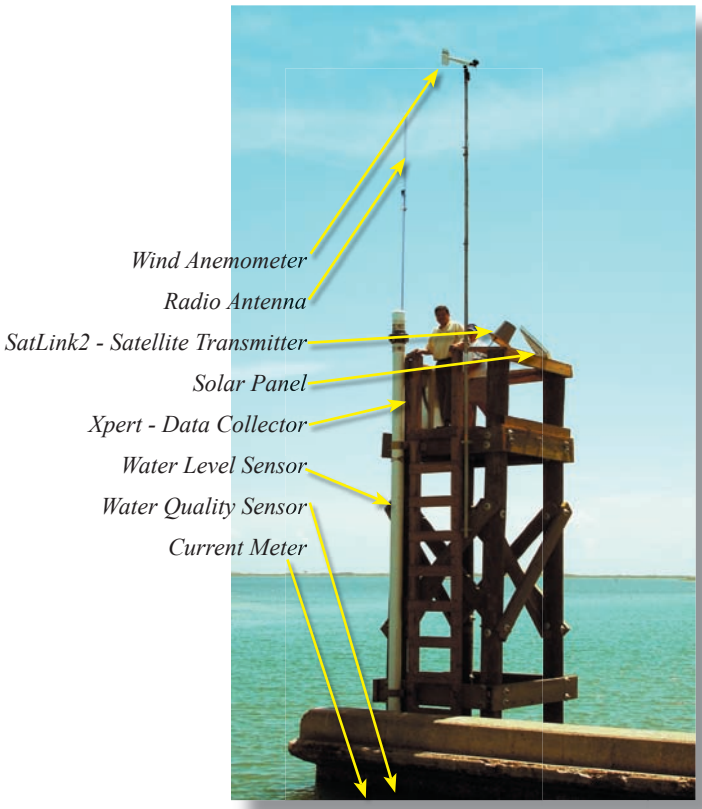
TEXAS COASTAL OCEAN OBSERVATION NETWORK

TCOON data is primarily used...

- to establish tidal datums;
- to provide high-quality water-level information; &
- to prepare affected communities for events such as hurricanes & tropical storms.



In 1989 the Conrad Blucher Institute for Surveying and Science (CBI) at Texas A&M University-Corpus Christi commenced installation of a modern state-of-the-art water-level measurement system along the Texas coast.

In 1991, this network of water level gauges became the TEXAS COASTAL OCEAN OBSERVATION NETWORK (TCOON, http://lighthouse.tamucc.edu/TCOON/HomePage).

TCOON is managed under the direction of the Texas General Land Office, in cooperation with the Texas Water Development Board, the U.S. Army Corps of Engineers, and the National Oceanic and Atmospheric Administration (NOAA). The network utilizes the NEXT GENERATION WATER LEVEL MEASUREMENT SYSTEM (NGWLM) developed by NOAA's National Ocean Service (NOS) and Sutron Corporation for the National Water Level Observation Network. Water-level data and other environmental parameters are made available in near-real time via packet radio, cellular telephone, and the Geostationary Operational Environmental Satellite (GOES). The TCOON system was installed using NOAA criteria for guidance to obtain reliable water level data and to address legal concerns for the admissibility of the data in the determination of littoral boundaries.

The information collected by TCOON has also been used for

- Oil-spill preparation and response
- Recreation, marine and navigation safety
- Oceanographic and environmental research,
- Coastal engineering and construction
- U.S. Army Corps of Engineers dredging operations and management of Texas coastal waterways

The TCOON system has 26 stations , the majority of which are Sutron Tide Stations, in addition to the seven long-term NOAA NOS NWLON stations established and operated by NOS as part of its National Water Level Observation Network.

In addition to WATER LEVEL DATA, most stations provide supplemental data such as WIND SPEED and DIRECTION, AIR TEMPERATURE, and WATER TEMPERATURE. Additional stations provide WATER CURRENT, SALINITY, PH, and DISSOLVED OXYGEN DATA.

This water level and wind data are collected at six-minute intervals (0.1 hours), all other data are collected at some multiple of the standaed of 6 minutes.

OWNER:	Texas A&M
PURPOSE:	To establish tidal datums; to provide high-quality water-level information; & to prepare affected communities for events such as hurricanes & tropical storms.
EQUIPMENT:	Sutron Tide Stations, Sutron's Xpert Datalogger, Sutron's SatLink2 GOES Transmitter, wide variety of sensors
DATE:	1989 - on-going
CONTACT:	James Rizzo Division of Nearshore Research Texas A&M University Corpus Christi 6300 Ocean Drive Corpus Christi, Texas 78412 Ph: (361) 825-5758

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In order to manage this large volume of data, a database management system has been developed which supplies data to sponsors and the public via the Internet at the Division of Nearshore Research Web site @ http://lighthouse.tamucc.edu and through voice telephone response systems.

Several related projects have been established based on the data collection and management systems developed for TCOON. These projects include

- THE NUECES BAY SALINITY PROJECT - City of Corpus Christi

  5 near-real-time water quality monitoring stations measuring parameters such as salinity, dissolved oxygen, and PH.

- THE CORPUS CHRISTI REAL-TIME NAVIGATION SYSTEM - Port of Corpus Chrisiti

  A system to provide the Port of Corpus Christi with real-time navigation data such as water level, water currents, and meteorological conditions

- NATIONAL WEATHER SERVICE OFFSHORE PLATFORM

  Provides meteorological and wave data to help local forecasters create marine condition forecasts.

- THE CONRAD BLUCHER INSTITUTE (CBI) FOR SURVEYING AND SCIENCE has developed one of the most sophisticated water level and environmental observation systems available. The system provides data used for hurricane preparedness, littoral boundary definition, water quality monitoring, real-time water level and meteorological monitoring for marine safety, and recreational users of the bays and estuaries of South Texas.

  THE HIGH QUALITY OF THE DATA provides the potential to expand research initiatives into oil spill prevention and response, eustatic sea level, and shoreline subsidence monitoring, and a host of environmental studies related to water quality and circulation

STATION CONFIGURATIONS

Several different CBI-DNR data collection stations and systems collect coastal measurements, however, each station consists of...

- Sensors to measure various environmental parameters
- A data collection computer for controlling the sensors and temporarily storing data on-site
- One or more telemetry devices for retrieving data from the station and transmitting it to headquarters -including satellite, spread-spectrum packet radio, & telephone modem
- Solar panels and batteries for power

Each station's instrument configuration is determined by the purpose of the station and local conditions. For example, instruments used to measure parameters such as WATER CURRENT, SALINITY, & DISSOLVED OXYGEN are expensive to install and maintain, thus they are deployed at a limited number of sites. The presence of buildings or other physical structures near a data collection station may prevent accurate wind measurements, so wind is not measured at these stations.

The original NGWLM used the highly reliable Sutron 9000 datalogger. Although many are still in operation over 20 years later, they are being replaced with Sutron's new Tide Stations using Sutron's state-of-the-art Xpert Datalogger.

SENSOR SAMPLER

- Acoustic transducers for measuring water elevations
- Wind anemometers for wind speed and direction
- Acoustic doppler current profiling instruments
- Multiparameter water-quality probes
- Water current
- Salinity
- Dissolved oxygen
- Air & water temperatures
- pH
- Barometric pressure
- Turbidity
- Air gap

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CBI-DNR's operations staff performs routine maintenance and calibration of each sensor.

All the stations in TCOON and related projects measure environmental parameters at a multiple of six-minute intervals. For example, water-level measurements are taken every six minutes, while other measurements such as salinity or barometric pressure may be made every thirty or sixty minutes. The data are stored on-site in the data collection computer and then transmitted to CBI-DNR by one or more communications channels including satellite, spread-spectrum packet radio, or telephone modem. The choice of communications depends on availability of telephone or radio connections and the degree of need for real-time observations. For example, stations in the Corpus Christi Real-Time Navigation System and Freeport FlowInfo System use line-of-sight packet radios to allow for frequent acquisition of data from the on-site data collection computers-typically downloading new data once every twelve minutes. At stations where radio or telephone connections are not available, satellite transmissions are used to transmit data at hourly or three-hourly intervals. Thus, the time from measurement to acquisition at CBI depends on the measurement interval and the communications medium used. The data arrive at CBI somewhere between six minutes and six hours after measurement.

INTEGRATED SUBSYSTEMS

1. The "data acquisition" subsystem retrieves the data from network sensor packages and observation platforms. Because of the wide variety of communications links and platform hardware used for measuring environmental data, the data acquisition subsystem is actually a small number of independent software modules that implement communication with specific platform hardware and/or specific communications media. As new platform hardware configurations or communications channels are added to the observation network, it is easy to develop the corresponding acquisition component and integrate it into the existing acquisition subsystem.
2. The "data archival/decoding" subsystem is responsible for maintaining an archive of the source data and converting the raw data files into a standardized interchange format for storage in the MySQL database. The clerk and its decoder programs also perform quality-control data checks to prevent erroneous data from entering the online database system.
3. Any further corrections or adjustments to the data are recorded in MySQL database as separate "correction" records and automatically applied to data.
4. The "data extraction" subsystem also provides an interface to allow users to query the observation database.

DATA APPLICATIONS

TIDAL DATUM

The need to reduce to a common level depth soundings taken at different stages of the tide during hydrographic surveys spawned water level datums. Increasingly, the need of the land surveyor uses this data to determine waterfront boundaries by tidal definition. However, at many locations the astronomical tide is often masked by local meteorological conditions and long-term trends in the Gulf of Mexico, which makes standard procedures difficult to apply and increases the degree of labor required to produce a tidal datum. As a result, CBI-DNR has developed Web-based software that automatically computes datums from water-level data stored in the CBI-DNR database.

LITTORAL BOUNDARY DEFINITION

Tidal datums are used to determine littoral boundaries between submerged and privately owned lands. Bench-mark leveling is performed annually at each TCOON station to ensure station stability and to relate water-level information to reference points on land. CBI-DNR publishes bench-mark elevation sheets on its Web site that indicate the elevation of bench marks above tidal datum planes; surveyors then use these elevations for precisely locating littoral boundaries. For example, the Texas General Land Office used TCOON data to successfully defend against a lawsuit challenging its ownership of lands along the Laguna Madre, saving the state millions of dollars in oil and gas revenues.

NAVIGATION AND MARINE SAFETY

TCOON data has great value to navigation interests. Information provided by TCOON is augmented with current meter data from other systems to provide near-real-time reports of conditions in heavily trafficked shipping channels in

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several Texas ports. One such system is the Corpus Christi Real-Time Navigation System sponsored by the Port of Corpus Christi. CBI-DNR has installed acoustic doppler current profiler instruments at key locations along the Corpus Christi Ship Channel; near-real-time data from these instruments and TCOON platforms allow ship pilots to better navigate large vessels in and out of Corpus Christi Bay. Pilots simply call a local telephone number to receive a digitized voice summary of the latest current, water-level, and meteorological conditions for the stations in Corpus Christi Bay.

The NOS-sponsored Houston/Galveston Physical Oceanographic Real-Time System (PORTS) makes similar use of TCOON stations to assist pilots in Galveston Bay, and the Freeport FlowInfo system monitors currents and water levels for Port Freeport.

CHANNEL DREDGING AND MAINTENANCE

The United States Army Corps of Engineers Galveston District uses TCOON data to plan and execute its maintenance of Federally authorized channels and waterways along the Texas coast, including ship channels and the Gulf Intracoastal Waterway. Navigation channel maintenance and operation activities require knowledge of water level, tidal datums, and other environmental parameters before, during, and after dredging.

OIL-SPILL RESPONSE

A significant application of TCOON data involves developing circulation and oil-spill trajectory models. Each night, the latest water level measurements are automatically downloaded from the TCOON Web site, and used to generate a new set of model calculations that predict currents for the following three days. These current predictions are input into a trajectory model that predicts where oil will move if a spill occurs. Oil-spill emergency response teams are deployed based on these models to deploy to minimize a spill's impact.

HURRICANE AND STORM PREPARATION

An initial and ongoing application of CBI-DNR's tide stations has been to provide timely water-level data to assist the local Corpus Christi National Weather Service Office, and thus the entire community, with hurricane or storm preparedness regarding inundation of low-lying areas along the coast, road closures, and evacuations. The local National Weather Service Office seamlessly integrates near-real-time observations into its weather forecasting systems to better predict the effects of an incoming storm. Because the A&M-CC campus is evacuated if a hurricane threatens the area, CBI-DNR can move its data-collection system to local emergency operations centers to continue collection and distribution of TCOON data during the storm event.

RECREATION & BENEFIT TO THE GENERAL PUBLIC

A particularly successful application of TCOON data has been CBI-DNR's WindInfo system. WindInfo is a telephone voice-response system (361-992-WIND) that provides the general public with wind and water conditions for any

station in CBI-DNR's observation networks. In 1993, WindInfo received over 60,000 calls from windsurfers, sailors, fishermen, and other recreational enthusiasts desiring near-real-time information along the coast.

FUTURE

A collaboration of Texas A&M University researchers are investigating neural-network-based models to make short-term predictions of water level and currents along the Texas Gulf coast and to make real-time predictions of storm surge of tropical storms. The new models will use the real-time and historical observations from TCOON coupled with wind forecasts from the National Weather Service to predict water elevations and currents in a 1 to 30-hour time horizon, necessary for navigation, oil spill response, and marine operations. Preliminary results indicate that for Texas coastal waters a neural-network-based model can significantly outperform forecasts of water levels based on traditional harmonic analysis methods.

The Department of Computing and Mathematical Sciences at A&M-CC is developing a Scientific Visualization Laboratory which will provide facilities for interactive visualization and investigation of the multidimensional multivariate data gathered by the TCOON system.

TCOON plans to expand its data management system to include environmental observation networks from other states and organizations. Preliminary efforts to integrate data from the Texas Automated Buoy System and the University of Southern Florida's Coastal Ocean Monitoring and Prediction System have been successful. A centralized data management system that can accommodate multiple observation networks will reduce the need to redevelop systems such as TCOON and allow better communication among the producers and consumers of environmental data.

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