Do I Really Need a Multibeam Echo Sounder – Maybe Not?

At CEE HydroSystems we do not make multibeam echo sounders. It is true that for many survey types, the multibeam has rightly become the hydrographic instrument of choice. It is equally true that multibeam is very unlikely to replace single beam survey methods for many small area, remote, or shallow water surveys.

Always choose the right tool for the job. As the name suggests, a single beam echo sounder transmits a single beam directly downwards to the sea bed. It then waits to receive an echo from the seabed. The interval between ping and echo is directly related to the water depth and this technique is simple and robust. Many survey-quality single beam echo sounders have dual channels operating on significantly different frequencies for differential penetration through water and the bottom sediments. Multibeam echo sounder systems (MBES) transmit a fan-shaped set of multiple pings and so achieve a swathe coverage of the seabed. Multibeam echo sounding is a complicated technique and needs careful set-up of equipment, calibration and monitoring.

Simple logic first dictates that there is a major benefit in using any system that can cover a swathe of the seabed in one survey pass over an area when compared to a single beam instrument which may require several passes to achieve the same coverage. However, as with many things in life, in the real world of hydrographic surveying various other factors have to be considered and something more complex than simple logic comes into play.

Firstly, look at equipment cost including initial cost of hardware and necessary software. Single beam echo sounders and associated transducers are much cheaper than MBES. Single beam transducers are relatively easy to install and outboard rigs on so called “vessels of opportunity” i.e. local rentals, are really easy. A modern single beam echo sounder gives the depths plus information as to what is in the water column. A dual channel single beam echo sounder gives the User the depth as measured to the top of the sea bed plus a certain amount of information resultant from echoes from pings that penetrate into the seabed. In others words an acoustic picture of the sea bed stratification. This is not an exact science as much depends on the bottom. A hard bottom will give the same depth value on both channels. However, a bottom having a deposit of silt overlying a hard rock base with give two distinct values for depth with a lot of information about the bottom characteristics around those two depth values. And of course there are many types of bottoms, we can add silt over compacted clays, we can have silt over fine sand or coarse sand. Multibeam systems give the water depth as measured to the top of whatever is on the seabed.

Operating a MBES system requires a number of peripheral instruments of considerable cost. Personnel training is another factor. Then there is a cost, not always taken into account, relative to the practical utilisation of the system. This cost should include the cost of transportation, cost associated with installation when it is necessary to change vessels.

While MBES offers almost complete bottom coverage, for many surveys total bottom coverage is simply not necessary. For instance, area and volume/capacity calculations do not need total bottom coverage, a judicious choice of line spacing for a single beam echo sounder will yield much the same results and of more importance will indicate areas of sediment build up. In shallow water, the MBES advantages start to disappear. As the swathe width is directly proportional to the water depth, as water gets shallower the line spacing needed to achieve total coverage gets closer. At some point even achieving total coverage becomes impossible and benefits of the MBES are essentially gone.

Surveys for navigation purposes are generally limited to water depths less than 40 metres, and do require as close to total bottom coverage as is possible to achieve. Does this rule out single beam instruments? Well, while the multibeam is certainly the instrument of choice for these surveys, still in many cases a single beam approach may make more sense. Indeed, the IHO accepts that a single beam echo sounder simultaneously operated with a sidescan sonar (SSS) can achieve similar results to the results from multibeam systems. The technique for a navigation survey undertaken using a locally rented boat using a single beam echo sounder augmented by SSS requires that the two transducers (echo sounder & SSS towfish) be mounted on the same support pipe with the positioning antenna mounted on the same pipe, this is to say, with no offsets. Survey line spacing is set to allow the SSS to adequately cover area between lines. Any seabed features detected by the SSS can then be investigated by closer line spacing.

It may make more sense to invest in a single beam echo sounder (supplemented by a shallow water SSS when necessary) and accept that time on site might be longer than if using a MBES. However, the cost of extra boat rental, extra accommodation, extra labour etc. may in cases be less than the overall capital cost of initial purchase and maintenance of a MBES, plus freight and installation.

The following table provides a brief comparison summary of factors to be considered when deciding whether to buy a SBES or a MBES.

Single beam, dual channel CEESCOPE with GNSS RTK	Factors to consider	Multibeam echo sounder
Moderate	**Cost of instrument**	**High**
Low	**Cost of transducer, dual**	**High**
Low, nominal	**Transducer mount fittings**	**High**
Moderate	**Cost of Software**	**High**
Moderate	**Cost of acoustic velocity meter(s)**	**High**
Not required	**Cost of heading device**	**High**
Optional, not included	**Cost of heave/motion device.**	**High**
Side scan option	**Effective Seabed coverage**	**95% @ 60° swathe**
Yes	**Water column information**	**Yes**
Yes	**Sub bottom information**	**No**
Easy, Intuitive	**Ease of use**	**Difficult**
Excellent	**Portability**	**Moderate or Poor**
Simple, very simple	**Installation**	**Involved/expensive**
Simple, very simple	**Calibration**	**Involved**
Minimal	**Maintenance**	**Expensive**
Minimal	**Personnel training**	**Expensive, very involved**

Multibeam systems can justify their expense when employed in permanent installations where the same vessel is used in the same area week after week. A typical application for a MBES is in a busy Port where it is necessary to check a wharf area for obstructions prior to vessel(s) berthing. In this sort of application MBES is quick and effective. Over large areas MBES also have considerable advantages because installation and associated calibration time are much the same whether you are surveying an area 100 x 100 metres or surveying an area 100,000 by 100,000 metres. In small areas a SBES can be deployed and the survey done before a multibeam system has even been unpacked.

In summary: So the question of which is best for you depends on what business you are in. If you are a survey Contractor travelling by air away from base and frequently using a local "vessel of opportunity" you would need a major project to justify the use of a MBES system. A single beam system can be carried as accompanied baggage and installed on most vessels in 30 minutes. Surveying areas requiring closer line spacing will add time to your data acquisition but these costs are likely considerably less than overall cost of using a MBES. If on the other hand you are engaged in the offshore sector with large projects, then a multibeam system would quickly pay for itself.

One last word, with multibeam systems using the right software you can generate beautiful 3D pictures of underwater topography. They may not be exactly accurate but they do look great. And as it happens you can also create beautiful 3D pictures from SBES data. They may not be exactly accurate but they look great.