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THE COASTAL DATA INFORMATION PROGRAM A SUCCESSFUL FEDERAL, STATE AND UNIVERSITY COOPERATION

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Abstract

The Coastal Data Information Program (CDIP) is a cooperative effort managed jointly by the U.S. Army Engineers, Waterways Experiment Station and the State of California, Department of Boating and Waterways. The program is conducted by the University of California, Scripps Institution of Oceanography for the purpose of collecting, analyzing and disseminating coastal environmental data, with an emphasis on nearshore wave climate.

Introduction

The CDIP network was conceived in the early 1970's to fill the need for continuous instrumental records of nearshore wave height and direction along California and other coastlines of the United States. At that time, only short term wave records were available and no measurements suitable for wave climate determinations existed in the shallow, nearshore waters of California, or any other state. Nearshore wave information was limited to biased ships observations, intermittent shore observations and dubious hindcasts.

In California and elsewhere, waves have long been recognized as the primary driving force for beach and shoreline processes. These include longshore sand transport,

beach profile changes and coastal erosion. Coastal engineering problems such as breakwater overtopping and coastal flooding also require quantitative knowledge of wave climate. Finally, all manner of commercial and recreational activities including boating, fishing, swimming, diving and the quintessential California sport of surfing, depend on, or are influenced by coastal wave conditions. The need for coastal wave climate measurements is akin to the need for weather observations over land.

Since 1975, CDIP has been collecting wave data at over 70 locations, including some on the east coast, the Great Lakes and Hawaii. The wave network's capability is well illustrated in Southern California, a heavily urbanized and utilized shoreline subject to seasonally and interannually varying wave conditions. Understanding these conditions is crucial to effectively managing this important coastline, yet technical hurdles exist that only basic research backed by long term monitoring can address.

This program is an excellent example of a successful cooperation between federal and state government and academia. It produces a valuable, widely used product at reasonable cost, while furthering scientific research and education.

Program Goals

The primary objective of the CDIP program is to provide wave climate data at selected sites. The first CDIP station was installed in 1975 at Imperial Beach, located in the southern part of San Diego County near the international border. Imperial Beach has had a long history of beach erosion and coastal flooding. Wave measurements were desired as part of a plan to develop viable, cost effective coastal defenses for the city. Erosion, flooding, planning as well as wave measuring are still ongoing.

An important and continuing goal of the program is to maintain uniform data analysis and timely reporting on a strict, monthly schedule. This has been achieved. In addition to the regular monthly data reports, annual reports and occasional longer term summaries are also issued. Raw measurements from all CDIP sensors are archived to allow for improvements in data analysis methods and computation capability. Over the years, this has created a storage problem since data was archived to magnetic tapes until recently. The transition is now being made to optical laser disk storage.

Basic research has always been an important element of CDIP and is essential for the program to remain a viable university based activity. The research function includes financial and technical support of graduate student dissertation projects. At the same time, the university environment supplies vitality to the program through new ideas and methods. Most importantly, the research feedback ensures that the data gathering and analysis will indeed be useful to address the problems of concern.

This has been demonstrated in Southern California, where the rugged offshore bathymetry and the offshore islands introduce great complexity into the coastal wave conditions. The wave climate is dominated by long swell generated by distant

Pacific storms, and occasionally mixed with locally generated, high and steep storm waves. Research efforts have revealed that wave conditions at one coastal site may be much different than those at another site only a few km away. However, experiments have shown that modern computer refraction codes are successful in transforming offshore, deep water frequency-directional wave spectra into shallow water throughout the Southern California Bight. The basic problem of how to estimate wave information at sites with no measurements can be overcome by using the coastal data as a constraint to construct realistic offshore spectral estimates. These are then refracted toward shore to the site of interest.

These kinds of research results provide a firm footing for the applicability of the CDIP wave monitoring effort. As a final benefit, the University of California provides a cost-effective base for this publicly funded program.

Hardware

CDIP typically relies on an inventory of five or six measurement systems. These include instruments to measure shallow and deep water wave energy and directional distributions, as well as wind and currents.

Most stations consist of offshore pressure sensors mounted on the bottom at depths between 5 and 15 m. To observe ocean wave energy spectra in shallow water applications, a single submerged pressure sensor package is usually deployed. Anchored to a hard rock bottom, or scoured into a sandy bottom, these devices are rugged and economical, with typical lifetimes of over five years. These instruments are connected to a shore station by armored cable, which quickly scours into a sandy bottom. In harbors and bays or on offshore platforms, sensors and cables may be fastened to pier pilings or other suitable structures.

A compact pressure sensor array is routinely deployed to measure shallow water directional wave spectra. This compact "slope array" consists of a square frame made of pipe, measuring 6 m on a side and housing 4 pressure sensors, one on each corner. As with most of the shallow water applications, data is cabled to a nearby shore facility.

Occasionally, a "PUV gauge" is deployed in shallow water to measure directional properties. A PUV gauge is a co-located pressure sensor (P) and a current meter that measures the horizontal velocity components (U and V). Functionally, this arrangement is equivalent to the slope array. It has some advantages, in that all the sensors are located at one position and current velocities are also measured. The chief disadvantage is that flow meters generally require more maintenance, and this usually prohibits using this device for long-term deployments.

Sea surface following buoys are generally used for measurements in deep water. The buoys sense vertical acceleration and are designed to perform on-board signal (double) integration, resulting in a vertical excursion measurement. Data is radioed to shore, since cables are impractical for deep water deployments because of the large distances.

"Pitch and roll" buoys, linked to shore by radio, are used where directional data is required in deep water. These instruments float on the surface sensing vertical motion (pitch) and tilt (roll), and are also functionally equivalent to the slope array. Recently, a pressure sensor array has been deployed on the legs of an offshore oil platform. In this circumstance, a microwave and telephone link was available for data transmission.

Data from the various sensors are held in the station's memory buffer which is continuously filled with the latest data. The data are stored synchronously, such that there is no phase lag between data from different sensors. At predetermined times, usually 8 times per day, the field station is called through normal commercial phone lines and down loads its memory buffer to the central facility computer. Considerable flexibility of sampling intervals and durations has been built into the shore stations.

Central Facility

The central data gathering, processing and dissemination facility is based at Scripps Institution of Oceanography in La Jolla, CA. Following some preliminary data quality checks, the data are written to an archive tape and transferred to a minicomputer for further processing. In the event the data fail to meet initial quality criteria, the computer automatically redials the station to reacquire the data.

Data are screened and further analyzed and then routed in near real time to an online data bank. From there, summary wave data is available to a limited number of dial-up users. Summaries are also furnished to the National Weather Service (NWS) in near real time. From the NWS, data are forwarded to appropriate field stations for routine broadcast over the local marine band radio frequencies. This service is broadly popular with the region's many boaters.

The station call-up schedule can be modified to accommodate unusual circumstances, including intense storms or a tsunami alert. During such conditions, the field stations of interest are placed in a continuous interrogation mode and provide uninterrupted observations. Continuous sampling during intense storms helps ensure that peak conditions are captured, providing a better profile of the associated wave intensity. Under a cooperative arrangement with the National Oceanic and Atmospheric Agency's Pacific Marine Environmental Laboratory (PMEL), a procedure has been developed to activate continuous sampling of certain modified stations when PMEL determines a tsunami is pending. These stations have expanded memory buffers to record the days long, continuous time series necessary to accurately monitor water level changes related to tsunamis.

Contract Considerations

The Coastal Data Information Program is operated under a cooperative agreement between the U.S. Army Engineers, Waterways Experiment Station (WES) and the State of California's Department of Boating and Waterways. The cooperative agreement provides a relatively simple method for federal and state agencies to essentially contract with each other for certain specified products and services.

Contracts for services between federal agencies can be issued under a Miltary Interdepartmental Purchase Request (MIPR), containing a scope of work and fund citation. These can be faxed between parties and be effective in days. Exchange of funds or services between federal agencies to or from a state for activities covered by the cooperative agreement can be facilitated in this way. These contract mechanisms are ideal to accomplish jointly supported environmental monitoring programs such as CDIP.

The actual agreement is a relatively simple 13 page document. It specifies the program's purpose, intent, implementation, management and a dozen other, more mundane contractual items that are either required by law or desirable under the circumstances to protect both parties. In the present case, the governing document was signed by the U.S. Army Chief of Engineers and the Director of the Department of Boating and Waterways. The State of California Department of General Services provided legal review from the state's perspective and final state approval. Unless it is amended, the cooperative agreement remains in place unchanged over time, while the actual work to be performed is specified in a new scope of work each year.

The scope of work is negotiated annually between the federal and state program managers with the input of the university principal investigators. The Corps' approval of the scope of work has been delegated to the Director of the Coastal Engineering Research Center, which is the research unit of WES. Thus, essential control of the work statements remains relatively close to the technically competent personnel best qualified to shape the technical program agenda.

The scope of work consists of a list of gauge site orders specifying sites where measurements will be made and detailing the required instrumentation. Budget information is also specified, including the contributions from the federal and state partners, as well as those from any other cooperating agencies. The federal contribution is paid quarterly to the state in this instance, although the cooperative agreement structure allows the flow of money to be in either direction, as appropriate. The state adds its contribution and, acting with federal approval, contracts with the University of California to provide the specified services.

The contract between the state and the university is a so-called "Standard Agreement." Contracting between a state agency and the University of California is simple, since the university is the research arm of the state. The standard agreement is based on the usual university proposal which incorporates the federal-state scope of work as well as other provisions to satisfy state audit and reporting requirements. Once federal and state budgets are approved, the typical turn around time from university proposal submission to funding is about 6 weeks.

Conclusion

The Coastal Data Information Program is a successful cooperation between federal and state government and academia. It produces a valuable, widely used product at reasonable cost, while furthering scientific research and education. The cooperative agreement provides an ideal legal mechanism for the federal government and a state agency to jointly fund an environmental data gathering and research effort.