

Surveying dams with a multibeam echosounder in the mountains of Colombia

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Colombia is this beautiful tropical country in South America that provides a great variety of contrast in its stunning landscapes. This is the only country in South America to have both a Pacific as well as a Caribbean coastline. The Andes Mountains, stretching north to south along the western edge divides the country into three large regions: the Caribbean coast; the Pacific coast, and the Orinoquia / Amazon region.

From the air, Colombia clearly shows its powerful and dominant mountain chains which separated by valleys and extensive rivers.

It is in one of these mountain chains a few hours away from the city of Medellín (Antioquia region) where KONGSBERG made history in Colombia.

In 2013 we embarked on this ambitious project with Empresas Públicas de Medellín (EPM) for the mapping of large reservoirs areas in the mountains of the Antioquia region in Colombia using a multibeam echosounder, which at that time had partially been done only with singlebeam technology.

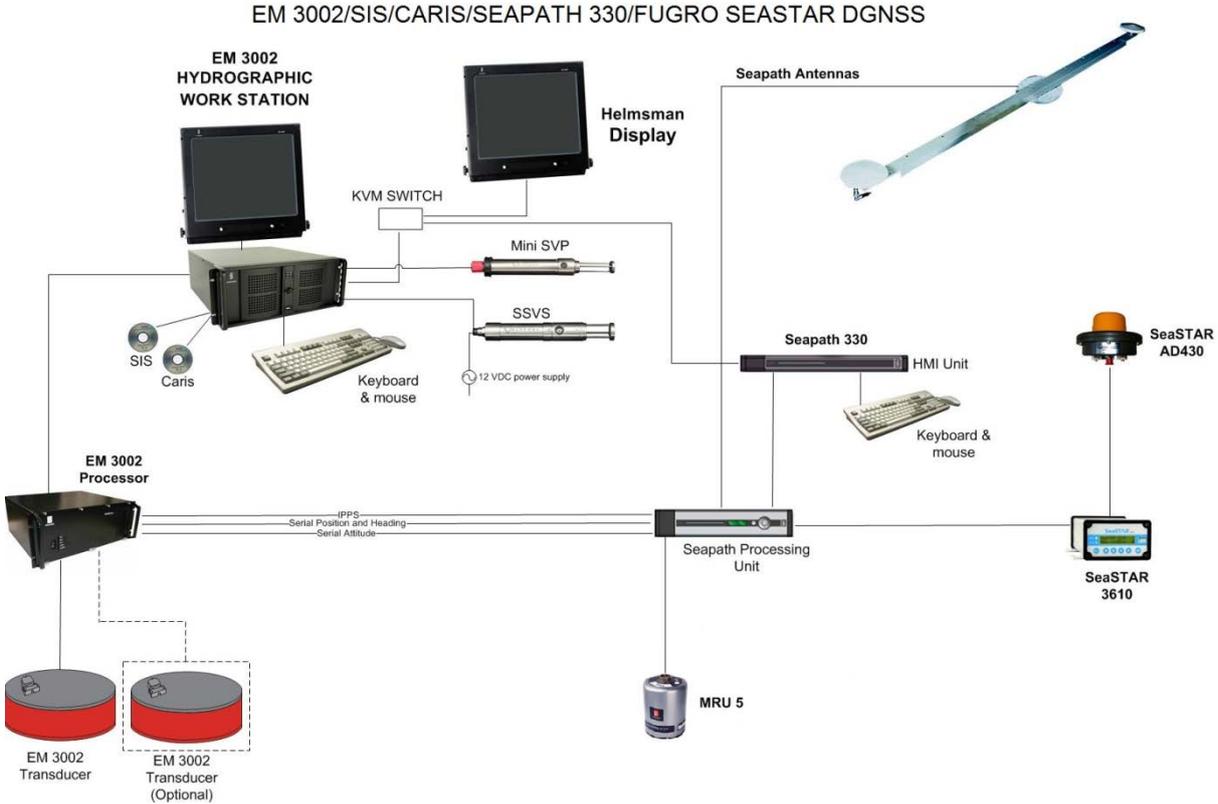
Multibeam bathymetry is based on the fact that more beams are better than one. They map the seafloor by generating several hundred beams over a crosstrack profile for each ping, and each beam generates at least one depth sounding. While the survey platform sails forward the seafloor is covered with a dense pattern of soundings producing high-resolution bathymetry data and geo-referenced high resolution seabed imagery throughout the survey area and thus providing 100% coverage of the seafloor.

EPM is organized as a state-owned, industrial and commercial enterprise, owned by the municipality of Medellín, EPM provides electricity, gas, water, sanitation, and telecommunications.

Through many years EPM has built the backbone of the hydroelectric system in Colombia. Porce II and Porce III are EPM's most important hydroelectric power plants built in the last few years.

EPM became the first state-owned company in Colombia to start a project of this magnitude, using a multibeam echosounder of their own. To accomplish this goal a long and complex public tender process had to be put in place. Multibeam technology demonstrations were also required. KONGSBERG emerged as the best bidder providing the best integration and the most reliable solution of all bids.

In 2013 the delivery of the entire multibeam system and ancillary sensors consisted of the following components: EM 3002 Multibeam Echosounder, Seapath 330 Positioning and Motion Sensor, Valeport SVP for Water Column, Valeport Surface Sound Velocity Probe, Fugro SeaStar Differential Correction and USM Mounting Pole.



Simplified connection diagram of EPM's multibeam survey equipment.

A new survey launch ('Galileo') was designed specifically for this multibeam system project by Eduardoño shipyard in Medellín. KONGSBERG assisted in many key aspects of the survey launch design to guarantee the best performance of the multibeam system as well as assuring that the sensors' installation process would be an easy task to accomplish.



Galileo survey launch at Porce II dam with all survey equipment installed.

The challenges of surveying in dam (reservoir) areas are diverse. First, these survey sites are located in remote areas in the mountains hence it brings a certain difficulty to the mobilization of the survey equipment. The roads (although in very good shape in these areas in Colombia) are usually far away from the dam, requiring transportation of the survey launch and all the equipment in a trailer using heavy duty trucks.



View of Porce II hydroelectric dam and Galileo placed in the water.

Second, usually there is very little accurate knowledge of the seafloor due to the complex geomorphology and the constant changes in water levels; a tree or a rock may come out in the middle of nowhere with no apparent reason for it to be there.

Third, running the multibeam survey lines in reservoirs in the mountains of Colombia is more than a challenge; it is often an act of survival. It is almost impossible to follow a planned survey line due to the presence of navigational hazards such as submerged trees and other features.

Reservoirs (dams) in the mountains can be very dynamic. Many of these places may remind us of the dynamics of rivers in canyons where the water level often rises or decreases several meters in a very short time.

The first recommended task in unknown dam waters is to run a reconnaissance hydrographic survey to get an overall idea of the seafloor topography and determine the areas suitable for a calibration patch test. The key is to go slow, be very vigilant of navigational hazards and do not get close to shore.

In order to map close to the shoreline the universal sonar mount allows the sonar head to be tilted up to 45°. This is crucial as it allows the survey launch to stay away from the dense vegetation that is gathered close to shore. It is also an important feature when surveying around the structures of the hydroelectric plant itself.



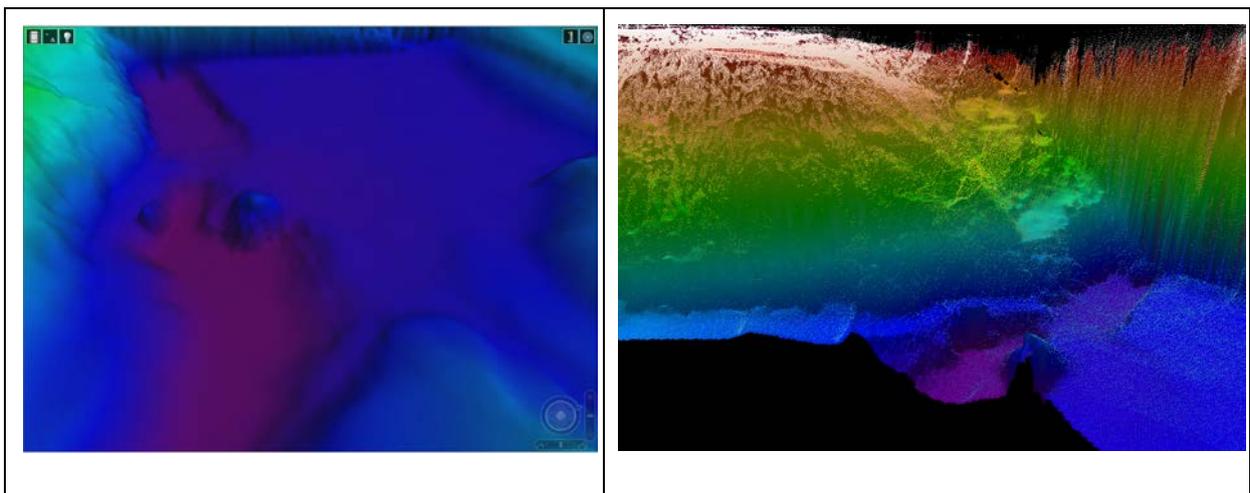
Several protection devices were designed to protect the Sonar Head, MRU-5 and SV Probe.

Last but not least, a protection device needs to be designed and built to protect the equipment; and the investment. This will also help in obtaining a good insurance policy of the entire system.

The multibeam bathymetry takes an important role in generating accurate digital terrain models of a dam floor helping with monitoring the sedimentation and changes in its topography.

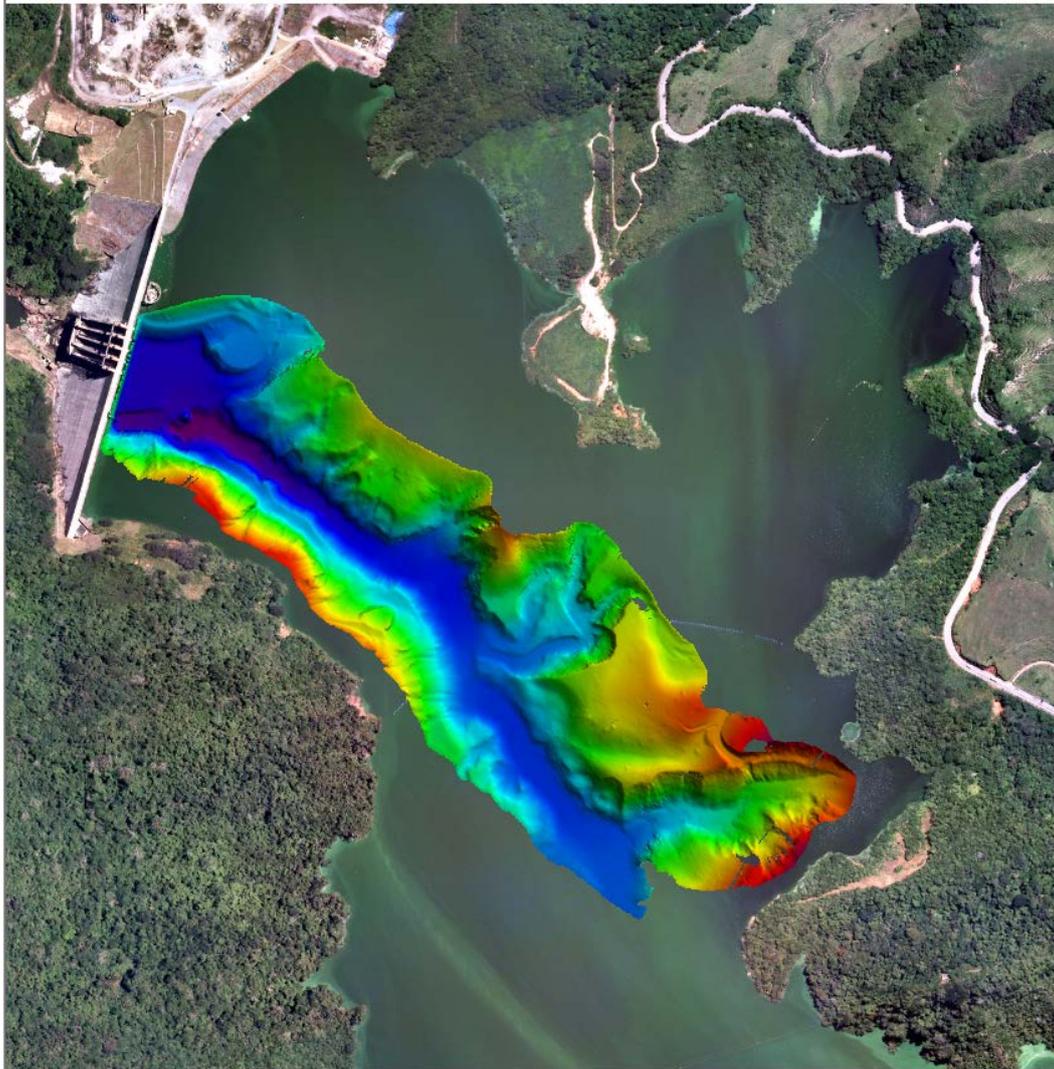
For dam maintenance purposes detailed information of the depths in the area as well as the total volume of water is required; this is also of paramount importance to manage irrigations plans and improve flood control.

Multibeam bathymetry serves as an inspection tool as well as enabling operators to have a closer look at the entire dam structure. The accurate terrain models (navigation surfaces) are also an important element in the safe operation of the hydroelectric facility.



Seafloor features close to the dam structure in Porce II that had never been detected before.

Since 2013 the EM 3002 multibeam echosounder used by EPM in the dam areas in the mountains has revolutionized the way that hydrographic surveys had been historically conducted in these waterways.

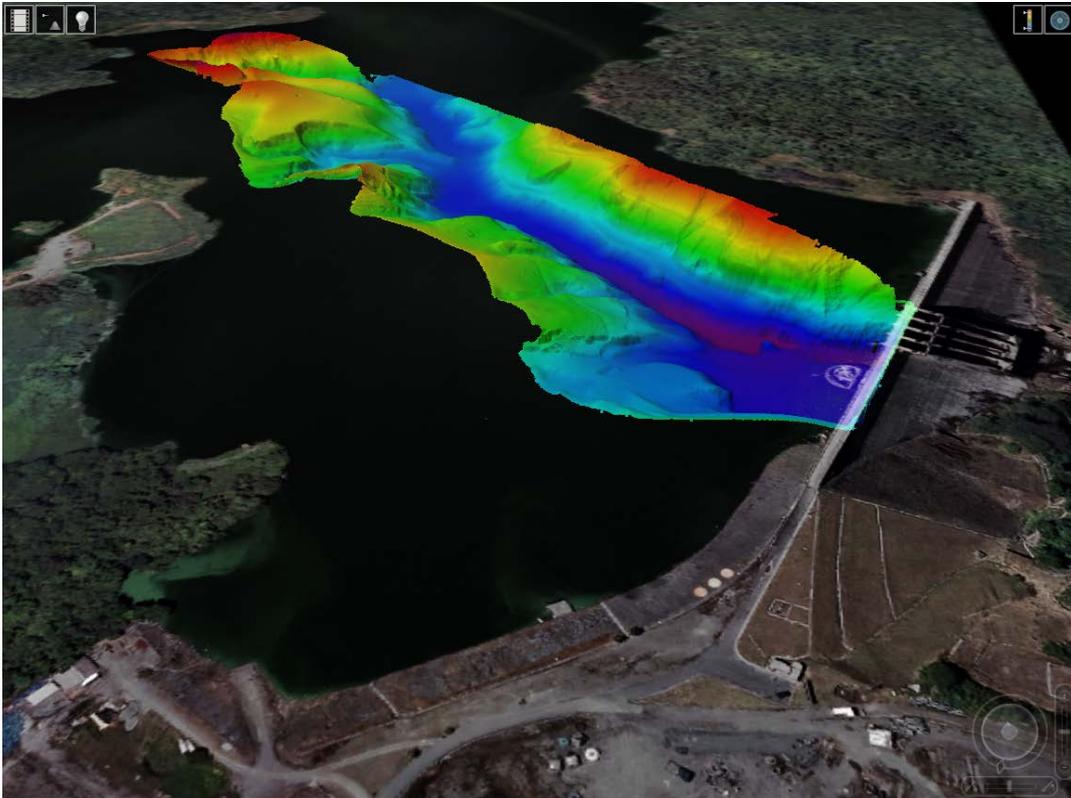


EM 3002 Multibeam bathymetry and Satellite Imagery of Porce II dam. Image courtesy of EPM

Data collection and processing times as well as the delivery of the final cartographic products have been reduced dramatically. By using the latest acquisition and post-processing technologies the final products can be delivered in a relatively short time.

Real time data processing and visualization software gives the surveyors immediate information about the progress of work and the quality of the data that is being collected.

From mapping reservoirs/dams in the mountains, port areas, shipping channels, large continental shelves to finding sunken ships and airplanes; the applications of hydrographic surveys are limitless.



EM 3002 multibeam bathymetry and Satellite Image of Porce II area. Image courtesy of EPM

"For many years KONGSBERG continues to set standards in the market of high resolution multibeam echo sounders. We are committed to delivering customized integrated solutions for shallow, medium and deep water applications that fit specific customers' needs around the world. EPM's successful story is unique in that there were no other actors at the time conducting this type of survey operations of dam areas in the mountains in Colombia, they area pioneers and we are proud of their achievements", said Chris Hancock, Vice President of Sales, at Kongsberg Underwater Technology Inc.

EPM's continued success with the EM 3002 multibeam system comes with hard work; their hydrographic team relies on dedicated highly qualified survey engineers that are always willing to go the extra mile in conducting their daily survey activities.

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