



Palm-Sized CastAway-CTD Reveals Complex Dynamics in a Small Harbor



The Mexican Institute for Water Technology (IMTA) had big questions to answer as it studied plans for the expansion of the Port of Manzanillo, an important container shipping center on Mexico's Pacific coast. The port authority received permission to upgrade the harbor on the condition that it restore an adjacent lagoon, cut off from the rest of the harbor by a road embankment decades ago.

Reconnecting the lagoon to the sea will return circulation to the system and improve water quality. However, the lagoon has evolved into a freshwater system highly impacted by wastewater from the surrounding community, which has become home to mangrove stands and the bird populations that led it to be dubbed Laguna de las Garzas – Lagoon of the Herons. Biologists raised concerns that simply opening the lagoon to the harbor would alter the lagoon's salinity too quickly, stressing the mangroves and threatening the ecosystem that has developed there.

“We needed some environmental studies related to circulation and how to maintain good water quality,” says Dr. Rubén Morales of IMTA's Grupo de Hidráulica Ambiental (Environmental Hydraulics Group) in Jiutepec, Morelos, Mexico. “We wanted to understand the dynamics of the harbor induced by tidal forcing and gain insight into the vertical structure of the water column. With that information, we could predict what was going to happen when they opened the canal between the lagoon and the harbor. We needed to study the residence time of fresh water in the lagoon and the canal.”

Working in a small boat in a harbor that rarely exceeds 50 feet (15 meters) in depth, Morales, Ariosto Aguilar and Armando Laurel harnessed the power of a new, palm-sized instrument – the CastAway-CTD from YSI – to get a clearer understanding of the dynamics of water column in Manzanillo. Weighing just

one pound (0.45 kg) and reeled in and out on a fishing pole, the CastAway-CTD instantly delivers the same information that typically required a heavy, bulky instrument and extensive data processing.

New Tool

The CastAway-CTD uses its patent-pending design to collect high-resolution data on its free-falling downcast, and to continue logging conductivity, temperature and depth readings as it is reeled back up through the water column. Every cast is georeferenced by the instrument's built-in GPS.

The CastAway-CTD has no moving parts – instead, an innovative flow-through design keeps water in continuous contact with the instrument's sensors, which capture data at a sampling rate of 5 Hz, or five samples per second. The CastAway-CTD temperature sensor responds in less than 200 milliseconds, the pressure sensor is accurate to within 0.25 percent of FS, and its unique conductivity cell is contained to shield its six specially arrayed and sequenced nickel electrodes from the possibility of errors from nearby conductive materials.

The result is data as accurate and as high in resolution as a previous generation of heavy, complex conventional instruments can gather – without the headaches and strained muscles.

The CastAway-CTD also eliminates the hassles of field maintenance. A rinse with fresh water and an occasional scrubbing of the electrodes with dish soap are all that is required to keep the instrument ready for deployment in the field. Calibration is handled by

YSI during annual factory maintenance. Power is supplied by a pair of AA batteries, accessed by a simple twist of the rugged plastic housing. In fact, the only tool required to operate the CastAway-CTD is a plastic stylus to activate the unit's features.

Almost immediately after each cast, the unit's built-in color LCD



Gathering conductivity, temperature and depth data at multiple sites in Manzanillo harbor was easy with the one-pound CastAway-CTD. Results will guide the reconnection of the harbor with the freshwater lagoon to its north.



Compact and lightweight, the CastAway-CTD is a perfect fit in a small boat used by (l to r) Héctor Vélez, Rubèn Morales, Armando Laurel (holding the CastAway), José Urquiza and a driver to study Manzanillo harbor.

screen displays data points and graphs depicting conductivity and temperature versus depth – the measured parameters – as well as derived values for speed of sound and salinity. The instant feedback on the water column, allows users to adjust their sampling programs on the fly, doing additional casts or targeting specific areas or depths for further study.

“You can understand what’s happening and you can say, ‘I need more data’ and cast again,” Morales notes. “It’s really incredible because we can even plan at which depth we should sample.”

With the lightweight CastAway-CTD, doing another cast is simple and painless, especially compared to hauling a larger unit. “We probably did 50 percent more casts because it’s so simple, you want to try it wherever you go,” he says.

Intuitive Software

After viewing data from each cast on the LCD screen of the CastAway-CTD, Morales and his colleagues used the unit’s Bluetooth connection to upload data onto a computer running YSI’s Windows-compatible CastAway-CTD software.

The convenience of a dedicated, wireless connection – no cords snaking around the boat, no pins and connectors to step on, no worries about compatibility or handshaking – was matched by the convenience of working with the intuitive software.

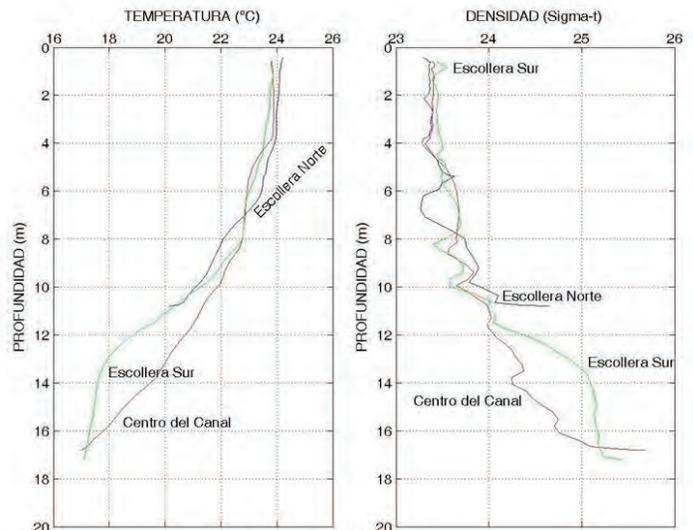
CastAway-CTD software plots every cast – georeferenced with GPS coordinates, time stamp and unit number – on an interactive map. With drag-and-drop functionality, users can group or compare data, creating tables and graphs with the click of a mouse.

“It’s definitely very easy and very practical to see the plotting of the data,” says Morales. He used CastAway-CTD software to view and graph the data from his fieldwork and publish it in his preliminary report. For further analysis, it is quick and convenient to export data from the CastAway-CTD to industry standard software packages such as Excel, Hypack and Matlab.

Vertical Gradient

Morales and his team saw a significant lateral temperature gradient – two degrees C at 12 to 14 meters in depth – at the entrance to the harbor. Guided by data from the CastAway-CTD, they gathered current data with a SonTek acoustic Doppler profiler (ADP) to determine that water flows through Manzanillo harbor in different directions on either side of the thermocline (a two-layer flow).

“At the main entrance to the lagoon, there is a very strong lateral gradient, which is really important in the dynamics of the harbor,” Morales reports. “Travel in the surface layer is toward the sea. At the same time, water in the lower layer is moving toward the



Data from a CastAway-CTD revealed to Rubèn Morales and his team from the Mexican Institute for Water Technology (IMTA) a strong temperature gradient at the mouth of Manzanillo harbor, directing further exploration of the harbor’s dynamics.

port. Normally, it is thought that in small, semi-enclosed harbors the circulation is barotropic, but in the Manzanillo harbor, there is two-layer flow, which has been corroborated with the CastAway-CTD and a towed SonTek ADP. That’s important to understanding residence time and the distribution of pollutants inside the port.”

Identifying the temperature gradient in the water column illus-



trated to Morales and his colleagues the need to assess the port with more powerful models than they had been using before. “Normally we think we can model circulation with 2-D models, but what we found is that harbor dynamics in Manzanillo are not as simple as everybody thinks,” he says.

Morales’ future work will continue taking him to coastal lagoons and inland lakes to study vertical structure and motion in the water column. The instrument’s high-resolution data and instant feedback are sure to yield more insights into the dynamics of Mexico’s extensive coastal waters as well as lakes that supply drinking water to area communities.

“It’s really important for us to understand the structure of coastal lagoons,” he notes. “We can also take the CastAway to an inland lake to measure stratification and see how the water is mixing. If we have stratification during the summer, we can have anoxic areas. In some cases, we will want to have mixing systems to improve water quality.”

Existing equipment has reliably provided CTD data for years. But those huge, heavy, complicated systems can be a real challenge to manage in the small boats that Morales tends to use in his research. The appeal of the CastAway-CTD – its accuracy, convenience, flexibility and speed – all of which are contained in a carrying case the size of a lunch box.

“Normally, in coastal studies, we just need a small boat,” Morales says. “It’s easy to just take the CTD in its box. It’s not cumbersome.”

For more information on the CastAway-CTD, visit www.yei.com/castaway.



Research with the CastAway-CTD provided a foundation for better understanding of the dynamic ecosystem of Manzanillo’s harbor, lagoon and coastal habitat.

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