water (from 7 to 13 fathoms below mean low water springs, with a 24-ft tide range) for deep draft ships.

There was substantial use of coastal engineering in the design of the two Mulberry harbors ("A" at St. Laurent (Omaha Beach) and "B" at Arromanches): wave and tide prediction (the design was for a 24-ft tide range), wave diffraction, wave-induced forces, bottom conditions, placement. Details of design, installation and performance are in the papers and discussions of: *The Civil Engineer in War. A*

Symposium of Papers on War-time Engineering Problems. Volume 2, Docks and Harbours (ICE 1948). Wave diffraction theory to predict wave transmission about a breakwater tip and penetration into the lee of the structure and through breakwater gaps was developed for this project (Lockner et. al. 1948; Penney and Price 1952). Hydraulic model experiments were made in a wave tank to test various concepts of mobile breakwaters (Todd 1948). Todd stated:

> "It was finally decided to adopt a wave-breaker having complete vertical walls without any openings." This "...also greatly simplified the construction work and thereby saved time in building..."

The code name for them was "Phoenix" units. Todd also said that there were very few actual measurements of wave forces or pressures on vertical walls at that time. (I add a comment here. Most breakwaters in the United States are of the rubble-mound type. Probably owing to this, there has not been much work done in the United States in recent years of wave loadings on, and performance of, vertical wall concrete caissons. Most of this type or work has been done in Europe and in Japan, and proceedings from several workshops/conferences are available.)

Several months after the invasion, great amounts of cargo were still being discharged over the Normandy beaches by DUKWs (called "ducks"), operating from cargo ships in open roadsteads and the shore. According to Seiwell (1947):

a. "Wave heights less than 2 feet in the exposed Channel did not affect the normal discharge of cargo."

b. "Wave heights of 3 to 5 ft in the exposed Channel caused a reduction of up to 80 percent in discharged tonnage."

c. "Wave heights in excess of 7 ft caused all DUKW operation to cease."

The relationships between surf heights and daily discharged tonnage at Omaha Beach from 1-28 October 1944 are presented in graphical form by Seiwell.

It was not just in Normandy that storms caused heavy damage during WW II; for example, during the operation which started on 15 September 1944 at Peleliu in the Palau Islands, with their ragged coral reefs. According to Doane (1945):

> "About two weeks after the causeways were installed, a heavy storm broke them apart and scattered them over several miles of the beaches. About 3 weeks later the Seabees started to dredge a channel and small boat harbor with the repaired pontoon causeway forming a bulkhead for the basin. Pontoons were placed along the channel to form a dock, and these were filled with coral to prevent their floating and make a stable dock..." "During the tropical storm of November 6, the pontoons on the east side of the island broached and were broken up, and those on the west side between the unloading dock and the shore were broken apart and spread over a mile of the beach along with dredges and barges. The unloading dock which had been constructed of pontoons filled with coral remained in position through the storm."

A little before the Peleliu operation, there was a major Army assault in the southwest Pacific, of Biak Island, New Guinea on 27 May 1944. I mention this, as (Heavey, July 1945; for more detail see Anon. 1946, pp 86-90) states:

> "The installation of ponton causeways at Biak was the first instance of their use in the Southwest Pacific. As expected they proved very valuable and were slated to be used in many of our subsequent operations. The only difficulty in their use is holding them in place in storms and in cases where lateral currents are strong. Guy lines can hold only so long. Driving pile dolphins seems the best solution but that is difficult to do in the early stages on an operations."

The ponton causeways were launched from an LST.

Post WW II Studies

As a part of the work on amphibious operations/oceanography done at the University of California, Berkeley, during 1946-1952 for the Marine Corps under contract with the Office of Naval Research, I read the operations reports for most of the Marine Corps assaults in the Pacific. Many casualties to landing craft and amphibian vehicles were due to enemy action, but more were caused by waves and currents - capsizing, broaching, getting stuck on bars, filling with water and sand when the ramps were down (e.g., Isely and Crowl 1951, p. 517). (While preparing this, I read of other military operations in which waves caused most of the damage to landing craft. For example, at Port Lyautey, Morocco, on the Atlantic Ocean, on 9 November 1943:

> "In the morning sun all spirits rose. So did the breakers. Soon we could land no more supplies or tanks on the beach because of the high surf. Already scores of our landing craft were broached on the beach." (Henney 1944).

Another example was the landing at Nassau Bay, New Guinea (Heavey, May 1944):

> "...due to the storm, the leading wave of LCVP's hit the beach only to encounter 10 to 12-ft surf, but no (enemy - RLW). It was too much for our boats. Only a few were able to retract before being swamped by the high surf...Twenty-one of our LCVP's were left turned every which way on the beach and pounded into distorted shapes by the heavy seas."

See also, Anon. 1944, pp 39-40.)

Another major problem was vehicles getting stuck in the beach sand because of poor trafficability. Particularly difficult sand was at Iwo Jima, volcanic cinder (Morris 1948). Trafficability tests were made on some U.S. beaches as a part of the UCB IER project (Wiegel 1950). A study was made of trafficability and its relationship to sand characteristics, beach slope, water level, vehicle type for the U.S. Naval Civil Engineering and Evaluation Laboratory (Horonjeff et al. 1953). One observation cited from the earlier UCB IER studies was "...the saturated sand near the water's edge was caused to liquify due to the vibrations produced by vehicular traffic. As a result the vehicles would sink and become stuck." (Trafficability of beaches is mentioned again in the section herein on Vietnam.)

An extensive field study of many of the non-enemy inflicted problems of amphibious operations was a part of the work by UCB/IER. Field observations were made at locations where the beaches/surf were very different: Camp Pendleton, CA; Monterey Bay, CA (Fort Ord/Del Monte); Clatsop Spit, OR (on the south side of the mouth of the Columbia River); Waianae, Oahu, HI. A major part of the studies was to learn about amphibian vehicle performance in high surf, too high to use personnel safely, so a remote control system was developed and used with an LVT. Many technical reports were written, and they were summarized in *Summary Report of Amphibious Studies for the Period 1 Jan. 1949 to 31 Dec. 1950* (Wiegel 1951). As an example, the joint effect of wave steepness and beach slope on breaker type and landing craft/amphibian vehicle performance (Patrick and Wiegel 1955) was found to be very important. (Incidentally, the ratio of these two values was used by Hunt (1959) as a correlation with wave runup on sloping breakwaters, and later extended by others to wave runup on beaches; the ratio is called the Irabarren Number and also the "surf similarity parameter." I believe the use of the ratio rather than the two values separately is not as reliable for correlation.) Others were making observations and developing theories useful for explaining some of the problems; for example, surf beat (e.g., Munk 1949).

Detailed observations were made of several full-scale amphibious assault training exercises, and reports written on the observations and findings. One was Operation MIKI, across three beaches in the Waianae - Pokai Bay coast of Oahu, Hawaii, on 25 October 1949 (Wiegel and Kimberley 1949). There were substantial landing craft casualties on the shore face due to wave action, owing to the combination of long period waves and steep beach face, with waves surging up the beach face. (There was a similar situation on Iwo Jima - Thompson (1977-1978, p. 38).)

(Owing to the problems of moving personnel, equipment, and supplies through the surf and over the beach, major development of helicopters and air cushion vehicles was started after the end of WW II. For some information on air cushion landing craft, see Dukes (1984).)

Amphibious Operations, Republic of Korea (ROK)

An amphibious assault was made at Inchon, Republic of Korea, D-day being 15 September 1950.

> "General MacArthur said ... conception of the Inchon landing would have been impossible without the assurance of success afforded by the use of the Seabee pontoon causeways and piers." (Lovell 1952).

Tides at Inchon have a great range, with an extreme range from approximately -2 ft at low tide to +31 ft at high tide. "At the extreme low tides mud flats are bared for miles out from shore, and the only approach to the port is through a narrow channel at present little over 3 to 6 ft deep at zero tide and correspondingly less at minus tides." (McCollam 1952). Mann (1952) says:

> "Manmade structures in approximately 60 percent of the area surrounding the beach and port area had been destroyed. And worse than that was the 30-ft tide which exists at the harbor. It was the first time many of the engineers had seen a sea of water change so quickly to a sea of mud or vice

versa. Getting onto the beaches required meticulous timing and a slight delay might mean being ignominiously stranded in the mud."

(The south and west coasts of the Republic of Korea have extensive mud flats and hundreds of small conical islands, while the east coast is mostly rocky seacliffs and pocket beaches of sand. At Inch "...tidal flat deposits maintain substantial exposure at least 50 km offshore at low tide." (Wells and Huh 1979).)

The port had a tidal basin and facilities; these were relatively intact at the time of the invasion. The lock gates were demolished during the U.S. evacuation in January 1951, and were rebuilt by the 50th Engineer Port Construction Company upon the return of our forces in Feb. 1951 (Mann 1952; McCollam, Jr. 1952).

Vietnam, Ports

Peter F. Legasse (1979) describes the coastal engineering studies made for, and the construction of, port facilities in Vietnam, including ramps for landing craft and LSTs, by the USACE (18th Engineers Brigade) from mid-1966 to mid-1967 (the U.S. Navy, Officer in Charge of Construction (OICC), was responsible for the deepwater ports at Saigon-Newport and DaNang, and they had studies made for dredging planning for these and seven other sites - see Daniel et al.1966):

> "The Army port construction program included four berths at Qui Nhon, two berths at Vung Ro, ten berths at Cam Ranh, and two berths at Vung Tau, as well as numerous shallow-draft and lighterage facilities.... Detailed port facilities design was accomplished in-house by the port constructions section using baseline data from the earlier OICC studies (References 1-5) and relying heavily on the U.S. Army Coastal Engineering Research Center's (CERC) Technical Report No. 4, *Shore Protection Planning and Design*, (11), as a source of data and techniques currently used in the solution of coastal engineering problems."

Earlier work (1965-1966) was documented by Yens and Clement (1966; 1967).

The key element was the DeLong Corporation fabrication and installation of piers and prefabricated causeway components, and the use of self-elevating work barges. (For some information on possible uses of mobile self-elevating platforms, floating breakwaters, portable reflecting wave barriers, see DeLong Corp. (1959)).

It was emphasized that the sand on many of the Vietnamese beaches was such that "with heavy use becomes almost impassable, severely limiting over-the-shore lighterage operations" (Legasse 1979). In an earlier report (Yens and Clement 1966), attempts of stabilizing the sand were described (rock, concrete articulators, pierced steel planking, and others), with a beneficial life range from a matter of days to two weeks. Also, waves over the foreshore undermined them, and the bearing capacity decreased, resulting in the structures to virtually sink out of site. They learned of WW II experience with coral for stabilizing beaches (e.g., Belmont 1951). They used deposits from underwater, using blasting and draglines for excavation, with the coral being crushed and moved to the landing sites. Yens and Clement (1967) state:

"The foreshore area was excavated to 18 inches and crushed coral was then placed in layers and compacted with rollers, and then the beach was graded to its original alignment. This process gave very satisfactory results and lasted several months with only minor repairs."

The work described by Lagasse (1977) included the installation of the "expeditionary port at Vung Ro to support the major tactical air base at Tuy Hoa." Typhoon and prevailing waves were estimated, and wave refraction studies made. This was used in planning the port layout which "...included LST ramps, a floating pontoon cube barge dock, and a two A barge DeLong pier (600 x 80-feet) with two girder spans off a 120 meter rock fill causeway....Port development also included the installation of tanker mooring facilities and submarine pipeline west of the main port area, and a six inch pipeline running 9.6 kilometers to a...tank farm south of the Tuy Hoa airstrip." It is important to note that their design was based solely on data and techniques contained in the CERC manual, and "seven months after completion these structures survived a typhoon (Nov. 196 6 – Robert L. Weigel (RLW)) which produced wave conditions exceeding the design wave criteria."

Tuy Hoa, about 240 miles north of Saigon on the South China Sea was developed into a major air base in 1966-1967. There were no port facilities nearby, and equipment and supplies were delivered across the beach with amphibious invasion assault methods (using LCMs, LCUs, LARCs and BARCs).

"... with cargo from deep-draft ocean vessels being lightered in barges and landing craft onto the beach adjacent to the construction site. During the monsoons and high seas, the unloading operations were moved 22 miles south to the protected waters of Vung Ro Bay. Then the landing craft and barges made their way up the coast to the mouth of the Song Da Rang River, where an entry channel and turning basing were dredged into a sheltered area behind the sand spit." (Curtin 1977).

I use Tuy Hoa as an example, as I was a consultant at a late stage, after much dredging had been done. It was still under way when I visited the operation on 18 and 19 November 1966 (Wiegel 1966). (The coastal area south of Tuy Hoa and north of Vung Ro was still contested, with a tactical operation planned by the Army to secure it.) The U.S. Air Force wanted the harbor constructed. There is a great amount of sand in this region, delivered to it by rivers. The USACE had made recommendations (e.g., Woodbury, Jr. 1966), based on studies by J.M. Caldwell, R.Y. Hudson, and others of CERC. The site they recommended was several miles south; it also required jetties and dredging of the entrance, but the 3-fathom line was much closer to shore than in the immediate vicinity of the river mouth. A hydraulic model study of the entrance and jetties was done at the U.S. Army Engineer Waterways Experiment Station for the U.S. Navy (Wilson 1966). However, the Air Force was having the dredging done in Song Da Rang Bay. When I was there, the dredging of the harbor was nearly complete, and a partial channel had been dredged through the bay mouth sandbar just south of the natural inlet at the mouth of the Song Da Rang River. One question I was asked was about the possible use of sunken ships as the entrance jetties rather than rubble-mound, owing to the long time required to construct rubble-mound jetties. I

recommended against it, owing in part to what had happened to the "sunken ship breakwater" at Omaha Beach in Normandy during WW II, and the likelihood of there being typhoon-generated waves at the site in the future; they accepted this recommendation. I also recommended that after jetties had been built, the main gap between the north and west islands (which consisted of dredged material) be filled so the river would no longer flow through the harbor. I also mentioned the general observation of J.H. Douma (1955, p. 5) about tidal entrances where there is much sand:

> "A channel that remains open during normal conditions may be virtually filled during a single severe storm or freshet with suspended of bed-load material carried by the high velocities."

The need for jetties and the great amount of dredging required resulted in the decision:

> "After several months of pilot channel dredging it was conceded by the contractor that installation of a facility (i.e., harbor/port - RLW) at this location was clearly impractical." (Lagasse 1977).

Appendix 1. Military Intelligence Information (NRC:COA, 1951)

"(a) Hydrography, with special emphasis on surf and swell conditions, tides, currents, depths of water, water temperature, and salinity.
(b) Weather with relation to temperature, rainfall, force and direction of wind, frequency of storms, visibility, flying conditions, special phenomena, astronomical data, daylight and dark tables, and sunrise and moonrise tables.
(c) Beaches, with reference to their location, length, width, physical consistency, navigational landmarks, offshore approaches, gradient, nature of bottom reefs, rock shoals, and other possible hazards.
(d) Terrain, especially that immediately adjacent to and behind the landing beaches, with reference to approaches, observation posts, fields of fire, obstacles, cover and concealment, and roads from portions of shoreline on which landings seem practicable to logical objectives inland.
(e) Enemy defenses, .."

Appendix 2. Normandy, Mulberry Harbors, WW II, Storm of 19-23 June 1944

Manning (1944) states:

> "At this time, the artificial harbor was approximately 85 percent completed, and each unit of the artificial harbor (that is, pierheads, bridging, causeways and Rhino's) were actually operating satisfactory....The fury of the storm was sufficient either to sink or tear loose from their mooring all the cruciform units ("Bombardon floating breakwater" - RLW) in the outer floating breakwater, setting many of them adrift and adding still more to existing hazards... Several units of the reinforced concrete caisson breakwater which were topped by the waves, succumbed to the incessant battering and collisions with floating objects and craft, and were damaged to the extent that some were destroyed almost to low-water and consequently rendered ineffective as a breakwater..." "...the sunken ship breakwater, likewise, was damaged. Practically all vessels, including the British battleship, broke their backs....The damage to the artificial harbor installation at the British beach several miles to the eastward (Mulberry "B" - RLW) of the American beaches, while serious was not as extensive as the damage to the American harbor (Mulberry "A" - RLW).... Each harbor utilized units of the same design and manufacture, and therefor the variation in degree of damage must be traced to other causes. These causes, undoubtedly, were: (a) the fact that the British beaches, being located so far to the eastward from the American beaches, are in the lee of the Fecamp coast line; (b) to the north and eastward of the British artificial harbor, is located the extensive area of shoal water (the Calvados shoal; discussion by Jellett, ICE 1948, p. 333 - RLW) caused by the Calvados Rock which provide, to a certain degree, the advantages of a protected harbor;..."

Seiwell (1947, p. 206) states:

> "Thus, wave heights as occurred during June 1944 in the English Channel were not unique, and had been recorded for this same season of other years. Information of this kind was summarized and disseminated in a report on the Military Oceanography of the Channel Coast of France, by the Army Air Forces Oceanographic Section, in 1942 and 1943[4]. In this paper it was shown that in the area, of what later became the American and British invasion beaches, between Le Harve and Cherbourg, wave heights in excess of 8 feet had an occurrence expectancy of approximately 5 percent during the month of June. Thus, while seas of this magnitude are not the usual rule for June, the probability of occurrence was sufficiently high to have been considered in the design of a project as momentous as the Normandy artificial harbors, if the designers had been cognizant of the situation. The resulting destruction, and consequent cost in human life and equipment is but one of the instances where inclusion of relevant oceanographic data into an operational plan would have been a means of lessening, if not avoiding, a disaster."

References

Anon., *Combined Operations. The Official Story of the Commandos*, The MacMillan Co., New York, NY, 1943, 155 pp.

Anon., *History of the 2d Engineer Special Brigade, 1942-1945*, Studies in Military Engineering Number 2, USACE Office of History, Fort Belvoir, VA, printed by The Telegraph Press, 1946, 278 pp.

Arrian (Lucius Flavius Arrianus), *The Campaigns of Alexander*, written circa 138- AD, translated by Aubrey de Selincourt, revised by J.R. Hamilton, Penguin Books, 1958, revised 1971, 430 pp.

Bates, Charles C. and Richard H. Fleming, "Oceanography in the Hydrographic Office," *The Military Engineer*, 39 (262), Aug. 1947, 338-344.

Bates, Charles C., "Utilization of Wave Forecasting in the Invasions of Normandy, Burma, and Japan," *Annals of the New York Academy of Sciences*, 51 (Art. 3), May 1949, 545-572.

Belmont, Richard L., "Coral for Construction," *The Military Engineer*, 43 (292), March-April 1951, 126-131.

Bretz, Glenwood, "Development of Deployable Ports May Prove Vital to U.S. Navy," *Sea Technology*, 29 (9), Sept. 1988, 12-18.

Buck, Douglas Victor, "Notes on Military Dredging Activities, 1939-1945," *The Civil Engineer in War. A Symposium of Papers on War-time Engineering Problems. Volume 2, Docks and Harbours*, The Institution of Civil Engineers, London, U.K., 1948, 78-90.

Buzzaird, Raleigh B., "America's First Chief Engineer," *The Military Engineer*, 39 (266), Dec. 1947, 505-510 and frontispiece.

Combs, Rear Admiral Lewis B., "Innovation of Amphibious Warfare," *The Military Engineer*, 36 (220), Feb. 1944, 44-47.

Curtin, Maj. Gen. Robert H., "Turn Key Project at Tuy Hoa," *The Military Engineer*, 59 (389), May-June 1967, 162-163.

Daniel, Mann, Johnson, & Mendenhall, *Oceanographic & Engineering Report on Investigation of Sedimentation, Silting & Dredging Requirements. Various Locations, Republic of Vietnam*, for the U.S. Navy, OICC Naval Facilities Engineering Command, Contract NBy-79844, 30 June 1966, various pagination.

DeLong Corporation, *Mobile Self-elevating Platform with Breakwater Used to Form a Multi-purpose Harbor Unit: A Feasibility Study*, for U.S. Naval Civil Engineering Laboratory, Port Hueneme, CA (Contract NBy-3153), Nov. 1959, 77 pp.

Doane, Kendric Pike, "Harbor Construction at Peleliu," *The Military Engineer*, 37 (240), Oct. 1945, 414-418.

Douma, J.H., Engineering Problems in U.S. Tidal Waterways," *Proc. ASCE, Hydraulics Div*., 81 (Paper No. 789), Sept. 1955, 22 pp.

Dukes, Wilfred H., "Air Cushion Landing Craft - Structural Design Approach" and discussions, *The Role of Design, Inspection, and Redundancy in Marine Structural Reliability. Proc. of an International Symposium, Nov. 14-16, 1983*, Marine Board, National Research Council, National Academy Press, 1984, 446-470.

Eisenhower, Dwight D., *Crusade in Europe*, Double Day & Co., Inc., 1948, 559 pp.

Gaillard, D.D., *Wave Action in Relation to Engineering Structures*, 1904 (reprinted in 1935), the Engineer School, Fort Belvoir, VA, 218 pp.

Heavey, Brig. Gen. William F., "Amphibian Engineers in Action. Operations in the Southwest Pacific Area," *The Military Engineer*, 36 (223), May 1944, 145-152.

Heavey, Brig. Gen. William F., "Amphibian Engineers in Action. Part II. On to Corregidor," *The Military Engineer*, 37 (237), July 1945, 253-262 and frontispiece.

Heavey, Brig. Gen. William F., " 'Down Ramp'. Story of the Army Amphibian Engineers in World War II," a series in *The Military Engineer*, May 1946, June 1946, July 1946, Aug. 1946, Sept. 1946, Oct. 1946, Nov. 1946, Dec. 1946, Jan. 1947,

Henney, Lt. Col. Frederic A., "Combat Engineers in North Africa. Part 1. The Capture of Port Lyautey," *The Military Engineer*, 36 (219), Jan. 1944, 1-4 and frontispiece.

Herodotus, *The Histories*, written in the middle of the 5th century BC, translation by George Rawlinson and introduction by Hugh Bowden, J.M. Dent & Sons Ltd., London, 1992, 748 pp.

Horonjeff, R., H.B. Seed, C.J. Van Til, R.L. Wiegel, P.D. Trask, *A Review and Evaluation of Research Related to Trafficability of Beaches*, for U.S. Naval Civil Engineering Research and Evaluation Laboratory, University of California at Berkeley, IER Research Report Series 59, Issue 1, July 1953, 78 pp.

Hunt, Ira A., Jr., "Design of Seawalls and Breakwaters," *Jour. Waterways and Harbors Div., Proc. ASCE*, 85 (WW3), Sept. 1959, 123-151.

The Institution of Civil Engineers, *The Civil Engineer in War. A Symposium of Papers on War-time Engineering Problems. Vol. 2: Docks and Harbours*, papers and discussions, published by The Institution of Civil Engineers, London, U.K., 1948, 450 pp.

Isely, Jeter A. and Philip A. Crowl, *The U.S. Marines and Amphibious War: Its Theory, and Its Practice in the Pacific*, Princeton University Press, 1951, 636 pp.

Jellett, John Holmes, "The Lay-out, Assembly, and Behaviour of the Breakwaters at Arromanches Harbour (Mulberry 'B')," *The Civil Engineer in War. A Symposium of Papers on War-time Engineering Problems. Vol. 2, Docks and Harbours*, The Institution of Civil Engineers, London, U.K., 1948, 291-312.

Johnson, J.W., M.P. O'Brien and J.D. Isaacs, *Graphical Construction of Wave Refraction Diagrams*, USN Hydrographic Office, H.O. Pub. No. 605, 1948, 45 pp.

Keulegan, G.H., *Depths of Offshore Bars*, USACE, BEB, TM 8, 1945.

Lagasse, Peter F., "Design, Construction, and Performance of Deep-Draft Port Facilities, Vietnam 1966-67," *Coastal Structures 79, March 14-16, 1979, Alexandria, Virginia*, ASCE, 505-536.

Lockner, Robert, Oscar Faber, and William G. Penney, "The 'Bombardon' Floating Breakwater," *The Civil Engineer in War. A Symposium of Papers on War-time Engineering Problems. Vol. 2, Docks and Harbours*, The Institution of Civil Engineers, London, U.K., 1948, 256-290.

Lovell, Kenneth C., "Navy Engineer Support in Korea," *The Military Engineer*, 44 (302), Nov.-Dec. 1952, 413-417.

Mann, Frank L., "Operation Versatile, Korean Saga of the 2d Engineer Special Brigade," *The Military Engineer*, 44 (299), May-June 1952, 168-173.

Manning, Rear Admiral John J., "Normandy's Artificial Harbors," *The Military Engineer*, 36 (230), Dec. 1944, 389-394.

McCollam, William, Jr., "Raising the Tidal Basin Lock Gates at Inchon, Korea," *The Military Engineer*, 44 (298), March-April 1952, 96-101.

McGill, John T., "Coastal Classification Maps: A Review," *2nd Coastal Geography Conference, Coastal Studies Institute*, Louisiana State Univ., April 1959, pp 1-22, with a color map "Coastal Landforms of the World," 35 in. by 57 in., scale 1:25,000,000 insert.

Morris, Col. D.A., "Engineer Operations on Iwo Jima," *The Military Engineer*, 40 (271), May 1948, 199-203 and frontispiece.

Munk, W.H., "Surf Beats," *Trans Amer. Geophys. Union*, 30 (6), Dec. 1949, 849-854.

National Research Council, Committee on Amphibious Operations, *Amphibious Operations: Synopsis*, NRC Rept. Serial No. NRC:CAO:0002, Jan. 1951, 59 pp.

O'Brien, M.P. and J.W. Johnson, "Wartime Research on Waves and Surf," *The Military Engineer*, 39 (260), June 1947, 239-242 and frontispiece.

Patrick, D.A. and R.L. Wiegel, "Amphibian Tractors in the Surf," *Proc. First Conf. on Ships and Waves*, The Engrg. Foundation, Council on Wave Research and Amer. Soc. Naval Architects and Marine Engineers, 1955, 197-422.

Penney, W.G. and A.T. Price, "Diffraction of Sea Waves by Breakwaters and Shelter Afforded by Breakwaters," *Phil. Trans. Roy. Soc. (A)*, 244 (882), 1952, 236-253.

Putnam, William C., Daniel I. Axelrod, Harry P. Bailey, John T. McGill, *Natural Coastal Environments of the World*, prepared under contract between the Office of Naval Research and the University of California at Los Angeles, 1960, 140 pp, many aerial photos, and 3 insert maps.

Seiwell, Lt. Col. H.R., "Military Oceanography in World War II," *The Military Engineer*, 39 (259), May 1947, 202-210.

Thompson, Warren C., *With the Amphibious Forces in the Western Pacific and Other Experiences During the War Years 1939-1946; Autobiographical Memoir*, 1996-1997, m.s., 72 pp, enclosures, photos, appendix.

Todd, F.H., "Model-Experiments on Different Designs of Breakwaters," *The Civil Engineer in War. A Symposium of Papers on War-time Engineering Problems. Vol. 2, Docks and Harbours*, The Institution of Civil Engineers, London, U.K., 243-255.

U.S. Army Corps of Engineers, Coastal Engineering Research Center, *Shore Protection Planning and Design*, Tech. Rept. No. 4, 3rd Ed., 1966, various pagination.

U.S. Navy, Hydrographic Office, *Wind Waves and Swell: Principles in Forecasting*, H.O. Misc. 11,275, March 1943, 61 pp.

U.S. Navy, Hydrographic Office, *Breakers and Surf: Principles in Forecasting*, H.O. Pub. No. 275, Nov. 1944, 52 pp and plates.

U.S. Navy, U.S. Fleet, Headquarters of the Commander in Chief, *Surf Manual for Amphibious Operations*, COMINCH P-9, 8 Oct. 1945, 46 pp.

University of California, Berkeley, Institute of Engineering Research, *Manual on Amphibious Oceanography*, R. L. Wiegel Project Engineer and Editor, under contract with Office of Naval Research, Amphibious Branch, Contract N7-29535, Project No. NR 252-003, Pentagon Press, July 1952, 2 volumes, 1750 pp.

Wells, John T. and Oscar K. Huh, "Tidal Flat Muds in the Republic of Korea: Chinhae to Inchon," *Scientific Bulletin*, Dept. of the Navy, Office of Naval Research Tokyo, 4(4), Oct. to Dec. 1979, 21-30.

Wiegel, Robert L. and H.L. Kimberley, *Operation MIKI, Hawaiian Amphibious Phase (Ground Coverage)*, Univ. of Calif., Berkeley, Inst. Engrg. Res., Series 29, Issue 14, 25 Oct. 1949, 18 pp and 37 figs.; many photos.

Wiegel, Robert L., *Trafficability Studies of Selected Beaches on the Pacific Coast of the United States and Oahu, T.H.*, Univ. of Calif., Berkeley, Inst. Engrg. Res., Series 29, Issue 30, Sept. 1950, 14 pp, numerous photos, figs.

Wiegel, Robert L. (project engineer and editor), *Summary Report of Amphibious Studies for the Period 1 January 1949 to 31 Dec. 31, 1950*, Univ. of Calif., Berkeley, College of Engrg., for U.S> Marine Corps, ONR Contract N7onr 29529, Tech. Rept. HE-155-45, Feb. 1951, 232 pp.

Wiegel, Robert L., *Harbor Design, Tuy Hoa, Viet Nam*, consulting report to Walter Kidde Construction, Inc., for the U.S. Air Force 5 Dec. 1966, 19 pp. figures, appendices.

Wiegel, Robert L. and Thorndike Saville, Jr., "History of Coastal Engineering in the USA," *History and Heritage of Coastal Engineering*, ed. by Nicholas C. Kraus, ASCE, 1996, pp 513-600.

Wood, Cyril Raymond James, " 'Phoenix'," *The Civil Engineer in War. A Symposium of Papers on War-time Engineering Problems. Vol. 2: Docks and Harbours*, The Institution of Civil Engineers, London, U.K., 1948, pp 336-368.

Woodbury, Brig. Gen. H.G. Jr., *Harbor Dredging, Tuy Hoa*, Letter to Mr. James Bush, MRK-BRJ, Saigon, from Acting Director of Civil Works, USACE, 18 May 1966, 5 pp.

Yens, David P., 1LT, CE and John P. Clement, III, CPT, CE, *U.S. Army Port Construction in Vietnam, 1965-1966*, 15 pp, photos, maps and charts (enclosures), internal rept., 18th Engineer Brigade, 1966. Also, "Port Construction in Vietnam," *The Military Engineer*, 59 (387), Jan.-Feb. 1967, 20-24.

Discussion

Dr. Edge recommended that Professor Wiegel submit his report to either the *Waterways Journal* or *Shore and Beach*.

Rapidly Installed Breakwater System/ Logistics-Over-the-Shore

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Coastal and Hydraulics Laboratory
U.S. Army Engineer Waterways Experiment Station
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The capability to project and sustain military forces worldwide is basic to U.S. strategic mobility objectives. This requires the ability to conduct Single Service and Joint Logistics-Over-the-Shore (LOTS/JLOTS). In spite of a Department of Defense requirement that LOTS operations be viable through sea state 3 (significant wave heights up to 5 ft), past and recent exercises (LOTS I, 1977; JLOTS II, 1983-1984; and JLOTS III, 1993) have shown that actual operations begin to experience significant difficulties even at the upper range of sea state 2 and are totally shut down by sea state 3 conditions. Failure to meet this performance standard is currently viewed as a potential "war stopper" for U.S. military forces; consequently, a large, joint effort is now under way to solve the "Sea-State 3 Problem."

The U.S. Army Engineer Waterways Experiment Station's (WES) Coastal and Hydraulics Laboratory presently has a number of ongoing efforts, which are related to the Sea-State 3 Problem. Under the U.S. Army Corps of Engineers Military Engineering Research, Development, Test, and Evaluation (RDT&E) Program (6.2 funding), the following LOTS related efforts are under way:

a. Coastal Integrated Throughput Model (CITM) - This is a time-stepping, constructive simulation model that is linked to WES's across-the-shore and inland mobility models. It is being incorporated into the Military Traffic Management Command's (MTMC) force projection models and is expected to play an important role in course-of-action analyses and LOTS decision-making.

b. Global Littoral Information System - This work will provide the framework to develop the complete set of coastal databases needed for modeling systems and prudent operations in all areas of interest.

c. Nearshore Rapidly Installed Breakwater System (NRIBS) - The NRIBS will be the shallow-water counterpart to the RIBS currently being developed. After completion of its concept formulation under RDT&E funding, it is expected to transition to 6.3 funding and acquisition.

Under funding from an Advanced Technology Demonstration and the Office of the Deputy Chief of Staff for Operations, the Rapidly Installed Breakwater System (RIBS) work element is under way. The

RIBS is a floating breakwater concept that has just moved into the 6.3 development phase. It is a proven concept that will reduce wave heights for offshore ship discharge by 50 percent. This will reduce all sea state 3 conditions to the mid-range of sea state 2 and below for the sheltered area in the lee of the RIBS. An ocean-scale experimental model will be tested in the Atlantic Ocean near Cape Canaveral during 17-31 May of this year.

Discussion

Mr. Jarrett asked what is the sea state to deploy the breakwater? *Dr. Resio* said it is being designed to be able to be deployed in waves of 3-5 ft at sea state 2 or 3.

Dr. Dean thought the breakwater was originally to be in a collapsed form. *Dr. Resio* stated that since we have our own barge, the advantage of a collapsible form vanishes. It will be continuous, and is all cabled so everything comes together. It will not fold in the vertical, but horizontal. Once it is pulled from the ship, it unfolds in a long, linear form, and the mooring is already in place.

Operations and Research Needs

RADM Kenneth E. Barbor
Naval Meteorology and Atmospheric Command
Stennis Space Center, MS

Understanding the oceans is fundamental to our economic and military security, and the Navy should be a primary force in focusing on ocean policy, both nationally and internationally.

The mission of the Naval Meteorology and Atmospheric Command is global in concept and operational, so there are no funds to identify research and development needs. There are three disciplines that the Naval Meteorology and Atmospheric Command specialize.

a. Oceanography – Needed for amphibious operations, mine warfare, and antisubmarine warfare.

b. Meteorology - Safety of flight and proper routing of ships.

c. Department of Defense (DoD) numerical weather prediction activity.

Three mission areas are:

a. Fleet safety - navigational and meteorological.

b. Optimum deployment of sensors – use of geomorphology of the bottom, the water column characteristics, and sea surface.

c. Assessment and assistance in developing new systems. Two purposes are to help those system developers to understand what the environmental impact will be and to help us understand what sort of data is needed to collect to support those systems once they become operational.

I run a fleet of eight state-of-the-art oceanographic collection ships doing military survey. That military survey enables us to operate in other countries' EEZs without permission. Two coastal survey ships are operating in littoral waters of other countries at their request, sharing the data, getting it into our databases. The ships are deployed around the world and are continually collecting data. Methods for collecting data include:

a. Roll-on, roll-off equipment that can image the bottom acoustically, electromagnetically, with video capabilities.

b. Civilian and military satellites.

c. Wave buoys.

d. Airborne laser bathymetry.

e. Hydrographic survey launches.

Research and development issues are:

a. Tactical capability to access denied areas.

b. UUVs to multiply ability to collect information.

c. 4-D assimilation.

d. Enhancement of COAMPS, a coupled air/ocean model with a feedback both from heat flux out of the ocean into the atmosphere, and then, turned around, wind pressure on the sea surface to generate the wave models that are going to be necessary.

The Naval Meteorology and Oceanography Command has a supercomputer , which is part of the major shared resource centers of the DoD. It is focused on meteorology, oceanography, and computational fluid dynamics, and is there for all DoD research people to use.

In summary, data are collected, assimilated, and then atmospheric products, models, and databases are generated. We do all the databases for bathymetry, waves, and currents. We then have to get these products to the user in a fashion they can use, and we need to work on technology insertions that capitalize on our visualization techniques. The bottom line is to get that tactical support out to the warfighter – pick the right platform, weapons, settings, area, tactics, and time to maximize combat effectiveness.

Discussion

COL(P) Madsen asked how big an effort is it going to take to get the sense of data that we need to really operate around the shoreline of nontraditional places where we don't do very good mapping of land? *RADM Barbor* stated that a congressional study was done in 1996. He said that he figured we had 340 shipyears of data that were necessary to collect. With the use of satellites and lasers, where applicable, multiplying our eight ships with the use of autonomous vehicles, we have had many successes, but there are some areas we cannot get into. When the Iron Curtain came down, one of the survey ships surveyed an Albanian port, and we have a number of areas where the commanders in chiefs have issued priorities, and we do everything possible to respond to their highest priorities.

COL(P) Madsen asked if they get fair funding and direction on specific sites. *RADM Barbor* answered yes.

Dr. Edge stated that in other speakers' presentations that there is a lot of movement along the bottom, the bars come and go. He asked if there were any plans to resurvey some areas? *RADM Barbor* said they calculate a revisit seasonally.

Strategy in the Asia-Pacific Region

MAJ Jeffrey S. Lavallee
J-5, Strategic Planning and Policy Directorate of Pacific Command
Camp Smith, HI

The Asia-Pacific region contains nearly 70 percent of the world's population, 43 countries and the world's 6 largest armed forces. If you traverse the distance from 17 deg E to 90 deg W, you cross 16 times zones. Our area of responsibility covers over half the earth's surface.

The aggregate size of the Asia-Pacific economies has outpaced the individual economies of the United States and the European Union since the late 1980s and indicates their growing importance to the world economy over the next decade. The 1997 plunge in East Asian currency and stock markets has dampened short-term growth prospects for many of the region's economies. Asia's widespread economic decline is partially offset by China's estimated growth. Given institutional reforms, growth will moderate and, in the long run, will continue, although predicting the timing of recovery is uncertain.

The dollar value of U.S. trade with the nations of the Pacific has been greater than our trade with the European Union for the past 20 years. U.S. trade with the Asia-Pacific region is greater than our trade with either our North American or our South American neighbors. In 1997, U.S. merchandise trade with the Asia-Pacific region rose by $35 billion to $548 billion, which represents 35 percent of U.S. trade. However, in the first eight months of 1998, data indicate that trade with Asia declined about $25 billion, or 2 percent, due to the Asian recession.

U.S. direct investments in Asia have quadrupled since 1987. These long-term direct investments continue to be held by U.S. companies despite the flight of short-term capital symptomatic of the current economic crisis. The high volume of trade and U.S. trade and investment in the region indicate the importance of the region to the U.S. economy.

The Asia-Pacific, perhaps more than any other region, is characterized by a confluence of the diplomatic, economic, and military elements. The security and stability of the region are key factors for prosperity for both the United States and the other nations of the region. The economic linkage means that events that occur in this region affect the people of the United States.

We must balance the confluence of military with diplomatic and economic elements of national power to protect and promote U.S. interests and regional security. Security is the linchpin for creating and maintaining the stable conditions that permit economic growth. Despite the continuing economic crisis, the size and strength of the economies of the Asia-Pacific region remain a key factor in the world economic outlook. The important point we are making is that America's economic future and our political interests are tied to the Asia-Pacific region.

To meet the challenges and opportunities of this era, the United States has adopted a National Security Strategy focusing on the next century. We derive our National Military Strategy from our National Security Strategy. Our National Military Strategy describes the critical role that our armed forces will play in helping to achieve our nation's objectives. The National Military Strategy of shaping, responding and preparing now addresses today's challenges and opportunities before us as well as those that await us as we approach the next century. Working with our allies, partners and friends, we will promote peace in an increasingly complex and potentially more dangerous world. From our National Security and National Military Strategies logically flow the four security priorities for the Pacific outlined by President Bill Clinton. He spoke of a new Pacific community and identified the continued American military presence as the bedrock of America's security role in the Asia- Pacific region. He promised stronger efforts to combat the proliferation of weapons of mass destruction and underscored America's willingness to promote and participate in new regional security dialogs.

The President also endorsed America's support for democracy and more open societies. The President reaffirmed his July 1993 commitment to the region in 1996 during a visit to Australia and again in 1998 during his visit to Japan and Korea.

In 1998, the Department of Defense published its security strategy for the East Asia-Pacific region, which reinforces these priorities. The reports states, "We support our commitments in East Asia. We will maintain a forward-deployed force structure that requires approximately 100,000 military personnel."

Admiral Blair, Commander-In-Chief Pacific (CINCPAC), receives his strategic guidance from the national command authorities, that is, the President of the United States and the Secretary of Defense. Each of the services provides him with the ground, sea, air, and amphibious military forces he needs to execute that policy. Under normal conditions, the CINC communicates with the Secretary of Defense via the Chairman of the Joint Chiefs of Staff.

The Pacific Command (PACOM) Mission Statement is rooted in the National Security Strategy, National Military Strategy, the Joint Strategic Capabilities Plan and the Unified Command Plan. Our mission articulates in broad terms who we are, what we do, our regional area of responsibility, and why we exist as a command.

Our vision statement goes hand-in-hand with our mission and gives us direction as well as declares what we desire for the future state of our command. From our mission and vision statements, we derive our Pacific Command strategy. The objectives for our Pacific Command strategy range from maintaining peace and security, to addressing the dangers posed by weapons of mass destruction, to preventing the emergence of a regional hegemony, to enhancing interoperability with our friends and allies and promoting democracy and the Rule of Law.

The Pacific Command strategy employs limited resources throughout the theater to achieve our strategic objectives and advance security and stability. We do this through our overseas presence, strong alliances and by having a robust crisis-response capability. Through these ways, we participate in developing the future of the Asia-Pacific region.

During peacetime, our goal is to be actively involved in working with our friends and allies. We want to be partners in the development of a peaceful Pacific region by promoting cooperation on a daily basis. During crisis, we want to be able to act promptly and decisively both to deter hostilities and to protect U.S. citizens and interests. And, in conflict, we want swift victory, multilaterally if possible, but unilaterally if necessary.

We implement our Pacific Command strategy with a balance of forces throughout the theater. This balance of forces is provided by our component commanders representing the four services and our subunified commanders. The headquarters of the four component commanders, U.S. Army Pacific (USAPAC) Pacific Air Forces, Pacific Fleet, and Marine Forces Pacific, are located in Oahu. The headquarters of our subunified commanders are located across the Pacific Command's area of responsibility. The Commander, U.S. Forces Korea, is in Seoul, Korea; the Commander, U.S. Forces Japan, is at Yokota Air Base, Japan; the Commander, Special Command, is in Oahu; and the Commander, Alaskan Command, is at Elmendorf Air Force Base.

The Commanding General, USAPAC, provides Headquarters 1st Corps and an infantry division and a separate infantry brigade. The USAPAC forces support PACOM's wartime mission and contribute to the continued security and stability of the Asia-Pacific from bases in Hawaii, Alaska, Japan, Guam, and Johnston Island.

The Commander, Pacific Air Forces, provides 25 fighter squadrons and several refueling and airlift squadrons. From air superiority to long-range day or night weapons delivery to close air support from air refueling, Pacific Air Forces can respond to any contingency from full-scale combat operations to humanitarian relief.

The Commander-in-Chief, Pacific Fleet, provides the world's largest naval command. It includes over half of the U.S. Navy's total strength consisting of aircraft carries and their associated battle groups, submarines, and numerous patrol aircraft. The Pacific Fleet is tasked with protecting the sea-lanes that link the United States with the Asian and Pacific nations. It projects a stabilizing influence overseas and supports allied forces ashore.

The Commander, Marine Forces Pacific (MARFORPAC), provides the 1st and 3rd Marine Expeditionary Force, comprising almost one half of the total U.S. Marine Corps strength. The maritime geography of the region highlights the need for an amphibious force capable of keeping the sea-lanes open and maintaining regional security. Using a Marine air/ground task force tailored to fit the mission,

MARFORPAC provides the unique capability to project power from the sea and gives PACOM maximum flexibility in firepower.

PACOM forces also include our four subunified commands. U.S. Forces Korea is a joint headquarters composed of over 35,000 military personnel with elements including the 8th U.S. Army and the 7th U.S. Air Force. U.S. Forces Korea reflects the mutual commitment of the Republic of Korea and the United States to maintain peace and security on the Korean peninsula.

U.S. Forces Japan pursues bilateral defense cooperation with the government of Japan under the terms of the U.S./Japan Treaty of Mutual Cooperation and Security.

Special Operations Command Pacific (SOCPAC) consists of Army, Navy, and Air Force forward-deployed special operations forces. SOCPAC's principal missions include unconventional warfare and special reconnaissance.

The Alaskan Command has operational command of U.S. Air Forces Alaska, U.S. Army Alaska, and U.S. Naval Forces Alaska totaling over 21,000 military personnel. These Pacific forces consist of forward-deployed, forward-based elements and forces based in the continental United States. Our overseas-deployed forces consist of forward-stationed forces located primarily in the Republic of Korea and Japan along with maritime forces continuously afloat in the Western Pacific. We also rotationally deploy units overseas such as Marines to Okinawa, Air Force squadrons to Singapore, and Navy patrol aircraft to Japan. The total overseas-deployed force is about 100,000 military personnel.

Pacific Command also has forces forward-based in Hawaii and Alaska, as well as afloat from the Eastern Pacific naval forces. Finally, PACOM can also call on forces in the continental United States. These forces are an integral part of Pacific Command.

The total of all of Pacific Command's forces is about 300,000 military personnel. This is the largest number of U.S. military personnel dedicated to any region or theater. These specific forces, along with our friends and allies, will continue to promote regional stability and progress in the Pacific theater through our PACOM strategy. However, because the nations that make up the region are so diverse, this requires a tailored approach.

The nations of the region differ greatly among themselves. They all have widely varying cultures, different political systems, different military capabilities and, most significant, different perceptions of the threats to their national interests. Because of this difference in threat perception, many nations view us as an honest broker among the Asia- Pacific nations and value our presence in the region. That is why we consider it important that PACOM pays attention to each individual country and works hard at nurturing bilateral relationships.

For some, these bilateral relationships produce a regional network, which advances Asia-Pacific security, stability, prosperity, and partnership. This network of bilateral security relationships also promotes multilateral discussion and initiatives.

In peacetime, our day-to-day activities help strengthen our bilateral relationships with nations in the region. The methods we use focus on the traditional employment of military forces and go far beyond traditional military activities.

PACOM's engagement strategy has many facets and ranges from permanently stationed forces to security assistance to international conferences to high-level meetings. A primary resource we have is our extensive theater-engagement program.

In the last fiscal year, Pacific Command conducted more than 1,600 engagement activities including 223 exercises and over 1,300 military to- military training events. These exercises in military interaction range from large combined and joint exercises like Cobra Gold in Thailand to more modest Air Force exercises between Pacific Air Forces and the Republic of Korea Air Force to the multilateral Rim of the Pacific (RIMPAC), naval exercise. Six nations, including Canada and Chile, participate in RIMPAC, providing the broadest multilateral participation of any exercise in Pacific Command.

Add to it a U.S. Army engineering exercise that included helping local workers to construct a new schoolhouse in Tonga. U.S. Navy ships routinely conduct visits to over 20 countries in the Pacific each year. During the last fiscal year, our Navy had over 655 port visits.

Our day-to-day activities are extensive and varied. Whether we are talking about our assistance to the Indonesian government with fire-fighting operations, or Special Operations units in Laos providing humanitarian de-mining assistance, or members of Joint Task Force Full Accounting conducting remains recovery operations in Vietnam, Laos, or Cambodia, or one of our multilateral conferences, or one of our 244 senior military officer or defense officials visits, or one of our 32 humanitarian and civic- assistance projects in such countries as Bangladesh, Fiji, and Laos, our shared activities shape the region's security posture.

The range of our engagement varies for each country, but our goal is the same, to encourage a maximum contribution to Asia-Pacific security and stability. The most fundamental contribution the nation can make to Asia-Pacific security is to have a credible self-defense capability. Beyond that, the contribution most favorable from our point of view comes from a country's ability and willingness to contribute to regional security.

Additionally, countries that employ equipment compatible with ours enhance our ability to perform this security role. Not all states in the region hold this view. However, with our present posture in the region, we are confident that together with our friends we can counter any threat to our mutual interests.

Shared concerns in the region span from regional conflict on the Korean peninsula to the proliferation of weapons of mass destruction to environmental issues. The current Asian economic crisis demonstrates that global economic interdependence requires ongoing cooperation to maintain security in the region. Certainly the transnational dangers such as terrorism and drug trafficking are also a major concern. In addressing these concerns, we ultimately want to prevent instability.

Elsewhere throughout the region, when the need arises, we follow a different approach. In a crisis, USCINCPAC establishes a direct command-and-control relationship with a designated joint-task-force commander who is on the scene. A structure such as this streamlines command and control and maximizes our response capabilities.

We also hope for greater multilateral cooperation in dealing with security problems in the future and would adjust our approach accordingly for a coalition effort. The success of United Nations actions in the Persian Gulf highlighted the importance of building coalitions.

Several of our Commanders' existing operational headquarters are designated and trained to serve as combined joint-task-force headquarters. Recently, the 13th Air Force on Guam has been designated a Joint Task Force (JTF) for smaller-scale contingencies.

None of the headquarters function in a single-service environment. When they become a JTF headquarters, they can be assigned a mixture of forces from each of the four services. We have used this concept successfully in numerous, real-world exercise scenarios, some of which included our coalition partners.

To assist the JTF commands, our Pacific Command deploys a Joint Task Force Augmentation Cell (DJTFAC). The mission of DJTFAC is to quickly broaden and deepen the joint expertise of the JTF commanders, primarily single-service headquarters staff. DJTFAC enables the JTF headquarters to apply the combat power of the Air Force, Army, Navy, and Marine Corps in a joint operations environment. This tailored team of experts is rapidly deployable and works directly for the JTF commander. DJTFAC is integrated into the staff cells and helps the JTF headquarters develop the Commander's estimate, campaign plan, and operational plan.

That's where we are today. PACOM's strategy is a flexible, ever-changing concept backed with trained, capable, and ready forces. These forces, through overseas presence and bilateral as well as multilateral relationships, provide the foundation for regional security and stability. Deterrence and conflict prevention are gained through USPACOM's robust crisis-response capabilities and confidence-building measures. If necessary, these same forces are ready to fight and win our nation's conflicts. By being a force for security, we effectively support our shared political and economic objectives in the region.

Changes in the strategic environment will continue to impact the region during the next decade. I will talk about some of the trends we see, the future of the Pacific and our role in that future. To set the scene for this topic, just let me address the prevalent conditions across the region. The first prevalent condition is geography, which creates the region's tyranny of distance. The sheer size, about 105 million sq miles, creates some critical time/distance factors. In the region there are territorial disputes, boundary disputes, and animosities between nations and religious, ethnic and cultural groups. Historically, these animosities have served as flash points for conflicts. China and Japan are both on there four times.

Related to these historic tensions and animosities are the diverse national security concerns of many nations in the region. The need for internal order is a common concern for the Asia-Pacific nations. We continue to be concerned about the authoritarian governments in the region. With the exception of North Korea, the authoritarian governments of Asia are experimenting with marketing economies in a socialist context. We see this as a positive sign for this region.

China's importance to the region and the world continues to grow. China has vast economic potential. It is also a nuclear weapons state with a large and increasingly sophisticated conventional force. Like other countries in the region, the United States sees the potential for both cooperation and disagreement with this growing power. We want to work together with China when we have common interests and to resolve problems and clarify areas of disagreement when we find ourselves at odds. By working with China, we build contacts that enable cooperation and continued dialog. This policy has found wide support throughout the region.

The explosion of information access and availability, which can reach virtually any spot on the globe, has speeded the process of economic and political change. As more people become aware of conditions elsewhere, the inevitable comparisons they make put pressure on existing decision-makers. This revolution in access to information will continue to grow.

Annually, scores of typhoons and hurricanes traverse the region. Add to this the earthquake-producing faults from California to Southeast Asia, and you have a near certainty for natural disasters, as in this picture taken after the Papua, New Guinea, tsunami. Earthquakes, droughts, typhoons, and other natural disasters are a common challenge and present a need for regional planning and coordination.

The PACOM strategy seeks to improve relationships among the 43 countries in the region. Some of these important relationships include mutual defense treaties and defense obligations. The United States has five of its seven mutual defense treaties in the Pacific Command area of responsibility. These agreements include mutual defense treaties with Japan, Korea, Thailand, the Philippines, and Australia as well as defense obligations with the Marshall Islands, Micronesia, and Palau. In addition to these formal treaties, key relationships in the region include the evolution of relations among the United States, Japan and China, our expanding relationship with the Southeast Asian nations and the ASEAN regional forum,

our developing relationship with India, our continued cooperation with Australia, and the need to fully consider Russia's interests in Northeast Asia.

Impacting on these prevalent conditions are some very important trends. The first trend is the economic crisis in the region. The current economic crisis in the Asia-Pacific region has shown the interdependence of the U.S. and Asian economies. U.S. regional relationships take on an added importance in view of that ongoing crisis. Financial difficulties in Southeast Asia and other Asian countries are serious with significant political and security implications.

The region has experienced a massive flight of short-term capital and is enjoying a severe credit crunch. In addition, the Asian economic crisis has triggered the world's worst global financial crisis in 50 years. This serious threat to global security requires painful economic medicine. While some Asian countries have begun to implement reforms that appear to be bearing fruit, others have yet to demonstrate the will to implement comprehensive reforms. In this respect, such traditional traits of hard work, high national savings, leadership, and vision continue to be valuable assets on the road to recovery. More than ever, the Asia-Pacific region needs a secure, stable environment where trust and confidence foster peaceful resolution of conflicts and differences and encourage long-term growth.

Environmental degradation threatens the future of many resources. The careless management of resource extraction, be it timber-cutting, mining or fishing, threatens the future of important industries and economies. Pollution from rapid industrialization threatens water supplies, air quality, and coastal waters. The trend is widespread throughout Asia.

As stated earlier, the region includes nearly three-fifths of the world's population. Based on projected growth rates, we can expect India to surpass China's population in the first half of the next century. We also see a trend in some of the South Pacific island nations of population growing at a rate of 3 percent per year.

The region has already surpassed Western Europe as an oil consumer, and we expect the region to overtake the United States by the Year 2000. The region's need for oil could become a major force, driving energy policy and economic issues as oil imports from outside the region will grow from one half of the region's consumption in 1990 to between two thirds and three fourths of the region's consumption by the Year 2010. The amount of growth is dependant upon the rate of the region's recovery from its current economic crisis.

Aging populations, disease, and urbanization cut many ways in the region. This hospital in Laos shows the health care challenges facing many of the Asian nations as they confront social issues including the spread of AIDS. The demand for resources, be it shelter, food or medical, and health care in the region, will be an increasing drain on national resources.

There is a trend on the lowering of trade barriers. Despite the current resistance of some countries in the region, Asia-Pacific Economic Cooperation (APEC) remains committed to the lowering of trade barriers. This should lead to greater economic interdependence and long-term growth.

While significant terrorist incidents in the Asia-Pacific region trail those in other parts of the world, terrorist-related events show an increasing trend. This increased activity gives all nations of the region cause for concern.

To shape the future, the things we are doing now we must continue to do to move with the Asia-Pacific community into the 21st century. The clearest imperative for the future is our continued engagement in the region, economic, diplomatic, and military. We also work together as partners in providing security, stability, and prosperity.

The United States will continue to maintain a credible overseas capability that provides for stability and promotes partnership among our friends and allies in the Asia-Pacific region. With increasing interdependence among nations, we are doing a better job of integrating and articulating our military, diplomatic, and economic policies. We are doing it at the national level, here at Pacific Command with our military policies and with embassy personnel within each country.

The U.S. military in the Pacific will be called upon to play a variety of roles. These roles range from direct combat action in a major theater war to humanitarian assistance, disaster relief, and peacekeeping operations. We will also sustain our strong bilateral relationships and conduct multilateral military activities throughout the region.

As we evolve to a smaller force, the U.S. military wants to be sure that it remains flexible to respond rapidly and decisively. These flexible capabilities will include a balanced force of ground, naval, amphibious and air capabilities and perform a variety of roles. We must also be able to operate in a joint and combined environment; the key to that will be familiarity with the region.

Amidst all this change, the constant is the size of the theater, 105 million sq miles. Therefore, to respond rapidly halfway around the world requires the proper mix of forward-deployed forces, prepositioned materiel, and strategic and theater lift.

That is our vision of the future. We see an Asia-Pacific region where America's interests are more closely tied to the region that ever before, a region that is a secure, prosperous and democratic Asia-Pacific community.

But the degree to which we fulfill our political and economic objectives in the future will be determined by how actively we remain engaged in the region today. To do that we must be forward-deployed and our forces must be properly equipped and properly trained. We also need as many friends in the region as we can get.

Our goal is to leverage the conditions and encourage the favorable trends while discouraging the disturbing trends. The result will be a dynamic Asia-Pacific region of economic and political growth with the United States an active player, partner, and beneficiary.

Discussion

BG Carl A. Strock added that the U.S. Army Corps of Engineers is interested in contributing in a more positive and active way to what CINCPAC is doing. We are in the early stages of trying to get involved in a theater engagement plan. Nations in this region are thirsting for the expertise that we have within our engineering community. We are currently working with China, Japan, Vietnam, and Thailand in active programs to share with them our expertise in hydropower, flood control, disaster response, environmental protection, and others.

Office of Naval Research and Waterways Experiment Station Collaborations at the Field Research Facility 1990-99

Dr. Charles Linwood Vincent
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Coastal and Hydraulics Laboratory
U.S. Army Engineer Waterways Experiment Station
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and

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The U.S. Army and U.S. Navy have complementary interests in understanding the processes of the nearshore and beach systems. The Navy interest is primarily focussed on real-time observations and short-term nowcasts and forecasts for such operations as amphibious assaults, mine clearing, and Special Forces operations primarily on the open coast. The traditional U.S. Army Corps of Engineers interest has been in patterns of sediment transport and predicting beach evolution so that the coastal engineering projects can be properly designed and their impact assessed. Prediction of the operational environment for Army Logistics-Over-the-Shore missions bears many similarities with the Navy's general operational requirements.

Beginning with the SWADE/SAMSON/DELILAH experiments in 1990, the Office of Naval Research's (ONR's) Coastal Dynamics Program and the Army's Civil Works Research Program in the Coastal and Hydraulics Laboratory began an extensive partnership. ONR has sponsored four major nearshore wave and process experiments at the Field Research Facility (FRF) in Duck, NC, that have brought together an unprecedented number of university and government laboratory scientists and engineers. DELILAH (1990) primarily emphasized the role of edge wave and other long-period motions in the surf zone. The Duck 94 (1994) and SandyDuck (1997) experiments emphasized the role of shear instabilities in the longshore current, description of bed forms, and measurement of sediment transport parameters. The Shoaling Wave Experiment (SHOWEX) that will be conducted this fall is the first major experiment to measure the primary source/sink mechanisms jointly for wave evolution on the shelf. The ONR investments in DELILAH, Duck 94, and SandyDuck will exceed $22 million. The investment in SHOWEX and the related Advanced Wave Prediction Program will exceed $12 million. Most of ONR's funding provides grants to universities although some funding has gone to government laboratories and to the FRF to support experiment infrastructure costs. Corps funding has been primarily in-house.

ONR recognized that the Corps, among others, had strongly supported the development of laboratory-scale and numerical models of coastal phenomena. ONR is funding studies of nearshore processes based on observation of natural seashores. The Navy and Marines must operate in real, not idealized, environments so this emphasis seemed timely and complementary to existing programs. While ONR emphasized basic research problems, Corps participation has been in extension of these results for practical engineering applications. This synergy has benefited the Navy as well.

With the completion of the Duck studies, ONR will likely shift its emphasis to coastal areas different in some fundamental way from Duck. Many of these sites are in the United States and are likely to be in coastal environments of interest to the Corps. So the opportunity for future collaboration is open.

Discussion

Dr. Edge commented that the shoreline where several people in the audience live did not have much in common with the Duck shoreline. They are muddy bottoms or a combination of muddy and sandy bottoms. He stated that the next series of experiments might be in the areas where there are muddy bottoms. There are major problems there and some very major physics that are not understood well.
Dr. Vincent agreed that they don't understand muddy shorelines very well. The theoriticians want to go to simple shorelines, whereas, the engineers want to go to places that there are structures. The Navy is apt to do a lot of operations in engineered shorelines. We need to understand those just as well as the pristine, beautiful, untouched shorelines that turn out to be not so simple to model. We are going to go through a multi-year process where we try to absorb what we have learned from the Duck experiments. When we have so much money, what is the most important question that we can answer for the Navy? If these experiments help the Corps and the National Oceanic and Atmospheric Administration, then, the more the better.

Dr. Dean stated that most of the Duck experiments are considered microprocess, where you measure something at a point, whether it be velocity or suspended sediment. At the St. Petersburg conference, there was discussion about considering projects where you have in place the large perturbations, such as a beach nourishment project, and then just seeing how the knowledge gained over the past decades could be applied to predicting the evolution of that project. It seems that would be very valuable to the Corps to test the theories to see how well they can predict the future in terms of the geometry of a project, its performance, and its longevity. Has that been given any consideration?
Dr. Vincent stated that there was more convergence in that area than a few years ago. It's a question of putting together packages of investigators and problems that say that this is really a wise use of the money.

Professor Robert L. Wiegel commented that we are learning a lot about one place, and we have to get out and get more information on a broad variety of places. The Navy has a number of studies, and the Corps should work with the Navy because the Corps has the people with expertise. It has to be a joint effort. *Dr. Vincent* said that a considerable amount of money was spent at Duck, and they cannot go around the world spending that kind of money doing these kinds of studies. So, they encourage investigators to see how we can use modeling, lidar, remote sensing, and supplement that with in situ data, and the Corps can help in this process.

Military Applications of Civil Works Modeling Capabilities

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U.S. Army Engineer Waterways Experiment Station
Vicksburg, MS

The U.S. Army Corps of Engineers has both civil works and military missions. The Coastal and Hydraulics Laboratory (CHL) is the only Corps laboratory whose research and development (R&D) is predominantly civil-works funded, but it has developed modeling technology for civil-works applications that has significant military applications.

The presentation will give examples of CHL using wave models developed for civil-works applications to support U.S. forces in Kuwait, Somalia, and Bosnia; the Navy's Fleet Numerical Modeling Center for global wave predictions to rout the fleet; and the Naval Oceanographic Command for operational predictions in coastal military hot spots.

CHL developed the highly-flexible ADvanced CIRCulation model to determine tidal and wind-driven circulation at dredged-material disposal sites. CHL has modified the model to simulate hurricane surge and detailed hydrodynamics for navigation projects. CHL first applied the model for military operations in support of the U.S. Navy by providing a model of the entire Mediterranean Sea with great grid resolution in hot-spot areas such as the Adriatic and Libya. CHL has developed for the Naval Oceanographic Command operational forecast models of tidal elevations and currents at hot-spot areas in several locations around the world.

CHL's physical modeling capabilities also have been applied to solve military problems. The Navy has physical-modeling facilities for deep-ocean simulations but not for shallow coastal areas. As a result, CHL has used its modeling facilities to model warship problems in coastal areas including studies of Trident submarines and aircraft carriers. The Army has more watercraft than the Navy, and CHL has used its physical-modeling capabilities to support testing of Army watercraft. For example, CHL recently tested modifications of the Army's Modular Causeway System (MCS) used during Logistics-Over-the-Shore operations to take tanks and other equipment from large ships to shore. MCS was having problems operating in a relatively low sea state, and CHL proposed and tested modifications of the MCS to allow it to operate in higher sea states.

Not only is modeling technology developed for civil-works applications used to support the military, but models developed by CHL primarily for military operations are applied to civil-works problems. For example, CHL has led a multiple agency and the Corps' laboratory development of the Department of Defense Groundwater Modeling System (GMS) for application to groundwater contamination problems on military bases. Currently, CHL is connecting GMS and the Surface Modeling

System (SMS), developed for civil-works applications, and applying the combined model to a major civil-works modeling study of South Florida. Surface and groundwaters have significant interactions in South Florida in areas such as the Everglades and Florida Bay.

There are cases where development of modeling technology is jointly funded by military and civil-works funds. CHL's Watershed Modeling System (WMS) has military hydrology funding, was used extensively during the conflict in Bosnia to forecast flood stages of the Sava River, and is being used in military hot-spot areas around the world. CHL is currently adding capabilities to WMS using funding from the Environmental Protection Agency. A major new R&D initiative of the Corps, the Land Management System, is being funded by both military and civil-works funds because it has significant applications to environmental problems that know no funding bounds.

Technology does not recognize boundaries between funding sources, and CHL has been successful in applying modeling technology to a full range of Army missions.

(There was no discussion following this presentation.)

Military Applications of Airborne Lidar Bathymetry

W. Jeff Lillycrop
Director
Joint Airborne Lidar Bathymetry Technical Center of Excellence
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The presentation shall provide an update to the Scanning Hydrographic Operational Airborne Lidar Survey (SHOALS) Program, which was last formally briefed to the Coastal Engineering Research Board on 9 November 1994 in Vicksburg, MS, and a summary of airborne lidar capabilities and applications to support a variety of military requirements. It concludes with a strategic plan for ensuring that airborne lidar bathymetry is able to fully support the Department of Defense (DoD) in the coming decade.

SHOALS began field operations in March 1994 and has met or exceeded many of its original goals. Nearly three years ago, SHOALS officially transitioned from developmental to fully operational, supporting a variety of U.S. Army Corps of Engineers civil works requirements, such as navigation project surveying, shore protection and coastal monitoring, and emergency hurricane response. The transition was marked by the creation of the Airborne Lidar Bathymetry Technical Center of Expertise (ALBTCX), combining the extensive operational capabilities of the Mobile District, with the research and development expertise of the Waterways Experiment Station (WES).

Today, SHOALS supports Corps operation and maintenance, engineering, and planning missions and is evolving to support the new Regional Sediment Management initiative. In addition to the Corps, SHOALS has conducted operations for the National Ocean Service, the U. S. Geological Survey, the state of Florida, New Zealand, and the U.S. Navy.

Since SHOALS development began in 1988, the Corps has worked closely with the U.S. Naval Meteorology and Oceanography Command, Naval Oceanographic Office, Stennis Space Center (CNMOC/NAVOCEANO). This informal relationship yielded enhancements to the SHOALS system and the Corps' capabilities in nautical charting applications. It has also provided benefits to the CNMOC/NAVOCEANO's capabilities in airborne lidar charting and evaluation of the technology. On 19 May 1999, this relationship was formalized by a Memorandum of Agreement establishing the Joint ALBTCX, adding CNMOC/NAVOCEANO's international hydrographic and nautical charting capabilities to the Center.

Work with the Navy and discussions with other DoD elements such as the Special Operations Command, Transportation Command, British Ministry of Defence, and the 29th Engineering Battalion indicate that neither the existing airborne lidar systems nor the "next generation" versions of these systems presently being developed by industry will be adequate to support all of DoD's projected

requirements in the next decade, which range from bathymetric surveying to nautical charting and hazard mapping to covert reconnaissance of beach and nearshore areas. The ability to provide this broad-ranging support is well within the span of existing knowledge and experience, but the effort to do so must be initiated soon in order to have a capability fully integrated into DoD operations before the end of the coming decade.

The Joint ALBTCX has developed a Strategic Plan to field a Generation-After-Next airborne lidar capability that meets existing and projected DoD needs, building on the experiences developed through extensive operation of the SHOALS system, the research and development capabilities of WES and the Naval Research Lab, and the technology integration strengths of NAVOCEANO. This plan, which contains technical, resourcing, and operational elements, will result in a capability that is much smaller, less costly, and more automated than existing systems, and that is less manpower-intensive to operate and maintain. The Generation-After-Next system will operate on military and commercial aircraft of opportunity with minimal integration, have greater coverage rates and lower operational costs, and support the full range of DoD requirements, including covert operation on unmanned airborne vehicles. Most important, however, is the fact that the system's low acquisition cost combined with the above attributes will allow the deployment and operation of multiple units, simultaneously increasing operational access to lidar technology for DoD interests worldwide while drastically reducing deployment times and mobilization costs.

Discussion

Dr. Edge was concerned with the fact that the system does not seem to have the capability to handle water that is particularly cloudy or muddy. *Mr. Lillycrop* stated that since it is an optical system, it is always going to have limitations. The Navy Research Lab is taking nearshore wave measurements and inverting them to get bathymetry. We measure wave heights as we fly an operation, and there is no reason why those wave heights couldn't be used to calculate a bathymetry so you would at least get a better idea of what is out there when you hit turbidity plumes and so forth.

Dr. Dean commented that one of the other applications not mentioned was mapping the wave transformation across the surf zone. There has been interest in how waves transform and dissipate, the whole transformation process, and with the SHOALS, you can measure the surface of the waves as well as the bottom, and that provides a very valuable tool for such experiments. *Mr. Lillycrop* agreed, but it was going to take some development.

RADM Kenneth E. Barbor commented that he had a program to try to buy a system, but it was too expensive. They were now able to get these data in other areas. If it were tactical, he could use it on a lot of other areas such as mapping and charting.

Naval Logistics-Over-the-Shore (LOTS) Programs

Theodore G. Vaughters
Naval Surface Warfare Center
Carderock Division
West Bethesda, MD

Logistics-Over-the-Shore (LOTS) is defined as: "….the loading and unloading of ships without the benefit of fixed port facilities in either friendly or undefended territory and, in time of war, during phases of theater development. LOTS operations are conducted over unimproved shorelines, through fixed ports not accessible to deep draft shipping, and through fixed ports that are not adequate without the use of LOTS capabilities." Navy LOTS supports Marine Corps amphibious assault, Maritime Prepositioned Force discharge, and assault follow-on resupply. Joint LOTS (JLOTS) operations are defined as logistics-over-the-shore operations conducted jointly by forces of two or more service components (normally Navy and Army) or by a unified command. As history has shown over 90 percent of our forces and supplies will continue to be delivered by sea, often to underdeveloped nations with limited port facilities.

Collectively, Service LOTS equipment can emulate functions normally performed at fixed port facilities. Navy auxiliary crane ships provide lift-on/lift-off capability to transfer containerized military supplies and other equipment to unimproved shorelines. Army and Navy roll-on/roll-off discharge facilities (RRDFs) allow tanks, trucks and other military vehicles to drive off ships anchored miles from shore for transport to unimproved shorelines. A variety of Navy and Army lighterage and watercraft ferry supplies and equipment where they can discharge over the beach to the Navy's elevated causeway, to the Army's floating causeway, or directly to the beach if the beach gradient allows. Navy offshore petroleum discharge systems (OPDS) also provide bulk fuel at unimproved shore locations.

Current LOTS and JLOTS operations are limited to operating in relatively calm seas, wave heights of 3 ft or lower and where long-period ground swells do not affect the ships. Based on their mission analysis, the unified commanders have stated a requirement to operate in Sea State 3 (SS3). Therefore, all LOTS systems must be able to operate and be interoperable in 5-ft-significant wave heights and in cases where long-period ground swells affect ship motions. The Naval Surface Warfare Center, Carderock Division, recently completed a JLOTS Environmental Requirements Study, which provided a compilation of environmental characteristics needed to develop valid system requirements for LOTS and JLOTS operations in the littoral area. Fifty-two specific potential amphibious logistics sites from nine broad regions have been addressed. The data which were gathered from many sources includes the following for each site: wind, waves, current, tides, distance to 50-ft water depth, beach gradient

(calculated), bottom condition and hazards, distance to road network, and general geographic characteristics of the area.

The Services under the auspice of a Joint Staff chartered JLOTS board, have initiated several research and development (R&D) programs to satisfy the unified commanders SS3 operating requirements. These programs are being coordinated through a JLOTS joint integrated process team (JIPT) in a system-of-systems approach to developing a SS3 operational capability. The Navy has initiated several programs, which are on the critical path of providing a SS3 capability by 2005. These include the following:

a. The Joint Modular Lighterage System (JMLS) ACTD. The objective is to build and demonstrate a service-interoperable prototype causeway lighterage system to safely assemble and operate in SS3. This system will include RRDFs with a connected platform to enable Navy LCACs to be used in a LOTS/JLOTS operation, causeway lighters, and floating causeway piers.

b. Ship Operations/Interfaces. This area includes all ship to ship, ship to lighter, and ship to roll-on/roll-off discharge facility interfaces systems such as: mooring and fendering; personnel transfer; ship ramp/platform motion compensation; ship heading control and ships used as breakwaters; and the transport of LCACs on SEABEE and LASH Barge ships.

c. Ship Cargo Movement Systems. This area includes all ship cargo handling systems such as: the Advanced Shipboard Crane Motion Control System (Navy ATD) to control load pendulation; vertical motion compensation; crane enhancements to facilitate safer operations; and other shipboard cargo handling innovations.

d. Training, Command and Control, and Doctrine. This area addresses the critical area of command and control and training simulators.

The Navy and Army are coordinating their research efforts as documented in the JLOTS Options Study and JLOTS Master Plan, which are both currently being revised to reflect both current and future R&D plans. These documents provide an integrated system of systems approach to resolving the difficult SS3 LOTS/JLOTS problem. The Master Plan was designed to reflect a hierarchy of measurable items from goals and objectives down through projects/programs or tasks to readily determine whether there are successes, shortcomings, or adjustments necessary in organizing, training, equipping, or projecting the LOTS/JLOTS force in conditions up through SS3.

Significant progress is being made to bring both the Navy and Army closer to meeting the 2005 goal of SS3 service-interoperable LOTS/JLOTS systems.

Discussion

Mr. Jarrett asked where the wave period fits into the definition of Sea State 3, given the various frequencies of response of the different elements within this system? *Mr. Vaughters* stated that the wave period, especially the groundswell aspects that create the ships to roll, is critical. Sea State 3 is not just Pierson-Moskowitz spectrum. You can have groundswells at Sea State 0. Sea State 3 is a very complicated issue.

Mr. Jarrett mentioned that several years ago they were trying to develop a sloping float breakwater for offloading protection, but there was a problem with connecting units together. They looked at an elastometric connector, and he wondered if that were still around. *Mr. Vaughters* said, yes, the JMLS system is being designed now, and will connect in any configuration, end to end or side to side to form platforms. The development of the connector is key.

Professor Wiegel commented that when you have these various degrees of freedom and different restoring forces, very often we see energy transferred from one load to another. Even though you are looking at a pitch or roll, you suddenly start getting heaves or sways, and you could easily get tortional motions. *Professor Wiegel* asked if they had gotten to the place where they can take care of these transfers of energy amongst modes? *Mr. Vaughters* said that that is being designed into the system to accommodate for those conditions. The JMLS has to operate in Sea State 3 and survive in 5. The harder requirement is that they have to be able to assemble in Sea State 3, and that is a challenge.

Iwakuni Runway Relocation

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Background

MCAS Iwakuni is the home for Marine Aircraft Group Twelve and four contingents of the Japanese Maritime Self Defense Force. The existing installation has an all-weather capable 8,000 ft-long-runway that can accommodate C-5A and 747 aircraft and a shallow port facility that can support small to medium ships.

In 1997, the government of Japan (GoJ) began a major project to construct a new 8,000 ft-long-runway 1,000 m, center line to center line, seaward from the existing runway. This GoJ initiative was undertaken to decrease noise off base and to increase aircraft safety by relocating the flight path seaward to avoid overflight of industrial facilities beyond the end of the runway. Relocation of the runway necessitates relocation of the port facilities in addition to approximately 44 buildings and the installation's ordnance magazines.

Project Data and Criteria

The runway relocation project will add approximately 530 acres of reclaimed land to the installation and provide a port facility with a 13-m depth wharf making MCAS Iwakuni the only co-located USG-controlled deep-water port and heavy lift airfield in Asia. GoJ designed the new seawalls of the port facility to withstand wave heights of 2.2 m (south), 2.6 m (southeast), and 1.6 m (northeast).

Construction Phasing

This relocation project is projected to take approximately 10 years to complete. In order to maintain the installation’s functional capabilities throughout the life of the project, construction will occur in three phases. Phase I will reclaim land in the south area and construct a new port facility and southern taxiway. Phase II will reclaim the north area and construct new ordnance storage facilities. The middle portion will be reclaimed in Phase III after relocation of the existing port facilities. This final phase will include construction of the runway and other airfield facilities.

Construction Features

Since 1997, construction activities to stabilize the seabed have been ongoing. The construction method uses sand piles and sand drains to increase existing seabed bearing capacity. The patented "Compozer" process is being used to install approximately 7,500 sand piles/sand drains in the three reclamation areas in water depths ranging from 65 to nearly 100 ft.

Approximately 18.3 million cu m of fill material (slightly more than five times the volume of the Pentagon) will be required to complete this project. About 95 percent of the fill material will be obtained by the demolition of Atago Mountain in Iwakuni City. The quarried materials will be conveyed 3.4 km to a temporary wharf using a series of 1,400-mm-wide conveyors. From the wharf, the materials will be barged 7 km to the construction site.

A side benefit of the demolition of Atago Mountain will be the creation of 252 acres of land suitable for housing development, public use, and green areas in Iwakuni City. Development of this new land will be accomplished with private funds and local city and prefectural funds.

Construction Costs

The overall project is estimated to cost $1.6 billion. Installed cost of the sand pile/sand drains is unavailable at this time due to uncertainties in the exact number of piles, depths of piles, etc. Fill costs (including demolition, transportation, and placement) are projected to be about $259 million.

Discussion

COL(P) Madsen commented that in the next number of years the runways at the San Francisco Airport are going to be reconfigured, and the airport will have to reclaim part of the bay to do that. Environmental interests would probably challenge the environmental impact statement. He asked how the Japan District got through all the environmental issues? *Mr. Constantaras* answered that housing was a real incentive. The city of Tokyo benefited from additional housing. *MG Russell L. Fuhrman* added that this was an environmental assessment and not an environmental impact statement.

Alaska District Coastal Projects

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Alaska's Uniqueness

The Alaska District includes more than 34,000 miles of shoreline. This exceeds the shoreline length in the lower 48 states. All this coastline presents a wide variety of coastal engineering challenges: tidal variations, Pacific Ocean swell, high winds, ice, earthquake effects, siltation, lack of wind and wave data, sparse population, harsh weather conditions, and transportation difficulties.

Water-related activities are extremely important in Alaska. Commercial fishing is second only to the oil industry in the state's economy. Approximately three fourths of the population lives in coastal communities, and almost all of these towns have docking facilities. Many of them are accessible only by sea and air. Waterborne transportation is a principal means of moving goods to, from, and within Alaska.

In the U.S. Army Corps of Engineers' tenure in Alaska of more than 100 years, we have constructed about 70 civil works projects in 55 different locations. Most of these projects are harbors.

Alaska harbors are usually built under the Corps' General Investigation or Continuing Authorities programs. In most cases the Corps, the state, and local communities all work together to get a finished harbor. The state generally participates through the Department of Transportation and Public Facilities.

Recently Constructed Coastal Projects

St. Paul Harbor is on St. Paul Island, the largest of the Pribilof group, approximately 800 miles southwest of Anchorage. The harbor was built in 1989 to support the Bering Sea fishing industry and to help the island's residents move away from reliance on the Government-supported fur seal harvest. The project has been modeled at the U.S. Army Engineer Waterways Experiment Station (WES) twice. It consists of a main breakwater of 22- to 30-ton stone for 1,800 ft and a detached breakwater of 5- to 8-ton stone for 1,000 ft. The breakwater, built to 37 ft above mean lower low water (mllw), is overtopped yearly by wave action.

St. Herman Harbor at Kodiak was constructed from 1993 to 1997. Kodiak, on the southeastern coast of Kodiak Island about 250 miles southwest of Anchorage, ranks among the top commercial fishing ports in the nation. The new breakwaters, which substituted for an inadequate floating breakwater, total 1,930 ft in length with an armor stone size of 2,500 to 4,000 lbs. The main breakwater was built in 60 ft of water over a bad foundation. The soft bottom material was consolidated with a 40-ft-deep settlement pad that was in place for 1-1/2 years before the main breakwater was built.

Mountain Point Boat Launch, built in 1993, is a 424-ft breakwater at a launch ramp near Ketchikan in Southeast Alaska. It enables recreational and small commercial fishermen to launch and retrieve their boats in protected conditions.

Channel Rock Breakwaters at Sitka were completed in 1995. Sitka, located on Baranof Island about 95 miles from Juneau in Southeast Alaska, has a busy commercial fishing industry and a rich Russian and native heritage. The three breakwaters constructed there, totaling 1,930 ft in length, protect an existing harbor from open-ocean swell and provide a large area for harbor float expansion.

The town of Homer on the Kenai Peninsula depends on its harbor at the end of a spit jutting out into Kachemak Bay. A state highway on top of the spit connects the harbor with the town. Waves frequently overtopped this highway during storms, damaging the road. A rock revetment was constructed in stages between 1994 and 1998 along 4,800 ft of the road, protecting it from storm damage.

Projects Under Construction

At Kake in Southeast Alaska, a breakwater is being built on an extremely poor foundation – muck, 70 ft deep. The poor quality foundation made the use of wick drains imperative to obtain a cost-effective project. Construction started in 1998. Wick drains already have been installed in a 3-ft gravel base. The drains will provide a way for water to drain out of the saturated foundation soils. The breakwater will be built in four lifts: first 10 ft of rock, then 6, then 4, then 15 ft on the top. Two months will be allowed between lift placements for the foundation to settle.

On Kodiak Island, harbors at the small communities of Ouzinkie and Larsen Bay are being constructed under the small-navigation-project Section 107 program.

At Ouzinkie, construction began in July 1997. The project is only partly completed because an unexpected rock outcrop was encountered that increased the construction cost. Three hundred feet of the 650-ft breakwater remains to be built. Most of the dredging is done, but the rock outcrop, totaling approximately 6,500 cu yd, remains to be dredged.

At Larsen Bay, three breakwaters were built in the summer of 1998. The entrance channel and basin dredging will be completed in the summer of 1999.

Construction Scheduled for Summer 1999

At Dillingham, near the world-class salmon fishery of Bristol Bay in southwest Alaska, 1,800 ft of sheet-pile bulkhead is being constructed with fill behind it to protect a city bluff from erosion.

At King Cove in the Aleutian Islands, a new harbor is being created southeast of the existing harbor. The new harbor, with a 13.5-acre mooring basin and maneuvering area and a 1-acre entrance channel area, will provide protected moorage for approximately 50 large commercial fishing vessels.

In Cook Inlet before the Port of Anchorage, Alaska's busiest commodity port, a channel 1,000 ft wide and 6,500 ft long is being excavated through Knik Arm Shoal. Currently, container ships have to

wait for higher stages of the tide to approach or leave the port. Tidal ranges in upper Cook Inlet exceed 32 ft, the highest in the United States and second highest in all of the Americas. The channel is expected to reduce the ships' delay of 4-6 hr per passage to 2.5-3 hr. This dredging job will involve removing 1 million cu yd of material in 30-ft tides and up to 6 knots of current.

Three underwater reefs will be built at St. Paul in the Pribilofs in front of the main harbor breakwater. Modeled at WES, these reefs will reduce the wave energy approximately 50 percent for waves with periods from 11 to 20 sec.

Harbors at Chignik, Sand Point, Seward, and Nome are in the final design stage. The first three are typical small boat harbors, but the last, Nome, is unique. The freight hub for a vast area of western Alaska, Nome was the first Corps project in the state. Its port is frozen from November until April. Nome built a 2,000-ft-long causeway in 1985. In 1998, after extensive modeling at WES, we developed a plan to add a breakwater parallel to the causeway and reroute the Snake River. This will keep the river deep enough for boats to enter the harbor during the ice-free period. It will also double the time available for barges to unload freight at the causeway.

Military Coastal Projects

Although not officially recognized as a military project, the Port of Anchorage is a critical supply line for the military presence in Alaska. The port is the major resupply station for Elmendorf Air Force Base and the Army's Fort Richardson, among others. This port is unique in that the Corps maintains both the approaches and the dockside berthing areas.

Eareckson Air Force Station on Shemya Island near the end of the Aleutian Chain has benefited by Corps design and analysis. The Corps used dolosse in 1994 to protect the shoreline on both sides of the dock, where all supplies and fuel are received. The Air Force wanted a zero-damage, no-maintenance structure. Twelve-ton dolosse were selected over 50-ton stone. WES was involved in this design. In response to breakage elsewhere, the Shemya dolosse have a wrist ratio of .36, the largest built to date. They were cast in Tacoma, WA, and barged to the site.

A shore protection project was designed for the Air Force at Barter Island on the Beaufort Sea to replace an earlier failed project. The low-cost solution involves 1-ton sandbags and in the future, groins.

A study is beginning under the emergency shore protection (Section 14) program to protect the landfill at the far northern community of Barrow. This landfill is a U.S. Navy responsibility.

Because of Alaska's dependence on waterborne transportation, the Corps' Alaska District engineers have had to develop expertise in both coastal and river engineering. Because of this broad knowledge base, the District was able to team with the Honolulu District to provide rapid flood hazard analysis after a severe flood in Korea. The quick analysis and report will help insure the new Army structures being built there will not be damaged by the same type of event in the future.

Discussion

Dr. Edge asked about the placement of wick drains. *Mr. Eisses* explained that the wick drains were put vertically on a 3-ft spacing under the whole profile of the breakwater and provided the water an avenue out through the compacted marine sediment or gravel base.

Mr. Magoon commented that there has been much controversy concerning St. George and St. Paul Harbors, and requested comments on what happened with St. George. *Mr. Eisses* said that St. George is not used very much because of the surge in the harbor. The Corps dredged out the entrance channel. There were a couple of pinnacles there in place. The Corps has not been able to go back in because the locals have not been able to procure money. The majority of the commerce has moved to St. Paul, which is only 45 miles away and works much better.

Summary of Marine Board Study on Coastal Engineering Research and Education Needs

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The National Research Council's Marine Board examined the national needs in coastal engineering research and education and assessed the effectiveness of existing institutions in meeting those needs in a study requested by the U.S. Army Corps of Engineers. The specific tasks were to:

a. Identify contributions of coastal engineering research and education toward protecting shorelines, maintaining ports and waterways, and managing the coastal environment.

b. Assess the capabilities of research efforts and facilities to meet the national needs.

c. Analyze the relationship between research facilities and the education of professionals.

d. Evaluate the effectiveness of current mechanism for investing in coastal engineering research and education.

The study commenced in February of 1987 and has just been completed.

National Importance of Coastal Engineering

Rising sea levels, damaging coastal storms, eroding beaches, deteriorating coastal habitats, and aging port and harbor infrastructure present formidable engineering challenges for coastal engineers now and in the future. With the increasing population growth at the shoreline, the costs of coastal hazards are rising dramatically – Hurricane Andrew caused $15.5 billion in insured losses. The east and gulf coasts alone have $3.15 trillion of insured property adjacent to shoreline most of which are eroding due to relative sea level rise and the presence of tidal inlets. Our ports are facing the prospects of having to dredge deeper channels to stay competitive in the face of more restrictive dredge material disposal requirements.

The role of tourism associated with beaches is slowly being recognized as vital to state and Federal economies. Beach preservation and restoration are a fact of life for many east coast beaches. Yet the Federal commitment to these types of projects is small.

Coastal engineering has traditionally tackled these problems. However, their solutions are becoming more sophisticated as additional concerns, such as the environment and public opinion, must be factored into the design. Further, a significant amount of research is needed to provide the coastal engineer with modern tools to attack the problems. Coastal engineering as we know it must change to meet these increasing national needs.

Research

For seventy years, the U.S. Army Corps of Engineers has played a major role in coastal engineering research in the United States, with the Coastal and Hydraulics Laboratory (CHL) and its antecedents providing a considerable impetus to the research in the field. However, this is not enough.

Coastal engineering has grown nationally and internationally due to ubiquity of the problems occurring at the shoreline. In the United States, this need has spawned a variety of commercial coastal engineering firms and the development of coastal engineering courses at about two dozen universities – with about a half dozen major programs with significant laboratory facilities. Internationally, government-sponsored laboratories were the original response to a nation's coastal engineering needs, but now many of these laboratories have been privatized and have become the foremost coastal engineering organizations in the world -- Danish Hydraulic Institute and Delft Hydraulics being the best examples.

The state of coastal engineering research and education in the United States is beginning to lag behind that of the European Union and Japan. While at one time, the United States had the lead in both research and education, this is no longer the case. Further U.S. international competitiveness is lagging, as there are no major U.S. companies to compete effectively with the large European firms, who both conduct research and carry out commercial projects. In the Far East, Japanese firms are the major competitors.

Education

The majority of coastal engineers in this country are trained in traditional graduate programs. There are approximately 20 colleges and universities that offer some courses in coastal engineering. However, none of these programs regularly offers a course in port/harbor engineering, or one in environmental concerns at the coast. Less than six of these programs have a large laboratory in which to conduct research. All of these laboratories, however, are falling behind the state of the art in terms of sophisticated measurement equipment.

Funding for coastal research in academia is low -- less than $6 million dollars. The principal funding agencies are Sea Grant, the Office of Naval Research (NSF), and the Army Research Office. NSF plays a very minor role in the field. External funding of academic research by CHL is very low.

There is concern that, with this low funding level, that the academic coastal engineering will not be maintained. In the last two years, only two coastal engineering positions have been filled in universities and the average age of the faculty is nearing that of retirement. While the Corps has obtained many of their coastal engineers from these programs, the programs are in serious danger of disappearing as engineer schools are more and more driven by the research dollars available.

The Corps needs to play a pro-active role in maintaining academic programs. It cannot rely on itself to provide the research base needed to conduct modern-day coastal engineering nor can it rely on itself for developing the tools of future coastal engineering.

Discussion

Dr. Dean asked how we can implement a program to better educate the public on whether we should protect the structures built on the shoreline or let nature take its course. *Dr. Dalrymple* stated that academia has not played a role in that, but there is an effort to put together an association of coastal engineers that could do some of the education, and it behooves the profession to make this effort in public education.

COL(P) Madsen commented that there were tremendous opportunities along the tidal estuary areas for environmental/coastal engineering expertise, and was wondering why there weren't any programs to steer students in this direction. *Dr. Dalrymple* agreed, but stated that the research dollars steer the research topics.

Dr. Edge mentioned that some of the Corps funding for the Marine Board report was going to be used to disseminate the report to the people who do make a difference.

Professor Wiegel commented that we lose a lot of creative engineering graduate students by making them write environmental impact statements. He thought that was a serious problem and wondered if that had been addressed. *Dr. Dalrymple* indicated that it had not been addressed.

Mr. Orville Magoon, speaking as a member of the committee, endorsed the results.

BG Strock asked who the recommendation to form an academic consortium would be presented to and how would the concept be converted into reality? *Dr. Dalrymple* said there was no way to do that other than through good will of the report and self-interest.

MG Fuhrman commented that when funding goes down, the piece that suffers is the research piece. Now that the budgets are going up again and increasing in public infrastructure and water resource development, it is an appropriate time to identify what is needed in the way of research.

COL(P) Madsen added that however the report is written, the more it is geared towards the economics the better because the policymakers and representatives understand this.

Honolulu Engineer District
Coastal and Navigation Program

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The Honolulu Engineer District's (HED) area of responsibility is located within 5 million sq miles of the Pacific Basin and is composed entirely of islands. Our present area of responsibility includes the state of Hawaii, the territories of Guam and American Samoa, and the Commonwealth of the Northern Mariana Islands (CNMI). We have also completed coastal projects in Western Samoa, the Republic of the Marshall Islands, the Republic of Palau, the Federated States of Micronesia and Diego Garcia in the Indian Ocean.

The HED was established in 1905 when Congress authorized Hawaii's first civil works project improvements to Honolulu Harbor. Since that time, the Civil Works Program has grown to include many activities and projects aimed at developing water resources not only in Hawaii but throughout the Pacific Basin.

The islands within our jurisdiction are sometimes separated by tens of miles, and often by thousands of miles. There are no roads or bridges that connect these areas. Because of this geographic isolation, the development of commercial harbors, both deep draft and shallow draft, are vital economic and humane necessities. These harbors are merely the off ramps to the ocean highways.

HED is also involved with the shore protection of the islands. Many of the islands are volcanic in origin. This means that the majority of the land area, usually the center portion of the island, is uninhabitable consisting of mountains and steep rugged terrain. This only leaves a narrow flat coastal area for the villages, roads, water, and other utilities to be located. Erosion on these narrow areas is considered extremely important problems, and in some cases, even as little as one foot of erosion may cause outages of water and other utilities. An erosion of 10 ft from a hurricane or large storm may totally cut off a portion of the island since there is usually only one road. This would cut off access to airports, hospitals, emergency relief, and items that are necessary during and following a disaster.

Other types of islands are lower in elevation such as atolls. The forecasted rise in sea level will cause major problems for these islands since a typical elevation for an atoll is approximately +6 mean lower low water (mllw). Because of the usual narrow nature of islands in an atoll, continued erosion or narrowing on these islands will cause all of the same problems discussed for the volcanic islands and also the possibility of cutting or losing a portion of the island totally.

In the state of Hawaii, we have completed or studied 17 navigation projects totaling $226,353,000 and 10 shore protection projects totaling $16,123,000 in nominal dollars. The navigation projects range from deep-draft and shallow-draft harbors to protected launching ramps. On the shore protection side, we have designed and constructed rock revetments and beach fill.

For the territory of Guam, the HED has constructed two shallow draft navigation projects totaling $4,022,000 and one shore protection project for $227,000. We have recently entered into negotiations for two reimbursable and three continuing authorities shore protection projects and have provided technical assistance for the design and construction of another shore protection project.

In the CNMI, HED has completed one shallow-draft navigation project totaling $3,170,000 and one shore protection project totaling $93,000. We are presently in negotiations for an additional $632,000 for shoreline protection and $1,000,000 for a shallow-draft facility. We also provided the design for the completed $40 million – plus commercial dock facility on the island of Saipan.

In American Samoa, HED has completed five shallow-draft navigation facilities totaling $18,661,000 and 14 shore protection projects totaling approximately $8,000,000. Presently in American Samoa, we have an active Work for Others Program in which we have provided coastal protection design training, technical assistance, designed and constructed two shore protection projects, and are in the design phase for two more shore protection projects.

Many of these areas are very remote and have different resources available for the construction of navigation facilities or shore protection. This means that standard practices sometimes are not practical and we must think "outside of the box" for solutions that are not only justified but also are low in maintenance.

Discussion

Dr. Dean asked what the average rate of erosion was around Oahu. *Mr. Boc* answered that the beaches are generally in recession of 2 to 4 ft per year, depending on the area. He also stated that there was a trend to get away from hardened shorelines.

Mr. Magoon asked Mr. Boc to comment on the Corps work at Kamalopau Harbor. *Mr. Boc* agreed that it was a very challenging project. It has everything from concrete-filled buses to dolos that have snapped like toothpicks. He said that the physical modeling has been done at the Coastal and Hydraulics Laboratory and right now the design is using the CORE-LOC. The plan and specs are ready to go, but construction funds have not arrived.

Future Direction of Corps' Shore Protection Program

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Mr. Chesnutt made this presentation for Dr. James F. Johnson, Chief of Planning, Headquarters, U.S. Army Corps of Engineers. Two items to be discussed are the rebuilding of the Corps' planning program as a necessary first step to rebuilding and revitalizing the Corps' Civil Works Program in general, and shore protection.

Three particular aspects of the planning program are the people, the process, and the program. Dr. Johnson wants to build a full-performance team. We have experienced large reductions in Headquarters' planning staffs over the last few years as the General Investigations budget for feasibility studies has diminished. If we are going to start reopening the pipeline, we must get the planners at the front end pushing the things through the pipeline.

We need to improve the process. In recent years, because of the budget deficits and the decisions to cut back on our investment in infrastructure, the people above the Corps were looking for reasons to say no. That is going to change. The decisions to invest more in infrastructure are beginning to come out of Congress, and, therefore, we need to change our attitude and how we define and determine which projects we ought to pursue.

We need to build the program itself. In an effort to build a full-performance planning team, Dr. Johnson has recommended several concepts to implement. The first is to implement a one-team approach. He wants to create a single team of planners that operate together and in unison at the District, the Division and Headquarters levels.

We need to improve the technical planning capability of the Corps. Training courses for planners is being reviewed.

In recognizing that we are part of a project delivery team, we are the front end of the project delivery team, but we are not an isolated island. We have to work together with engineering, construction, and operations on an ongoing basis in delivering projects.

To improve the planning process, we want to develop a pro-active, field-supportive process; help Districts get more projects on the ground more quickly; streamline and simplify the planning regulations; use existing authorities; and improve both organizationally and individually the people who are involved in the planning process and to modernize how we do things.

Shore Protection Program

Even though we have had a downturn in recent years, it is a matter of time before that turns around. A task force comprised of Mr. Norm Edwards, Planning Division, chairman; Messrs. Ron Connor and Gary Hardesty, Headquarters; Mr. Robert Caligiri, Chief of Planning, Philadelphia District, and Mr. Thomas Smith, Planning Division, Jacksonville District, was formed to find opportunities to accelerate the project delivery process through changing the process of how we formulate, design, and construct beach nourishment projects.

The team conducted a short-term effort to examine the current processes for implementing shore protection and to make recommendations for changes that hold promise for speeding up the slow project delivery. We want to reduce the time frame from eight to four years from when a customer requests a shore protection project until there's sand on the beach.

The Corps has had an aversion to risk that prevents us from scoping our decision-making better. Shore protection offers an opportunity to scope decisions based upon the complexity within acceptable risk parameters.

The three processes that the task force looked at were: Plan A - streamline the current process; Plan B - expand the Continuing Authorities Program; and Plan C - adaptive management. Each of the plans brings unique opportunities for schedule acceleration and, with it, increased levels of risk. We need to accept those risks, and there's a better opportunity to adjust to what we learn from project performance in beach nourishment projects than with the hard structures. Once you have got a large structure in place, you can't adjust to what you learn about risks. Beach nourishment allows us that opportunity. No option is generically superior to any other, and a right fit must be determined by the local sponsor.

Plan A - streamlining the current process. We are going to look at how we can delegate authorities down to the Major Support Commands for approval, develop molded PCAs with a one-month approval cycle to help accelerate the process, and restructure or eliminate the preliminary engineering design phase, so that we can move more quickly into final design and construction. We are going to get a research program in shore protection under way. We want to develop generic relationships for coastal storm characteristics and damages because we think we have enough experience with the number of beach nourishment projects that we have built in the last few years where we can begin to look for generic results here. We are identifying the needed policy changes at this stage to allow the implementation of Plan A. It does not appear that there are any legislative changes needed for implementation of this plan.

Plan B - expand the Continuing Authorities Program. Right now the cap on individual shore protection projects that can be approved by the Division Commander is very small ($3 million). Recently, the Continuing Authorities Program process action team recommended that Section 103 authority be increased to $5 million. The task force is recommending that we increase the maximum up

from $10 million to $15 million, allowing Division Commanders more flexibility in their shore protection project decisions. The guidance to reflect a cap would have to be changed and would require Congressional approval for the legislative change increasing the monetary limits.

Plan C - adaptive management. Instead of having a plan formulation phase and an engineering design phase, we would have an evaluation phase and an optimization phase. There would be two corresponding reports. The idea is to get material placed within two to three years after signing an agreement with a local sponsor and then verify and modify the project through extensive monitoring. We would anticipate getting the project 80 percent optimized at the very beginning and get some sand on the beach. Then as we get more involved in monitoring and use the monitoring data to help us with the formulation and the optimization of the design to determine when to place the renourishment. The optimization report would be comparable to traditional feasibility reports. We will be working on policy changes in the near future.

In conclusion, the task force will finalize the report in the next few weeks. Very shortly we would be recommending that we implement Plan A to the senior leadership and recommending creation of an implementation task force to refine the details and recommendations for Plans B and C. This is all very dependent upon getting a shore protection research and development program reinitiated within the Corps. We need a lot of help from people in academia in this process, a lot more monitoring, and the use of monitoring data would have to be a necessary part.

Discussion

Dr. Dean commented that unless the process is speeded up some, the Corps is going to lose out quite a bit on some of the opportunities. He stated that we can do that with some coastal engineering problems, such as beach nourishment or sand bypassing. He added that you simply cannot go wrong with putting good quantities of high-quality material on the beach and then monitoring it. Learn from that and adapt your future strategy.

In Florida, where projects range from about 40 cu yd per ft to 100 cu yd per ft – some projects constructed by local interests, such as Bay County, will be requesting costs reimbursements because they needed to expedite those projects. *Dr. Dean* noted that the state of Florida, which has set up a dedicated funding program for beaches at $30 million a year, is setting up what they call an advisory group simply because of the issue "What constitutes a good beach nourishment project?" This issue arose because of the difference between the Corps and two of the consultants in the state. They were concerned with how much sand should be placed per unit length of beach on the project. That advisory group will consist of four consultants, two academics, who will be rotated, a liaison member from the Corps, and a liaison from

the state. *Dr. Dean* added that he thinks that it's a time when a lot of areas, because of the investment along the coast will be looking for more rapid relief from some of their erosion problems. In his view, this effort is on the right track.

Professor Wiegel wondered why we have gotten to a place where we cannot design and build a project, such as the major complex irrigation system by Michael O'Shaughnessey on the Big Island around 100 years ago. He designed and built this system in 18 months. *Professor Wiegel* realizes that it is because of lawsuits, etc. He believes the internal resistance is tremendous. He added that there is a serious problem with the amount of money that is spent in studies, restudies and additional studies, and a little bit drips out finally to get something done.

MG Fuhrman commented that from his perspective there are two pieces to why the process is getting boggled down in the bureaucracy piece of it. First of all, in the last two decades, there has been considerably less Federal investment. There is only 17 percent of the Federal budget that is discretionary other than -- when you take away the discretionary piece of the Department of Defense. As we had the great buildup in the 1980s, the public works piece of it had to pay a good portion of that bill. It was either the public works or the entitlements piece. With what few dollars were there, more and more scrutiny was put on each individual project to see which ones would go forward, and a great bureaucracy was built getting there. It wasn't just in water resource development, but other public works development as well. *MG Fuhrman* stated that he tasked Dr. Johnson to take a look at what bureaucracy is there for the sake of bureaucracy and that we have control over, and try to decentralize when we can. He stated that the environment that we are in today in building any public infrastructure is considerably different than the environment his predecessors had to deal with in the 1930s, 1940s, and 1950s when the attitude of a burgeoning nation was: "Go out and build and ye shall come." He added that we would never get the Federal investment under the rules we have to deal with today in the Snake and Columbia Rivers that we did back in the public works days of the 1930s and 1940s and beyond that. It's just a different environment. Environmental impact statements take a look at regional impacts, whereas before we just took a look at local impacts. We have to figure out how we can expedite that and do it smartly so that we can continue to move our nation forward. *MG Fuhrman* added that it's a time that the young engineers out there and the energetic folks that we have trained need to roll up their sleeves and think of good ways of doing that. It's a challenging time in regard to water resource development.

New Directions in Coastal Research Needs

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Causes of Coastal Beach Loss and Solutions

Since my presentation at the 67th Coastal Engineering Research Board meeting in Florida, May 1998, the issues of the causes of coastal erosion have gained in local, regional, and national prominence. The solutions to coastal beach erosion, loss of sediments to the coast, and the loss of suitable spawning areas for endangered anadromous fish are being seriously discussed - for example - in southern California, by city and county elected officials as well as the general public.

The public in many coastal areas of our nation and around the world are convinced that methods must be found to maintain and enhance our beach areas for recreation, for protection of adjacent sores from the erosion by storms, and also for their important environmental values. In that regard, the California Shore and Beach Preservation Association and the Coastal Zone Foundation in cooperation with the Coastal Zone Management Committee of the American Society of Civil Engineers (ASCE) and others, is sponsoring a conference in Ventura, California, September 23-26, 1999, *Sand Rights '99 - Bringing Back the Beaches.* As the Technical Program Chairman, I would welcome the Coastal Engineering Research Board to meet at that time to speak to and learn from the national and international experts at this conference.

Design of Rubble-Mound Structures

A second very current issue concerns the design, plans, and specifications for coastal rubble-mound structures. As part of my duties as chair of the ASCE Rubble-Mound Structures Committee, I have been asked to look into the specifications for rubble-mound breakwaters. The question is are American rubble-mound breakwaters being planned, designed, and constructed in the most cost-efficient manner? Additionally, are the specifications of rubble-mound breakwaters as good as those of other countries? I believe that a Corps initiative combined with the knowledge of private coastal engineers is needed to assure that our specifications are consistent with and use the best available engineering information as developed by the Coastal and Hydraulics Laboratory and our universities.

Discussion

Mr. Boc commented that the construction inspector is also very important on a project. You can have the same set of specifications and have two almost completely different looking projects. Out of the

same specifications, one structure can be a stable with special placement versus a structure that is randomly placed.

Island Harbors

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The state of Hawaii depends heavily upon our nine commercial harbors to sustain our economic lives. As a state comprised of six major islands and separated from the lower 48 states by 2,500 miles of ocean, maritime commerce is of vital importance to us. Our nine commercial harbors handled about 15.3 million tons of cargo last year. This cargo supplied Hawaii's de facto population of 1.3 million people with the necessities and luxuries of life.

Descriptions of Hawaii's commercial harbors are as follows:

Harbor	**Pier Length (ft)**	**Shed Area (Acres)**	**Yard Area (Acres)**	**FY 1998 Cargo (Tons)**	**FY 1998 Vessel Calls**
Honolulu	29,347	38.40	205.10	8,479,576	3,938
Barbers Point	1,860	0.83	39.10	1,525,307	439
Hilo	2,669	2.80	15.60	1,369,675	953
Kawaihae	1,562	0.53	9.81	524,208	697
Kahului	3,019	1.99	23.48	2,366,682	1,229
Kaunakakai	691	0.17	2.88	116,848	415
Nawiliwili	1,916	1.76	31.50	704,308	663
Port Allen	1,200	0.80	0.73	175,209	108
Statewide Totals	42,264	47.28	328.20	15,261,813	8,442

Honolulu Harbor on the Island of Oahu is Hawaii's largest and busiest harbor, handling about 8.5 million tons of cargo in fiscal year 1998. This figure is down from the 11.3 million tons handled in 1992 and is reflective of the current depressed Hawaiian economy. Honolulu Harbor is the central element in Hawaii's hub and spoke marine cargo system. Most overseas cargo is received in Honolulu Harbor. Cargo types include containers, liquid and dry bulk, construction equipment, and automobiles. Cargo usually arrives from out of state in large ships. Part of this cargo remains on Oahu where the largest portion (70 percent) of the state's de facto population is located. The remaining part is

transshipped by interisland tug and barge service to the neighboring islands. Hawaii is a consumer community that imports a lot of goods and exports very little. Past export crops such as sugar and pineapple have been greatly reduced due to tough competition from foreign sources. However, new crops such as wood chips are making starts and are expected to play significant roles in our export activities. Other activities include cruise ships, commercial fishing, marine repair, and University of Hawaii oceanographic research.

Our recently completed 2020 master plan for Honolulu Harbor recommends that a second entrance channel be opened. The new channel would help to alleviate the heavy marine traffic in the single existing channel and also allow for larger ships to use the harbor. The U.S. Army Corps of Engineers is currently working with us to determine the feasibility of this recommendation.

Kalaeloa Barbers Point Harbor is located about 22 miles west of Honolulu Harbor and is the state's primary bulk port, receiving petroleum products, coal, and cement. Exports include petroleum products and scrap metal. Plans for container freight service to this harbor are being made and we hope to see container cargo there within a year or two. A Federal-state project to improve the navigation features of this harbor is under way. Proposed improvements include deepening the harbor and entrance channel, constructing a 450-ft jetty and possibly flaring the outer 1,000 ft of the entrance channel. Navigation modeling at the U.S. Army Engineer Waterways Experiment Station has been completed and the feasibility study is still ongoing.

Neighbor island ports include Hilo, Kawaihae, Kahului, Kaunakakai, Nawiliwili, and Port Allen harbors. Kaumalapau Harbor is privately owned and serves the Island of Lanai. Typically, these harbors are destination for cargo shipped or transshipped from Oahu. The neighbor islands are heavily dependent on these harbors for their cargo transportation needs. Navigation problems concerning surge are noted at Kawaihae and Kahului Harbors and a breakwater reconstruction is needed at Kaumalapau Harbor.

Large passenger liner cruise shipping has become an increasing important part of Hawaii's maritime activities. Foreign cruise ship arrivals have increased dramatically over the past few years and our locally based American Hawaii cruises have announced the building of the first new American hulled passenger liners in the past 40 years. However, these ships are growing in size and concern is being expressed about the abilities of our harbors to accommodate these giant ships. Concerns about channel size and alignments as well as turning basic adequacies are being discussed with ship pilots, the U. S. Coast Guard, and ship agents.

Alternative forms of international, interstate and intrastate cargo transportation are very limited. Air transportation remains the primary means to move people. A waterborne ferry system is being planned to carry commuters on Oahu, and an interisland ferry is being investigated for service between the islands of Maui and Molokai.

Hawaii's dependence on the ocean is obvious and Federal assistance is needed to improve our harbors. However, because of Hawaii's population distribution where the bulk of the population lives on Oahu and the minorities are spread out over the remainder of the islands, it is often difficult to impossible to prove Federal interest for many of our projects. Even though our residents depend on these projects, we have to ask for Congressional help to do needed projects with benefit to cost ratios less than one. A 1994 study by the Corps on this problem concluded that there are other ways to solve this problem than revisiting the Corps benefit-to-cost ratio policy. These included an exception from the Secretary of the Army or by Congressional funding. To date, we have been successful only with Congressional funding.

Discussion

COL(P) Madsen asked what harbor depths the cruise ships need? *Mr. Nunes* answered that harbor depths in Hawaii are 35 ft, and the cruise ships draft 25-33 ft of water.

COL(P) Madsen wondered why the container business was off. *Mr. Nunes* replied that the container volume is down because the gross product is down.

BG Capka commented that the State Harbors Division is working with the Honolulu District on the potential of opening the second channel in the Honolulu Harbor. He wondered if there were any other peculiar aspects associated with opening that channel other than the bridge-tunnel challenge connecting Sand Island? *Mr. Nunes* replied that they would have to dredge the old Kalihi Channel, and that would involve dredging some coral areas. There is a national coral reef initiative, so it might be difficult. Three areas to look at before dredging the entrance channel are the technical, environmental, and economics aspects. If there is a "nay" on any of those areas, it will not be built.

Dr. Albert G. Holler, Jr., asked what type material is being dredged and where the dredged material is being placed? *Mr. Nunes* answered that the material is silty and placed in designated ocean dump sites.

Professor Wiegel asked why cruise ships used the open roadstead instead of a harbor. *Mr. Nunes* responded that the open roadstead is right next to downtown Kailua-Kona and Kawaihai Harbor is in the middle of nowhere. The cruise ships tender the passengers into the towns because the cruise ship industry is tied to the landside activities. When, however, the cruise ships get serviced, they use a commercial harbor.

LTC Wally Walter commented that because coastal engineering has been destroying corals in order to accomplish projects, there is a need to protect the coral systems, and he recommended that artificial reef development be included as an aspect of coastal engineering.

The Influence of Geology, Demographics, and History on U.S. Army Corps of Engineers Coastal Projects

Charles B. Chesnutt
Headquarters, U.S. Army Corps of Engineers
Washington, DC

Dr. Andrew Morang
Coastal and Hydraulics Laboratory
U.S. Army Engineer Waterways Experiment Station
Vicksburg, MS

The U.S. Army Corps of Engineers (USACE) is responsible for designing, constructing, monitoring, maintaining, and administering a variety of civil works projects around the coasts of the United States. The purpose of this presentation is to:

- Summarize types and locations of USACE coastal projects - navigation, shore protection, and restoration.
- Review demographic and economic trends that influence these projects.
- Review geologic characteristics of U.S. coasts.

Types of Coastal Projects

Navigation. Maintaining navigable waterways is critical to the commerce of the United States. Over 90 percent of nation's top 50 ports in foreign waterborne commerce require regular dredging. Over 300 million cu yd are removed from navigation channels each year (USACE-sponsored and privately-funded), and another 100 million cu yd are dredged from berths and private terminals. The leading commodities shipped through U.S. ports are crude petroleum and petroleum products. In 1997, the top six U.S. ports in terms of total tonnage were the Port of South Louisiana, Houston, New York (NY and NJ), New Orleans, Corpus Christi, and Baton Rouge. Note that petroleum was the major commodity at all these ports, even New York. Maintaining deep-draft and small-craft harbors and waterways requires frequent dredging. In 1997, the USACE contract dredged 40.6 million cu yd for the Pacific ports, 116.1 for the Gulf of Mexico, 26.3 for the Atlantic, and 2.6 for the Great Lakes (these values are for coastal sites only and do not include inland river waterways). Additional dredging was conducted by USACE plant.

Breakwaters and jetties. Most inlets and harbors with commercial navigation are protected and stabilized with hard structures. Many of these have been built by the USACE or adopted as Federal projects after the Federal Government took over maintenance of state and local projects. Table 1 summarizes statistics for Federal projects.

Table 1. USACE Jetties and Breakwaters

Region	No. of Harbors with Structures	Total Length of Structures, km
Atlantic	131	74.5
Gulf of Mexico	30	118.9
Pacific	91	130.2
Great Lakes	107	131.1

Shoreline Protection and Beach Erosion Control. The Federal government's role in shore protection began in the 1930s in response to the growing recognition that haphazard and uncoordinated shore protection measures and poorly-designed hard structures were ineffective and damaging to the coastal environment. Shore protection research was interrupted in World War II, but increased steadily from the 1950s through the present via a series of public laws that created the Coastal Engineering Research Center, authorized cost-sharing with state agencies, and allowed for periodic renourishment. Of 82 total authorized shore protection projects, 56 are classified as large, having an average total cost of $12 million. The Miami Beach project, formerly the largest restoration project in the United States, cost almost $83 million. It has been surpassed by Sea Bright, NJ, now in progress and estimated to cost over $100 million total.

Demographic Trends

Numerous cultural and economic trends have influenced development of the coast and, therefore, the location of ports, channels, and shore protection projects. Some of these factors include:

- Development of coastal areas, especially barrier islands, for recreation and vacation homes.
- Locations of natural ports (originally not requiring much maintenance).
- Easy access to sources of raw materials (iron ore, minerals, and coal in the Great Lakes; grain in the Great Lakes; timber in the Pacific Northwest; petroleum in the Gulf of Mexico).
- Proximity to industrial base (heavy industry in the Great Lakes; refineries in southern California and the Gulf of Mexico; manufacturing centers along the Atlantic in the 1800s).
- Access to fishing grounds (New England).
- Access to European markets for trade, immigration (New England, Atlantic seaboard).

Economic changes during the 20th century have shifted the types of cargoes entering U.S. ports. During the early history of the nation, Boston, New York, Philadelphia, Baltimore, Charleston, and Savannah became centers of commerce, banking, and culture because their naturally-deep and wide harbors were suitable for sailing vessels. The industrial boom that followed the Civil War and the spread

of railroads across the Midwest brought grain, iron ore, coal, and industrial products to the Great Lakes, turning Chicago, Duluth-Superior, Lorain, Toledo, and Buffalo into major ports. In the Pacific Northwest, timber trade with the Orient greatly increased ship traffic to Portland, Seattle, Grays Harbor, and numerous smaller towns. Since the 1970s, the Northwest timber trade has diminished, but it has been partly replaced with grain, petroleum, and manufactured goods. The traditional East Coast harbors still carry significant seaborne commerce, but the bulk of U.S. tonnage (petroleum) now passes through Gulf Coast ports. Manufactured goods and machinery are now carried mostly by container vessels. New York, Norfolk, Miami, Galveston, Los Angeles-Long Beach, and Seattle have become major container ports.

Demographic statistics demonstrate the progressive shift in population since the 1960s toward the southeast states, especially Florida, and to southern California. The leading states in absolute growth between 1960 and 2010 are California (19.2 million), Texas (11.6), and Florida (11.2). The coastal counties of southeast and central west Florida are expected to grow an additional 35 percent between 1988 and 2010, and the coastal counties of central and southern California will grow over 30 percent for the same interval. This indicates that there will be increasing pressure on coastal resources, environment, and infrastructure. Many shoreline areas of California and Florida already suffer from sand deficits and overdevelopment, yet, most coastal residents want expansive, sandy beaches conveniently available for recreation.

Discussion and Conclusions

Since the 1960s, there has been a continuing shift in the U.S. population toward the southern states. This has been accompanied by increases in industry and agriculture, recreation, and the infrastructure required to support the millions of new residents. In the next century, it is highly likely that the Corps will have to devote increasing resources to coastal projects in the southern Atlantic region (east coast of Florida), Gulf of Mexico, and the coast of California. These activities will include several categories of projects:

Dredging. International trade is vital to the U.S. economy. Presently, the class of commodity with the greatest tonnage carried through U.S. ports is petroleum and petroleum products. With our growing dependence on foreign oil, annual imports and coastwise shipments are expected to increase. Much of the petroleum is shipped through Gulf of Mexico ports, all of which need frequent maintenance dredging because of large sediment supplies and shallow offshore gradient. Some major oil-handling ports, like New Orleans and Baton Rouge, are on the Mississippi River, which must be dredged constantly to maintain channels suitable for oceangoing vessels. Ports on the Atlantic and the Pacific support other classes of commodities and also need maintenance. For example, Miami, Fort Lauderdale, and other East Coast cities support a growing cruise industry. Norfolk is the leading coal facility in the nation. More and more grain exports, bound for the Orient, pass through Seattle. The Port of New York

is currently conducting a study to evaluate major expansion, which will need to accommodate deeper-draft vessels.

Harbor maintenance. Many jetties and breakwaters throughout the Great Lakes, built during the mid- to late-1800s, need rehabilitation. Pacific Coast jetties are subject to harsh wave conditions and also frequently need repair.

Shore protection and restoration. More and more Americans are moving to the coast, and barrier islands have become prime recreation and residential property. The Corps will probably see an increased demand for regional sediment budget and sediment management studies in numerous locations and be tasked to conduct comprehensive beach restoration and storm protection projects. Such projects are likely in: a) the heavily-developed Northeast, especially New Jersey and Long Island; b) the east coast of south Florida, where sand is in critically short supply; c) portions of southern California; d) areas of the Great Lakes such as the southeast shore of Lake Michigan and the south shore of Lake Erie, which suffer from rapid bluff retreat. In some areas, hard structures may have to be rehabilitated (similar to the rebuilding in progress along the Chicago waterfront).

Other classes of work not discussed in this presentation include wetland restoration (for example, the mangrove coasts in the Florida Everglades) and shoreline erosion control (deltaic Louisiana). Emergencies, such as major hurricanes, and river floods may require Corps participation in the form of beach rebuilding and emergence dredging. Another volcanic eruption on the West Coast, of the magnitude of Mount Saint Helens, may become a coastal problem if large masses of sediment choke rivers and need to be removed.

In conclusion, all signs point to the Corps taking an increasing role in a variety of vital coastal projects in the 21st century.

Discussion

Dr. Dean commented that it is evident that most of the population on the shoreline is not aware of the coastal hazards that exist and are not really prepared to respond to the aftermath of storms. He noted that there are government agencies that advocate not rebuilding and others who do and recognize the relatively infrequency of storms and the possibility of rebuilding in a proper way. He added that Mr. Chesnutt's presentation suggests that the trend in the United States is that shore protection will become more important to the future. *Dr. Dean* believes that we should consider establishing an effort to try to identify the areas that are appropriate for rebuilding after major storms and developing the framework for identifying proper response actions as well in advance of those storms.

Dr. Edge commented that the presentation by Mr. Chesnutt was that coastal engineering is more than just worrying about the beaches, reconstruction, maintenance, and recovery after storms. He saw a

great deal of focus on ports, navigational interests, and interest in our aging structures, coupled with environmental aspects, and we cannot lose sight of these things.

Mr. Herbie Maurer commented that it is not only the people who live on the coast, but people in Colorado and Mexico who enjoy the beaches and fishing of the coasts, particularly, Texas, so in defining coastal problems, we should not limit our education to just the people of the coastal areas.

Hurricane Evacuation Studies

Helen Stupplebeen
U.S. Army Engineer District, Honolulu
Fort Shafter, HI

Through Executive Orders 12148 and 12673, the Federal Emergency Management Agency (FEMA) is assigned the primary Federal responsibility for carrying out the functions of the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988. Under this authority, FEMA administers the Hurricane Program. It is also the lead Federal agency responsible for hurricane planning and preparedness in the United States and its territories. 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. FEMA and the Corps provide funding for these studies. There is no local cost-sharing requirement; however, non-Federal funds can be contributed to the study.

The Corps is authorized to use its resources for hurricane preparedness planning activities under the Flood Plain Management Services (FPMS) program, which was established by Section 206 of the Flood Control Act of 1960, as amended. It is through this program that the Corps is allowed to provide funding, technical expertise, and study management to support FEMA's Hurricane Program.

Hurricane evacuation studies conducted in insular communities, both in the Pacific and Atlantic areas, have generally followed Corps guidelines that were revised in September 1995 and were developed for mainland studies. The HES process has evolved into what is presently a series of five major analyses that are interrelated and conducted in an efficient, logical order. These include hazards, vulnerability, shelter, behavioral, and transportation analyses which develop technical data concerning hurricane hazards, population vulnerability, public response to evacuation advisories, sheltering needs, and timing of evacuations for a range of hurricane threat situations.

Specific written guidance does not exist for what types of additional analyses are needed for island environments. Due to the current increased funding for hurricane evacuation studies in the Pacific and Atlantic, the development of additional guidance is required. Under the auspices of the Federal Interagency Coordinating Committee on Hurricanes, chaired by FEMA, the Islands Task Force was formed to develop recommendations for specific guidance and procedures to be utilized in the preparation of hurricane evacuation studies in island environments. The task force is co-chaired by FEMA and the Corps. The initial meeting of the group was held in July 1998. Representatives of Federal, state, and local emergency management agencies from island and mainland coastal locations participated in the

session. Subsequent meetings are being held and the findings will be incorporated into new guidance, which will be issued for conducting hurricane evacuation studies in island communities.

Discussion

Dr. Edge asked what type of research was being done on wave setup? *Ms. Stupplebeen* replied that there was a recent island task force meeting, and this has been identified as a future research need and will be recommended for funding.

BG Capka asked if the island evacuation from a hurricane is directed from the wave runup effects and if tsunami evacuation was tied into it? *Ms. Stubblebeen* answered that there were no specific guidelines, but they are starting island studies. The studies are limited to hurricanes and do not include tsunamis.

Mr. Scheaffer from the National Weather Service and a member of the working group dealing with wind, waves, and water levels, mentioned that there is a complex evacuation scenario. There is surge, wave setup and runup at the coastline, damage to structures at high elevations, flash floods, and landslides. One of the things that came out of the working group was a request to set up a research facility to look at waves and water levels and winds associated with a major tropical system. The ideal location would be Guam.

LTC Walters pointed out some difficulties encountered in the Pacific setting. The islands are small, sometimes only two miles, and even though the frequency of storms is smaller, the impact of the storm is huge in terms of evacuation and other kinds of recovery or protection. The violence of these storms has torn up harbor structures and breakwaters and destroyed them in a single storm. *LTC Walters* hopes that attention will continue on this effort.

Disaster Related Issues on the Islands

Melvin Nishihara
Hawaii Civil Defense
Honolulu, HI

The Hawaiian Islands are a unique and special location in the Pacific Ocean placed in an isolated spot as no other on this earth. There is a potential for a multiplicity of hazards: hurricanes, flash floods, tsunamis, and volcanoes top the list.

The mission of the State Civil Defense System is to minimize loss of life and property, provide for the welfare and safety of citizens, restore vital services, provide for continuity of government, and to manage resources for recovery.

Under the authority of the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988, various chapters of the Hawaii Revised Statutes and the Governor's Administrative Directive, the State Civil Defense Division is charged with the responsibility to mitigate, prepare, respond, and recover from these hazards.

Hawaii enjoys a two-tiered system of government - the state and the county. The State Civil Defense System is composed of the Governor, the Director and Vice Director of Civil Defense, State Departments and Agencies, Federal and private organizations, and County Deputy Directors of Civil Defense (Mayors) and their respective administrators.

A comprehensive emergency management multihazard approach in preparing for and managing disasters is employed by the state of Hawaii. This coordinated approach allows the system the use of all available resources, private and public, and to coordinate, integrate, and focus first responders. The infrastructure is capable of a wide range of responses from a partial county disaster to a catastrophic event that may impact a jurisdiction.

An Emergency Communications Network links state, county and Federal agencies responding to disasters.

The partnership between the Federal Emergency Management Agency, the U.S. Army Corps of Engineers, and the state of Hawaii has proven to be an invaluable asset in successfully mitigating the impact of hazards faced by the State Civil Defense System.

Discussion

Dr. Edge asked if the Pacific Tsunami Warning Center is run by the National Oceanic and Atmospheric Administration and where it was located. *Mr. Nishihara* answered that it was located in an area called Ewa on the Island of Oahu.

Dr. Dean noticed that hurricanes and tsunamis had about the same ranking. He wondered which had the higher flood elevations. *Mr. Nishihara* stated that they know what the tsunami elevations are based on historical data that they have been used for the flood insurance rate maps. They are in the process of trying to find out if there are differences in elevation as far as the hurricane storm driven wave. Hopefully, with the advent of SHOALS, they will have a chance to validate data.

Dr. Dean asked if there was a physical reason why most of the historic hurricane tracks were south of the island chain? *Mr. Nishihara* stated that the atmospheric condition and the time of year were determining factors. There are more storms in the August/September/October time frame, and they generally come out of the south.

BG Capka asked if the seismic risk was associated with just the Big Island or others as well? *Mr.Nishihara* said there are faults going through the islands, but on the Big Island, there are thousands of tremors a day. It is being watched very carefully.

Professor Wiegel commented that damage from hurricanes in Hawaii is quite different from the mainland because there is no continental shelf. It is not the surge, but the waves and winds.

Public Comment

(There was no Public Comment.)

Comments by Members of the Board

All Board members expressed their appreciation to the people in the Pacific Ocean Division, the Honolulu District, and the Waterways Experiment Station for the organization of the meeting and for the excellent presentations.

COL(P) Madsen stated that it is always valuable to see how other people are working tough issues. He had a concern that we don't make a convincing argument to the resource providers, policymakers, about the national interests along the coastline and how important it is for us to better understand what the dynamics are. To a certain extent, he does not think our processes for resources and decisions mix well with our needs. He commented that we need to do a better job of making that case so we can make the right choices in the future and design construction and public investment. He is encouraged by the way we are going to proceed towards the next meeting because a lot of the effort is going to go into how do we charter, how do we design and give guidance towards demonstration projects that will test some of the theories that we want to test. *COL(P) Madsen* believes that demonstration projects are a way to relate to the people who make the resource decisions. Once we make our case better, the investments will come that will spur the better engineering for the future.

Dr. Dean spoke about the theme "Military Applications of Coastal Engineering." He thought the presentation by Professor Wiegel provided an excellent retrospective of some of the approaches and difficulties encountered in trying to traverse the surf zone during military applications, and it appears that we have not made a great deal of progress. He wondered if it is because of a lack of research, lack of effort, or lack of good research approach. He added that we are dealing in an area where the forces are very formidable and persistent, and there aren't any easy solutions. He believes the next few years will prove interesting in providing a basis for evaluating some of the research that has been done, such as Logistics-Over-the-Shore and Rapidly Installed Breakwater System.

Dr. Dean was pleased to see the Board adopt regional sediment management as a thrust, as this will provide a framework within which we can evaluate the efforts of one single program on the adjacent shorelines. He added that it also brings to the forefront the value of good-quality sand as a nonrenewable resource and the need to keep that in the system rather than placing it offshore in a disposal area. He thinks that it is logical that the Corps adopt that role because it will result in conservation of our nation's natural and financial resources.

Dr. Edge focused on four specific issues:

(1) Suggests that sometime in the future, engineers and scientists present their ideas in a plan that can transfer knowledge gained from their activities to the area of the other coastlines where it is not quite the same kind of environment with large waves, large sand grains, and clear water. A lot of time, energy, and money are spent in developing a great deal of understanding in what happens in our clear-water

coasts, but in areas where the water in not clear, the beach erosion, beach recovery, and beach wave transformation are not well known. In these areas, traditional bathymetric surveys are still done.

(2) Suggests the Coastal and Hydraulics Laboratory advance SHOALS and that concept in the area where lidar does not work so that we can look at new vehicles to take high-speed surveys in order to provide response quickly.

(3) Suggests that the CERB support the conclusions and recommendations of the Marine Board committee on coastal engineering research and education because it is supportive to the Corps' mission, the profession of coastal engineering, and the students and future professionals.

(4) Suggests the need to focus on the needs that we are going to have in the future. At some point, structures are going to have to be repaired or replaced.

BG Capka echoed the fact that there is a requirement for us to encourage the public's understanding of what is going on in the coastal environment. He also echoed what COL(P) Madsen said that we need to make sure the decision makers know the importance and how the importance of these issues stack up with other priorities that are on their plate.

BG Capka stated that he was delighted to be able to continue with the leadership of the task force to set up demonstration projects that will look to the systems approach to managing the sediment.

BG Capka again thanked the State of Hawaii, all of the presenters; the hotel support staff; the Pacific Ocean Division staff, especially Mr. John Emmerson; the Honolulu District staff, especially Mr. Stanley Boc; the folks at Kaneohe Marine Corps for the excellent field trip; Mr. Charles Chesnutt of Headquarters, U.S. Army Corps of Engineers; the staff at the Waterways Experiment Station, including Colonel Robin Cababa, Mr. Thomas Richardson, Dr. James Houston, and Ms. Sharon Hanks; and the court reporter, Ms. Susan Soderberg.

The 69th meeting of the CERB was adjourned.

Appendix A
Biographies of Board/Speakers/Authors

RADM Kenneth E. Barbor

Rear Admiral Barbor graduated from the University of Michigan in 1972 with a degree in meteorology and oceanography and a Navy commission through the NROTC Program.

His first assignment was aboard the *USS Tawakoni* (ATF 114), which conducted salvage and towing operations in the western Pacific and Indian Oceans. In 1974, Barbor was ordered to the *USS Waddell* (DDG 24) as first lieutenant. While on *Waddell*, he was designated a surface warfare officer.

RADM Barbor attended the Naval Postgraduate School from 1976 to 1978, where he received a Masters of Science in meteorology and oceanography. During this period, he changed his officer designation Unrestricted Surface Line to Special Duty Officer (Geophysics).

In 1978, RADM Barbor reported to Fleet Anti-Submarine Warfare Training Center, Atlantic, where he taught oceanography, acoustics, and anti-submarine warfare tactics in the Surface Anti-Submarine Warfare Officer section. He also implemented a Mobile Training Team for Anti-Submarine Warfare Oceanography.

From 1982 to 1985, RADM Barbor served as Officer in Charge, Naval Oceanography Command Detachment, Brunswick, ME.

In 1985, he reported as Commanding Officer, Oceanographic Unit FIVE embarked in *USNS Harkness* (T-AGS 32). During his tour, he conducted hydrographic survey operations off Somalia, Oman, and Diego Garcia. He next served as Fleet Oceanographer for Commander SEVENTH Fleet.

He joined the staff of the Oceanographer of the Navy in 1988, serving as the Head, Tactical Oceanography Branch (OP-961E), and in 1991, he assumed command of Naval Oceanography Command Facility, Brunswick, ME.

In 1993, RADM Barbor reported to the Staff of Commander, Naval Meteorology and Oceanography Command as Assistant Chief of Staff for Program Integration and subsequently, Assistant Chief of Staff for Resources. From 1995 until 1997, he served as Commanding Officer, Naval Atlantic Meteorology and Oceanography Center in Norfolk, VA.

He became the Commander, Naval Meteorology and Oceanography Command on 23 October 1997.

RADM Barbor's personal awards include the Legion of Merit (two awards), Meritorious Service Medals (three awards), Navy Commendation Medal, and Navy Achievement Medal.

Stanley J. Boc, Jr.

Mr. Boc earned his B.A. degree in earth science from Bridgewater State College in Massachusetts in 1972, his M.S. degree in marine sciences (coastal engineering) from North Carolina State University in 1977, and is presently working on a Ph.D. in environmental engineering. After graduation from North Carolina State University, Mr. Boc became a lecturer in geology and geography at the University of North Carolina at Wilmington for two years. The next year was spent as a regional extension specialist in coastal engineering for the New York State Sea Grant Program. Mr. Boc began his Federal civil service career as a hydraulic engineer, coastal engineering specialist, for the Chicago District of the U.S. Army Corps of Engineers in 1980. From 1982 to the present, he has served as a hydraulic (coastal) engineer and a project manager for the Pacific Ocean Division and presently the Honolulu Engineer District (HED). Mr. Boc has extensive experience in the planning and design of coastal protection and shallow and deep-draft navigation projects throughout the HED jurisdiction, which includes Hawaii, Guam, American Samoa, and the Commonwealth of the Northern Marianas, as well as the countries of Western Samoa, Palau, the Republic of the Marshall Islands, the Federated States of Micronesia, and the island of Diego Garcia in the Indian Ocean. Mr. Boc also serves as a Field Review Group Member for the Coastal Navigation and Storm Damage Reduction Program, the Coastal Field Data Collection Program, and the Coastal Inlets Research Program.

BG J. Richard Capka

BG J. Richard Capka became the South Atlantic Division's Commander and Division Engineer on July 10, 1998. His immediate prior assignment was as Commander and Division Engineer of the South Pacific Division, where he assumed command in August 1996.

BG Capka has also served as Assistant Chief of Staff, Engineer, for U.S. Forces Korea and the Eighth Army, and as Baltimore District Engineer.

A 1971 graduate of the U.S. Military Academy at West Point, BG Capka has earned two post-graduate degrees: a Master of Engineering from the University of California at Berkeley and a master of Business Administration from the Chaminade University of Honolulu. He is a 1991 graduate of the National War College and is a registered professional engineer in Virginia.

Among BG Capka's other assignments are troop construction positions in the Federal Republic of Germany and command of the 43rd Combat Engineer Company with the 3rd Armored Cavalry Regiment at Fort Bliss, TX. He was the Chief of Force Design at the U.S. Army Engineer School, Executive to the

Chief of Engineers, and commanded the 1st Engineer Battalion of the 1st Infantry Division (MECH) at Ft. Riley, KS. He also served as a project engineer and deputy resident engineer in the Pacific Ocean Division, Ft. Shafter, HI.

BG Capka's military awards include the Defense Superior Service Medal, the Legion of Merit, the Meritorious Service Medal (four awards), and the Army Commendation Medal (four awards).

Charles B. Chesnutt

Mr. Chesnutt is a civil engineer in the Flood Plain Management Services and Coastal Resources Branch in the Planning Division of the Directorate of Civil Works at the U.S. Army Corps of Engineers Headquarters in Washington, DC. He received a B.S. degree in civil engineering and an M.S. degree in coastal and ocean engineering from Texas A&M University. He worked in the Coastal Processes Branch at the Coastal Engineering Research Center in Washington, DC, and Fort Belvoir, VA, from 1971 until 1982. He has been at Headquarters since 1982, where he has been involved in coastal resources planning issues. Mr. Chesnutt has been the Program Manager for the Planning Assistance to States Program and manages the Hurricane Evacuation Studies conducted jointly with the Federal Emergency Management Agency and the National Weather Service.

Andrew Constantaras

Mr. Constantaras has been the Chief, Construction-Operations Division, Engineering and Technical Services Directorate, Pacific Ocean Division (POD), since he arrived at POD in December 1998. Prior to this assignment, he was Deputy for Programs and Project Management and Chief, Programs and Project Management for the Japan Engineer District. Mr. Constantaras has held numerous senior engineering, construction and management and leadership positions with the U.S. Army Corps of Engineers (USACE) in the United States and overseas. These include civil engineering positions with the Chicago and Omaha Districts (1968-74); engineering and construction positions with the Mediterranean and Middle East Divisions in Italy, Saudi Arabia and Winchester, VA (1974-81); Deputy Chief, Construction Management and Chief, NATO Section with the Europe Division, Frankfurt, Germany (1981-90); Chief, Civil and Structures Section, Headquarters, USACE (1990-94); and Deputy for Programs and Project Management and Chief, Programs and Project Management Division for Japan Engineer District (1994-98). Mr. Constantaras started with the Corps in 1968 after graduating with a B.S. degree in civil engineering from the University of Illinois. He earned an M.S. degree in civil engineering

from the University of Nebraska, Omaha, and is a graduate of the Federal Executive Institute. He is a registered professional engineer in Nebraska and New Mexico, a member of the American Society of Civil Engineers and was Vice President and President, Tokyo Post, Society of American Military Engineers.

Professor Robert A. Dalrymple

Professor Dalrymple is the E.C. Davis Professor of Civil and Environmental Engineering at the Department of Civil and Environmental Engineering at the University of Delaware, where he has been employed for 25 years. He is the founder and director of the Center for Applied Coastal Research there. He also is a professor of Marine Studies in the College of Marine Studies at the University of Delaware. Professor Dalrymple served on the U.S. Army Coastal Engineering Research Board from 1989-1993. He is a Fellow of the American Society of Civil Engineers and, in 1996, he received their John G. Moffatt–Frank E. Nichol Harbor and Coastal Engineering Award. He is a member of the American Society of Civil Engineers Coastal Engineering Research Council and the Advisory Committee to COPEDEC (Coastal and Port Engineering in Developing Countries). He received an A.B. degree in engineering sciences from Dartmouth College in 1967, an M.S. degree in ocean engineering from the University of Hawaii in 1968, and a Ph.D. degree in civil and coastal engineering from the University of Florida in 1973. Professor Dalrymple is a registered professional engineer in the state of Delaware.

Dr. Robert G. Dean

Dr. Dean received his B.S. degree in civil engineering from the University of California, Berkeley, in 1954, an M.S. degree in physical oceanography from Texas A&M University in 1956, and a Sc.D. from the Massachusetts Institute of Technology (MIT) in 1959. He has been a senior research engineer with Chevron Research Corporation; professor at MIT, University of Washington, University of Delaware, and the University of Florida, where he is currently Chairman and Graduate Research Professor in the Coastal and Oceanographic Engineering Department. Between 1985 and 1987 he was Director, Division of Beaches and Shores, Florida Department of Natural Resources.

Dr. Dean is a member of the National Academy of Engineering and a recipient of the Outstanding Civilian Service Medal, the American Society of Civil Engineers (ASCE) John G. Moffatt-Frank E. Nichol Harbor and Coastal Engineering Award, the ASCE Award for Significant Contributions in Coastal

Engineering and Wave Hydrodynamics, and the Gold Medal Award of the Florida Shore and Beach Preservation Association.

Dr. Dean is a worldwide expert on nonlinear water wave theories, wave forces on structures, harbor resonance, beach erosion problems, tidal inlets, coastal hurricane effects, and sediment motion due to waves shoaling on a beach. He has over 170 publications.

Dr. Billy L. Edge

Dr. Edge is a professor of Ocean and Civil Engineering at Texas A&M University; Head, Ocean Engineering Program; and Co-Director, Texas A&M Center for Texas Beaches and Shores. He has B.S. and M.S. degrees in civil engineering from Virginia Polytechnic Institute and a Ph.D. degree in civil engineering from Georgia Institute of Technology. Prior to his current position at Texas A&M University, Dr. Edge worked extensively in the private sector, and was a professor at Clemson University.

Dr. Edge's professional interests lie in coastal engineering, dredging technology, coastal-zone management, hydraulic engineering, and water quality modeling. He has performed extensive research in applied hydrodynamics, coastal structures, dynamic coastal processes, mathematical modeling of natural systems, marine pollution control, physical modeling of hydraulic phenomena, sediment transport, and estuarine analysis.

Dr. Edge has published extensively with over 100 publications and has made numerous conference presentations both nationally and internationally, including Spain, Japan, Germany, Australia, South Africa, The Netherlands, Italy, Taiwan, and Canada.

Dr. Edge has achieved worldwide eminence. He has received the International Coastal Engineering Award in 1997 from the American Society of Civil Engineers (ASCE); the W. H. Bauer Professorship in Dredging Engineering in 1994, Texas A&M University; the Morrough P. O'Brien Award in 1993 from the American Shore and Beach Preservation Association (ASBPA); and the Arthur M. Wellington Price in 1983 from ASCE. Dr. Edge is a member of ASBPA, ASCE, Florida Shore and Beach Preservation Association, International Association for Hydraulic Research, Marine Technology Society, Permanent International Association for Navigation Congresses, and Western Dredging Association. His professional activities include being a member of the prestigious Marine Board, National Academy of Engineering; Secretary, Rubble-Mound Structures Committee, ASCE; secretary, Coastal Engineering Research Council, Waterway, Port, Coastal and Ocean Division, ASCE; and editor of the Proceedings of the world's most prestigious international coastal-engineering conference, the International Conference on Coastal Engineering.

Dr. Edge is the Co-Director of the U.S. Army Engineer Waterways Experiment Station/Texas A&M University Graduate Program.

Kenneth J. Eisses

Mr. Eisses is Chief of the Hydraulics and Hydrology Section of the U.S. Army Engineer District, Alaska (POA). He received his B.S. degree in civil engineering from the University of Washington (UW) in June 1981 and his M.E. degree in ocean engineering from Texas A&M in December 1991.
Mr. Eisses began his career with the Corps as a hydraulic engineer in July 1981 with POA. He has worked on coastal, riverine and hydropower projects. Mr. Eisses' duties and responsibilities include the management of the District's active coastal navigation and coastal protection program as well as the riverine erosion and flooding and Chena flood-control operation.

MG Russell L. Fuhrman

MG Fuhrman was selected as Director of Civil Works for the U.S. Army Corps of Engineers effective 11 October 1996.

Prior to his reassignment, MG Fuhrman served as Commanding General and Division Engineers, for the North Pacific Division, U.S. Army Corps of Engineers, from July 1995 to October 1996.

MG Fuhrman oversees the Corps' civil works activities, which has an annual budget of $3.5 billion and includes projects to provide navigation, flood damage reduction, and environmental restoration to the nation. He also oversees the Corps' emergency response mission, the regulatory mission in the nation's waterways and wetlands, and many engineering and construction activities, which the Corps performs for other Federal agencies.

Born in Shawano, WI, MG Fuhrman graduated from the U.S. Military Academy in West Point and holds a master’s degree in chemical engineering from Pennsylvania State University. He is also a graduate of the U.S. Army Command and General Staff College and the U.S. Army War College.

Prior assignments include Deputy Chief of Staff, Engineer, at Headquarters, U.S. Army Europe at Heidelberg, Germany, and Commander of the North Central Division in Chicago, IL. He has also held other command and staff positions with engineer units both in the United States and abroad.

MG Fuhrman's military decorations include four Legion of Merit Medals, three Bronze Star Medals, three Meritorious Service Medals, two Army Commendation Medals, the National Defense Service Medal, the Vietnam Service Medal, and numerous others.

MG Fuhrman is a registered professional engineer in the state of Virginia.

Dr. James R. Houston

Dr. Houston is Director of the U.S. Army Engineer Waterways Experiment Station's (WES's) Coastal and Hydraulics Laboratory (CHL) and the Coastal Engineering Research Center, which is a center within CHL. He has worked at WES since 1970 on numerous coastal and hydraulic engineering studies dealing with explosive waves, harbor resonance, tsunamis, sediment transport, wave propagation, numerical hydrodynamics, and beach-fill design. He is a recipient of the Department of the Army Research and Development Achievement Award; Presidential Meritorious Executive Rank Award; Meritorious Civilian Service Award; 1997 National Beach Advocacy Award; and was the 1993 Eminent Speaker of the Institution of Engineers, Australia. Dr. Houston received a B.S. degree in physics from the University of California at Berkeley, an M.S. degree in physics from the University of Chicago, and M.S. and Ph.D. degrees in coastal and oceanographic engineering and engineering mechanics, respectively, from the University of Florida.

James T. Jarrett

Mr. Jarrett is Chief of the Coastal, Hydrology, and Hydraulics Section of the U.S. Army Engineer District, Wilmington, Wilmington, NC. He received his B.S. and M.S. degrees in civil engineering from North Carolina State University (NCSU) in September 1965 and January 1967, respectively. Mr. Jarrett began his career with the Corps as a project engineer in September 1966 with the Wilmington District. Between 1972 and 1974, Mr. Jarrett worked at the U.S. Army Engineer Waterways Experiment Station as a Hydraulic Research Engineer, working in the General Investigations of Tidal Inlets Program. From 1974 until the present, Mr. Jarrett has been with the Wilmington District, as a project engineer in coastal engineering. In 1985, he became chief of the Coastal Branch. The Coastal Branch was combined with the Hydrology and Hydraulics Branch in 1994 to become the Coastal, Hydrology, and Hydraulics Section. Mr. Jarrett's duties and responsibilities include the management of the District's active Coastal Protection and Coastal Navigation Program as well as the Riverine Flooding and Water Control Program.

MAJ Jeffrey S. Lavallee

MAJ Lavallee is assigned to Headquarters, Pacific Command at Camp Smith, HI. He serves in the Regional Strategy and Policy Division of the Strategic Plans and Policy Directorate (J5). He is a Transportation Corps Officer in the U.S. Army Reserve on an extended tour of active duty.

W. Jeff Lillycrop

Mr. Lillycrop is Director of the Joint Airborne Lidar Bathymetry Technical Center of Expertise (JALBTCX) located at the U.S. Army Engineer District, Mobile. The JALBTCX combines the extensive operational capabilities of the Mobile District and the international hydrographic and nautical charting capabilities of the Naval Oceanographic Office, with the research and development expertise of the U.S. Army Engineer Waterways Experiment Station. Mr. Lillycrop earned a B.S. degree in engineering mechanics and an M.S. degree in coastal and oceanographic engineering, both from the University of Florida. He is a member of the Hydrographic Society of America and vice president of the Gulf Coast Chapter.

COL(P) Peter T. Madsen

COL(P) Madsen became the Commander and Division Engineer of the U.S. Army Engineer Division, South Pacific, on 1 July 1998. COL(P) Madsen's previous assignment was as the Executive Officer to the Chief of Engineers, U.S. Army Corps of Engineers, Washington, DC. He was selected for promotion to Brigadier General in May 1998.

As Division Engineer, COL(P) Madsen oversees engineering, construction, and real estate activities for the Army and Air Force in California, Arizona, Nevada, and Utah, and for the Air Force in New Mexico. He is also responsible for water resources development activities in the above mentioned states, as well as parts of Oregon, Idaho, Colorado, Wyoming, and Texas.

COL(P) Madsen is a 1975 graduate of the U.S. Military Academy at West Point and has an M.S. degree in civil engineering from the Georgia Institute of Technology. He is a 1995 graduate of the National War College and is a registered professional engineer in the Commonwealth of Virginia.

Major assignments with the Corps have been as Commander and District Engineer, U.S. Army Engineer District, Fort Worth, and as Program Manager with the U.S. Army Engineer Division, Missouri River. From 1991 to 1992, he also served as the Executive Officer to the Chief of Engineers. Other major command and staff assignments include Commander of the 41st Engineer Battalion at Fort Drum,

NY, where he also served as Division Engineer for the 10th Mountain Division. He served as the Operations Officer and Executive Officer of the 307th Engineer Battalion, 82nd Airborne Division, Fort Bragg, NC. In Germany, he served with the VII Corps, both on the Department of Engineering and Housing staff and as Commander of the 503rd Engineer Company. Major overseas deployments have been to Southwest Asia in Desert Shield and Desert Storm and Somalia.

COL(P) Madsen's military awards include the Legion of Merit, Meritorious Service Medal (five awards), the Army Commendation Medal (three awards), the Army Achievement Medal, and the Southwest Asia Service Medal. In Somalia, his battalion earned the Joint Meritorious Unit Award. He is also a Ranger and a Master Parachutist.

Orville T. Magoon

Mr. Magoon is the President of the Coastal Zone Foundation, whose purpose is to provide a forum for exploring and discussing coastal management issues. Mr. Magoon was an employee of the Corps of Engineers for 30 years with positions in the San Francisco District, as Special Assistant to the Director of the Coastal Engineering Research Center in Washington, DC, and retired as the chief of the Coastal Engineering Branch, South Pacific Division, in 1981.

Mr. Magoon received B.S. and M.S. degrees in civil engineering from the University of Hawaii in 1951 and Stanford University in 1952, respectively.

Active in coastal zone management and coastal engineering, Mr. Magoon is Vice Chairman, American Society of Civil Engineers, Coastal Engineering Research Council; Chairman, American Society of Civil Engineering Rubble-Mound Structures Committee; Co-chairman along with California Resources Agency Secretary Douglas Wheeler, of *California and the World Oceans '97*; Founder and chair for many years, starting in 1981, of the biannual Coastal Zone conferences; Co-chairman and organizer of Breakwaters '99, a proposed conference focusing on monitoring of breakwaters and rubble-mound structures. Mr. Magoon was awarded the Corps of Engineers Distinguished Service Award in 1981. He is a member of the National Academy of Sciences Marine Board Committee on Coastal Engineering Research and Educational Needs.

Dr. Andrew Morang

Dr. Morang is a coastal geologist at the U.S. Army Engineer Waterways Experiment Station's (WES) Coastal and Hydraulics Laboratory (CHL). He has worked at CHL since 1985 on numerous

coastal geologic and engineering studies dealing with inlet hydraulic and sediment processes, shoreline change, sediment transport, ocean wave analysis, detection of unexploded ordinance, and Great Lakes cohesive processes. He is the prime author of Part IV, "Coastal Geology," of the forthcoming *Coastal Engineering Manual* and has also authored an engineering manual and numerous WES Technical Reports on geologic processes and monitoring procedures. Before coming to WES, Dr. Morang worked for geotechnical engineering and seismic survey firms in Houston, TX. Dr. Morang received a B.S. degree in oceanography from the University of Washington, an M.S. degree in oceanography from the University of Rhode Island, and a Ph.D. degree in geology from Louisiana State University.

Melvin Nishihara

Mr. Nishihara is the Hurricane Program Manager for the State of Hawaii. He has been in this position since 1986 after his retirement from the U.S. Air Force. Mr. Nishihara received a B.A. degree in history from the University of Hawaii-Manoa.

Frederick S. Nunes

Mr. Nunes was born and raised in Honolulu, HI. He graduated from the University of Hawaii with a bachelor's degree in engineering. Mr. Nunes has been a registered professional engineer in the state of Hawaii since 1975. He has been employed by the State of Hawaii, Department of Transportation, Harbors Division, since 1971 and has held positions in the Planning, Maintenance and Design Engineering sections. In August 1998, Mr. Nunes was promoted to Engineering Program Manager for the Harbors Division and currently oversees the planning, design, construction, and maintenance of all harbor facilities for the state's nine commercial harbors. He previously held the position of Head Planning Engineer for the Harbors Division, in which capacity he managed the Oahu and Hawaii Commercial Harbors 2020 Master Plans, the recently completed Statewide Passenger Terminal Facilities (cruise ship) Study, and various studies with the Corps of Engineers for Barbers Point Deep Draft Harbor and Kahului Harbor.

Dr. Donald T. Resio

Dr. Resio became Senior Research Scientist (ST) at the Coastal and Hydraulic Laboratory, U.S. Army Engineer Waterways Experiment Station (WES) on 16 May 1994, in recognition of his career

achievements in the research area of coastal wave dynamics and coastal sedimentation. As a senior research scientist, Dr. Resio performs a range of research related to military activities including Logistics-Over-the-Shore (LOTS) and to the solution of Army civil works problems such as coastal erosion, maintenance of navigation channels, and disposal of dredged material. Dr. Resio serves as the Laboratory adviser to other scientists and engineers in their research and related applications.

Dr. Resio's education includes B.A. and M.S. degrees in geography/physics and environmental sciences, respectively, and a Ph.D. degree from the University of Virginia in environmental science. He was awarded a one-year post-doctoral fellowship at the University of Virginia sponsored by the Office of Naval Research. His prior experience includes eight years as a Research Physical Scientist at WES, three years as vice president of Oceanweather, eight years as president of Offshore and Coastal Technology, and four years as an associate professor of Oceanography at the Florida Institute of Technology in Melbourne, FL.

Awards and recognitions include the Army Research and Development Achievement Award in 1980 and 1997, the Department of the Army Meritorious Civilian Service Award, selection to the Wave Statistics Committee of the American Society of Civil Engineers (ASCE), and selection as an expert witness in several highly visible court cases of international significance. Dr. Resio has served as the chief oceanographic adviser to numerous private companies and government agencies worldwide and recently was the Australian invited lecturer providing a comprehensive series of wave prediction lectures to academia and industrial experts.

Dr. Resio has published numerous articles in a wide range of refereed journals, including *Journal of Fluid Mechanics; Journal of Physical Oceanography; Journal of Applied Meteorology; Journal of Geology; ASCE Journal of Waterways, Ports, and Harbors;* and *Coastal Engineering*. He has been an invited contributor to three books and has published over 40 conference papers.

Helen Stupplebeen

Ms. Stupplebeen is a project manager with the U.S. Army Engineer District, Honolulu. She works on a variety of civil works projects, as well as servicing as the Floodplain Management Services program manager for the District. Ms. Stupplebeen received a B.S. degree in civil engineering and a B.A. degree in political science from the University of Hawaii, Manoa. She is a professional engineer in the state of Hawaii.

Theodore G. Vaughters

Mr. Vaughters has over 35 years of engineering and program management experience in the development and testing of naval logistics systems including material handling systems to transfer cargo from ship-to-shore, from ship-to-ship, and within both Navy and commercial ships. From 1967 to 1977, he was a supervisory naval architect at Hunters Point Naval Shipyard and Mare Island Naval Shipyard. In 1977, he joined his present organization and became an office head in 1987. He has received numerous awards, including the Meritorious Civilian Service Award for the management of a program that developed a Ro/Ro ship offshore unloading facility. He is currently the head of the Logistics Research, Development, Test and Evaluation Department at the Carderock Division of the Naval Surface Warfare Center. His Department is managing a number of logistics research programs which include joint service logistics over the shore, sea based logistics, strategic sealift, underway replenishment, and shipboard cargo handling systems.

Dr. Charles L. Vincent

Dr. Vincent became Senior Research Scientist for Coastal Hydrodynamics, U.S. Army Engineer Waterways Experiment Station, U.S. Army Corps of Engineers, on 4 April 1991, in recognition of his career achievements in coastal hydrodynamics. As senior scientist, Dr. Vincent conducts research on wind wave prediction and modeling in deep and shallow water, nearshore processes, inlet dynamics and integrated coastal systems models in support of the Army's Logistics-Over-the-Shore efforts and its civil works program.

Dr. Vincent currently serves as a liaison to the Office of Naval Research (ONR) to maximize cooperation in coastal science/engineering research and development related to littoral warfare issues. He serves in liaison efforts with the National Research Council's Ocean Studies Board.
Dr. Vincent worked with the Council of Earth and Environmental Sciences sponsored interagency Subcommittee on U.S. Coastal Ocean Research. Immediately prior to his present assignment he was a Research Physical Scientist at the U.S. Army Engineer Waterways Experiment Station. He has also worked as a private consultant.

Dr. Vincent 's education includes a B.A. degree with distinction in mathematics (1969), M.S. (1971), and Ph.D. (1973) degrees in environmental sciences from the University of Virginia.

His awards and recognition include a Department of the Army Meritorious Civilian Service Medal, the Department of Army Research and Development Achievement Award, and the American

Society of Civil Engineers Walter Huber Prize for Research. He has served on committees or as a reviewer for the American Society of Civil Engineers, American Meteorology Society, American Geophysical Union, Journal of Physical Oceanography, Coastal Engineering, Journal of Geophysical Research, and Journal of Coastal Research. He has been a member of the steering committees of the National Science Foundation's Coastal Ocean Processes Experiment, the ONR/NASA Surface Wave Dynamics Experiment, and five other major international experiments. He has co-authored over 100 papers and reports.

Professor Robert L. Wiegel

Professor Wiegel is professor emeritus of civil engineering at the University of California at Berkeley, where he began his academic career in 1946 as a research engineer following service in the U.S. Army Ordnance Corps. His research interests encompass nearly all areas of coastal engineering and include beach erosion control and harbor arrangements, such as breakwaters and entrances. In addition to writing more than 145 publications, 95 technical reports, and the book *Oceanographic Engineering*, he is the editor of the books *Coastal Engineering Instruments* and *Earthquake Engineering* and has been the editor of *Shore and Beach* since 1968. Professor Wiegel's professional activities include numerous prestigious appointments to state, national, and international panels. Among others, he has served as commissioner of the California Advisory Commission on Marine and Coastal Resources; as a member of the Steering Committee of the National Academy of Sciences and the National Academy of Engineering International Decade of Ocean Exploration and the National Science Foundation advisory panel for that program; as a member of the U.S. Army Corps of Engineers' Coastal Engineering Research Board; on the National Research Council's Marine Board and its Committee on the Engineering Implications of Changes in Relative Mean Sea Level; on the Advisory Council of the Permanent Secretariat of the International Conferences on Coastal and Port Engineering in Developing Countries; as a U.S. State Department observer to UNESCO's Intergovernmental Oceanographic Commission; and as special advisor to Egypt and a United Nation's Development Program on the Coastal Protection Plan for the Nile Delta. In addition to being a member of the National Academy of Engineering, Professor Wiegel is an honorary member and fellow of the American Society of Civil Engineers (and former chairman of its Coastal Engineering Research Council) and a fellow of the American Association for the Advancement of Science. He received B.S. and M.S. degrees, both in mechanical engineering, from the University of California at Berkeley.

Appendix B

69TH MEETING OF THE COASTAL ENGINEERING RESEARCH BOARD ACTION ITEMS

ITEM	ACTION	AGENT
69-1	Fall CERB to meet for a day and a half at Dauphin Island. a. Recommendations from Item 69-5. b. Report on Item 69-6. (1) Other Divisions attend. (2) Read-ahead material. c. Invite ASA; Congressman Callahan.	SAD/SAM
69-2	Spring 2000 CERB to be in Southern California addressing wetlands and sediment management. Invite Congressman Packard to be keynote speaker.	SPD
69-3	Fall 2000 CERB to be in Texas; focus on fine grained sediment issues. Invite Congressman Lampson to participate.	TBD
69-4	Spring or Fall 2001 meeting in Pacific Northwest.	TBD
69-5	Lay out strategy for coastal engineering R&D: a. Basic and applied. b. ERDC/WES and university. c. Needs. d. Value added. e. Best investment potential. f. Articulation to key players.	HQ/CHL/ Civ Members
69-6	Develop holistic approach to sediment management demo projects: a. Requirements. b. Contact. c. Funding needs and sources. d. ASA engagements.	SAD/HQ

Appendix C

68th Coastal Engineering Research Board Meeting
Wilmington, NC
Norfolk, VA
14-15 October 1998

The 68th meeting of the Coastal Engineering Research Board (CERB) was held in Wilmington, NC, on 14 October 1998, and in Norfolk, VA, on 15 October 1998. The meeting in Wilmington was hosted by the U.S. Army Engineer District, Wilmington (SAW), under the command of COL Terry R. Youngbluth. The meeting was attended by Drs. Robert G. Dean, Billy L. Edge, and Richard W. Sternberg, civilian Board members; Messrs. Charles B. Chesnutt and David B. Mathis of Headquarters, U.S. Army Corps of Engineers (HQUSACE); COL Robin R. Cababa, Dr. James R. Houston, Mr. Thomas W. Richardson, and Ms. Sharon L. Hanks of the U.S. Army Engineer Waterways Experiment Station (WES); and COL Youngbluth, Messrs. William E. Davis, William A. Dennis, James T. Jarrett, David W. Leitch, Coleman Long, Douglas L. Quinn, Linwood W. Rogers, Jr., Robert E. Sattin, John B. Woolwine, Michael J. Wutkowski, and Ms. Debra K. Timah of SAW.

After a welcome by COL Youngbluth, various coastal programs and area projects were discussed. Mr. Jarrett presented an overview of the District Coastal Program, Mr. Dennis made a presentation on the Cape Hatteras Lighthouse Protection, and Mr. Wutkowski presented the Generalized Risk AND UnCertainty (GRANDUC) Program. Area projects discussed by Mr. Jarrett included Fort Fisher Revetment, Kure Beach, Carolina Beach, Wrightsville Beach, and Masonboro Inlet. Mr. Chesnutt gave a presentation on the North Carolina Beaches Study, after which the area projects discussed were visited.

The CERB reconvened in Norfolk, VA, and was hosted by the U.S. Army Engineer District, Norfolk (NOA), under the command of COL Allan B. Carroll. The meeting in Norfolk was attended by MG Russell L. Fuhrman, MG Jerry L. Sinn, and BG J. Richard Capka, military Board members; Drs. Dean, Edge, and Sternberg, civilian Board members; Messrs. Chesnutt and Mathis and MAJ Scott Schutzmeister of HQUSACE; COL Cababa, Dr. Houston, Messrs. Richardson and Charles C. Calhoun, Jr., and Ms. Hanks from WES; Dr. Albert G. Holler, Jr., of the South Atlantic Division; Mr. George W. Domurat of the South Pacific Division; and LTC Frank A. Jordano, Messrs. Jeffrey C. Irving, Douglas W. Lamont, Mark T. Mansfield, William A. Sorrentino, and Ronald G. Vann of NOA.

After a welcome and introductions by LTC Jordano, presentations were made by Messrs. Irving, Lamont, Sorrentino, and Vann of NOA concerning the Coastal and Dredging Programs. Following the presentations, the civilian members of the Board visited project sites at Virginia Beach, Rudee Inlet, Dam

Neck, and Sandbridge, VA. The military members of the Board traveled to the Coastal and Hydraulics Laboratory's Field Research Facility in Duck, NC, where they toured the facility.

During the Executive Session, the civilian members of the Board mentioned that they were quite impressed with the field trip in the Wilmington area. Dr. Dean stated that the Wilmington District is very interesting in the sense that it has a legacy of practicing regional sand management, where they dredge inlets and put the sand back on the beaches. They seem to be very effective in their operations, with just a little fine tuning necessary. The presentation concerning risk and uncertainty raises the issue as to how well do we understand beach recession and beach recovery after a storm? Dr. Edge mentioned the need for better monitoring for the completed projects and having that data available that goes into the risk assessment model. Another problem the Board sees is the lack of resources to provide the necessary tools needed to do more research and provide better solutions.

Mr. Calhoun reported on the Coastal Engineering Education Program of which 10 students from the Corps and one person from Spain participated. The Board fully endorses this program.

Also, during the Executive Session, the action items from the previous CERB meeting were discussed. Dr. Houston discussed research and development issues and budget, which included shore protection and restoration. BG Capka presented recommendations from the task force members on ways to implement regional sediment management to maximize the long-term environmental and economic benefits of managing programs, and this takes cooperative efforts from all levels of government. Proposals and challenges for demonstration sites were discussed, and recommendations would be presented at the fall meeting.

Mr. Chesnutt reported on the progress of the partnering initiative, that included meetings with the American Consulting Engineers Council and Federal agencies, and he identified three areas that hinder partnering with the private sector: liability, responsiveness, and funding. It was also noted that the Corps has acquired some international projects since the CERB meeting in Ft. Lauderdale, FL, in May 1998.

Various theme topics for the fall CERB in Honolulu, HI, were discussed with general agreement being coastal engineering support of the military because of the large military program in the Pacific Ocean Division.

COL Cababa briefed the Board on the reorganization of the Corps laboratories, with eight laboratories consolidating under one Center. The laboratories would physically remain where they are, but some functions would be consolidated to become more cost-effective.