Very Shallow-water Bathymetry

The River Murray Operations Unit (RMOU) of the South Australian Water Corporation surveys very shallow waters, a type of surveying that has its own specific problems overcome by non-conventional solutions. This article was submitted by a surveyor from the above survey unit.

I attended the Shallow Water Survey conference in Sydney in 2003 because that is what I was doing: shallow-water bathymetry - in fact, I was even doing it out of the water. To my surprise, shallow water seemed to be considered as something at about the 10 metre mark or a bit less; 10 metres, to me, was deep and not very often found. So I guess that I have been doing very, very shallow-water bathymetry. My survey patch is in the lower half of the Murray Darling Basin catchment area, predominantly in South Australia. The Bathymetric Survey Unit, or HYDRO-MAP, is a part of RMOU.

The Main Task

The River Murray and its storage and control structures are the main focus of the work undertaken by the RMOU. HYDROMAP has developed a slightly broader scope, still focused on the Murray and its structures but also encompassing work in the environmental, navigation and ecological fields.

The Real Challenge

The need to regularly survey and monitor the River Murray Mouth and the Coorong and lower-lakes area of South Australia has produced a host of new challenges.
The Coorong is a unique stretch of water some 70 kilometres long and separated from the Southern Ocean by a peninsula of sand hills. It is listed as a world heritage area and the River Murray mouth is its connection to the ocean. The River Murray mouth is a large shallow tidal area of constantly shifting sand and channels. It has an outflow of fresh water, the amount depending on river flows. The river flows are controlled by a series of barrages that prevent salt water from moving upstream into the fresh water lakes and the river system.
The mouth is surveyed to monitor sand movement and the survey data is then used to calculate volumes for dredging and beach degradation or build-up. The data is also being used for the development of a morphological model to enable the development of strategies for operation of the controlling barrages. Maintenance of the ocean connection is vital for the health of the Coorong and its associated ecology.

How It All Began

In the late 1970s a small part of my job was to survey the results of some dredging operations in the River Murray using a paper-chart single-beam echo sounder mounted in a small aluminium boat: in Australian slang, a ‘tinnie’. This operation has now grown into HYDRO-MAP. The purchase of a ‘real echo sounder’ a Honeywell Elac system, which, with its digitiser, its power transformer and other peripherals would have sent my tinnie to the bottom, signalled the beginning of growth into the present fleet.
While developing the survey unit and seeking advice, questions such as, “Why would you want to survey in water less than a metre deep?” and “What do you mean, you can’t use run lines?” were typical responses. The industry has not been driven by a need for this unusual type of bathymetric work and even now we have to trick our software into thinking that we follow run lines, which is a little hard when surveying a winding creek or river section that may only be 10 metres wide.

The Products

The priority task for the HYDRO-MAP unit is the collection of bathymetric data immediately adjacent to the River Murray locks, weirs and control structures. This is done regularly to monitor the riverbed for changes and to detect any scouring that could endanger the structure.
A variety of different outputs have been developed for the presentation of the data. An orthophoto draped over the riverbed bathymetry and a three-dimensional model of the structure is one example.
Our shallow river has numerous shifting sandbanks that can pose a danger to river traffic. These sandbanks are surveyed and a colour-coded chart produced to show the navigable channel; red shows non-navigable places, shades of blue are OK and the darker blue is good.

Fleet and Procedures

Survey Boat

The basic tool for most of our work is the survey boat. It is a five-metre aluminium tri-hull vessel set up to provide 240volt AC power and is fitted with a dual-screen PC for logging and control. It can be fitted with a variety of sounders and uses DGPS with omni-star corrections for guidance and positioning; a heave meter is available when needed. It is also fitted with a digital salinity meter and continuous surface-salinity levels can be collected while doing a bathymetric survey. The salinity data can be processed to produce colour-coded surface grids and presented in a similar way to the colour-coded depth data.

A more or less conventional bathymetric survey of the Murray Mouth channels could be achieved by using the boat at most times, with water depths ranging from 0.5 to a maximum of 5 metres, averaging about 2 metres. However, just surveying the channels was not enough. For a complete picture the sand islands, the areas less than 0.5 metres deep and the exposed sands also had to be surveyed, as did the beaches on the ocean side and the surf zone.
How? The height component of a real-time kinematic GPS became the shallow and above surface sounder. Initially, this was used in a backpack and serious walking along edges and through shallow channels kept me fit; however, it did not produce enough data in the time available. Then came a mountain bike to ride the edges, this was followed by a small, purpose-built aluminium catamaran with a trailing wheel, which bobbed up and down as it followed the surface and carried a RTK GPS antenna.

ARGO 6

All worked to some extent and were used until the perfect machine was found. An ARGO 6 wheel-drive amphibious all-terrain vehicle was purchased. This was fitted with an outboard motor, an RTK GPS and a handheld computer. It has performed beyond expectations. A trailing frame was developed to carry the GPS antenna and this allows shallow areas to a depth of 2 metres to be surveyed when the Argo is used as a boat and exposed sand-islands and beaches to be surveyed when the Argo is used as a vehicle. Its use attracts a lot of attention from tourists as it drives in and out of the channels. A frame is also being developed to allow an echo sounder to be fitted, which will extend the capabilities of this versatile vehicle even further. Of course, it can not be used in waves or high winds and we occasionally have to get out and push.

Jet-ski

The Jet-ski was initially purchased and developed to enable bathymetry in the surf zone and the shallow offshore beach areas of the Murray River mouth. These were ‘no go’ zones for the boat and the Argo. The Jet-ski too has performed well beyond expectations and its versatility, manoeuvrability and speed to the target area has resulted in almost constant use. The narrow creeks, large shallow lakes and areas remote from any boat launching facility no longer present a frightening prospect.
The Jet-ski is a 4-stroke 140hp beast that has been fitted with auxiliary batteries which power a mini-P3 computer running Windows XP and hydrographic software. A small black-box sounder has been fitted with a 200Hz transducer outside the hull and a DGPS system provides location and guidance; RTK GPS provides heave input. Careful placement of the transducer has given a clean water flow and allows logging speeds up to 30kph. A small screen built into a waterproof enclosure in front of the operator allows constant depth monitoring and superimposes position onto background maps or orthorectified aerial photographs.

The Paddle Ski

The newest addition to the fleet is a paddle ski, this has also been equipped with a small portable sounder and differential GPS using Omnistar real-time corrections for guidance and positioning. The need again was to go where the other machines could not go or be launched. It is used for small surveys in very shallow muddy areas, narrow creeks and around structures that are impossible to approach with conventional craft.

Data Processing

The GPS output is logged and a xyz data file is produced and then combined with depth data obtained from the conventional sounders on both the survey boat and the Jet-ski. The resultant composite data is then used to produce contours, comparative isopachs, ortho-draped 3-dimensional views and fly-through videos; it is also used to carry out volume calculations either of sand for dredging, or water for flows and capacities.
When surveying in enclosed waters the melding of land-based bank data with the bathymetric data is essential to give a complete picture of the terrain both above and below the water level. This is achieved by a combination of RTK GPS survey and digitising from ortho-rectified aerial photographs, satellite images and topographical maps. Spatially correct 3-D models of structures are also created and superimposed on the bathymetric data.

Continuing Challenges

The challenges continue. There is a need to obtain more detailed data when doing surveys around structures and in reservoirs, so the purchase of a suitable multi-beam or multi-transducer sounder is being investigated for the survey boat. Lateral thinking and a bit of inventiveness has allowed us to do bathymetry in some very difficult places.

My type of bathymetry is varied and exciting. How is yours?

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