Turbulence Generated by Tides in the Canal de Chacao

A Tidal Energy Conversion Site in Chile

Rodrigo Cienfuegos, Assoc. Prof., Environmnetal Engineering Dept., Pontificia Universidad Catolica de Chile**:** We are in the middle of Chacao channel, one thousand one hundred kilometers south of Santiago. We are doing current and turbulence measurements in collaboration with the University of Washington.

Narrator: An APL-UW team led by principal oceanographer Jim Thomson works with Chilean researchers. Their goal is learn more about the 8-knot tides that make the Chacao channel a prime candidate for hydrokinetic energy generation.

Jim Thomson: Underwater turbines make electricity. And what we are looking for is how much turbulence is present in the channels at what stages of the tide to help improve the design conditions for those turbines.

Narrator: Getting a handle on tidal turblulence is a major challenge.

Thomson: The measurements are noisy. They have some errors. The turbulence is the fluctuating part. So as the tides come and go, there's a very strong mean flow that is rather steady and as that flow comes and goes, turbulence comes with it. Those fluctuations require very precise measurement because there are some additional fluctuations that are just noise in the measurement. There're just instrument error. And so the difficulty for us is getting rid of that instrument error – that contamination – and trying to determine what the true turbulence is.

Our key tool is a velocimeter – measures the velocity of water and is a very precise instrument. But it can only work right at the local point where it's deployed. Now we'd like to have measurements up above the seabed in the middle of the water column between the bottom and the surface. To position an instrument there is very difficult. It's easier just to have an instrument on the bottom and measure the flow on the bottom or profile upwards. But those profile measurements are not accurate. So instead what we've done is deploy moorings to put the velocimeter right where we want the measurement.

Then we introduce another problem: the mooring moves. The mooring is like a balloon on a windy day. Try to hold onto it; the balloon makes it dance around all over the place. So now, we have a very precise measurement but we have contamination from motion instead of contamination from instrument noise. So now, a lot of our post-processing and data analysis is to remove motion contamination from the data. And that is well known – using an inertial navigation unit. So we have better information on that, than we do on the measurement error we would get from the bottom mounted version.

Narrator: Insight into turbulence and its effects in Chile's Chacao Channel can likely be applied to a tidal power project underway in APL's own backyard.

Thomson: At Admiralty inlet near Port Townsend, the project is moving forward and turbines may be installed as early as 2014. And one of the key things in designing those turbines and getting ready for that project has been our measurements of the turbulence and helping the turbine engineers understand what to expect in the dynamic loading of those turbines as turbulence comes and goes. The random fluctuations that cause the turbulence are going to cause fluctuations throughout the mechanical system of the turbine. That will age the turbine – perhaps prematurely. Those fatigue loads we know are very important in wind turbines. It's likely they'll also be very important in water turbines.

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