A New Era in River Discharge Measurements

Mobile Acoustic Doppler Profilers (ADPs) have been used on moving boats to measure discharge in rivers since 1991. Whereas conventional propeller-type current meters take hours to complete a discharge measurement, ADPs do the job in just minutes, and they can measure at any location.

Until recently, this technology was restricted to waterways with a minimum water depth of 80cm at any point. A new development is now considerably expanding the use of ADPs.

The ADP discharge measurement method is easily described. A boat or float carrying the instrument is moved from one river bank to the other without a defined course. Four vertical acoustic beams simultaneously measure the current velocity distribution over the entire water column in so-called â€˜depth cellsâ€™, the depth profile of the bottom, and the speed of the boat over ground (by the so-called â€˜Bottom-Trackâ€™). With these parameters, the PC software â€˜WinRiverâ€™ calculates discharge â€˜Qâ€™ on location and in real time.

Older ADPs could work only in deeper rivers, for several reasons. The most significant of these was the dead zone (blank) in front of the transducer head, where no measurement was possible. If one added to this blank the immersion depth of the instrument at the surface, a minimum water depth of 80cm was required to obtain meaningful results.

The goal of the new development was firstly to eliminate the dead zone by a redesign of the transducer head, secondly to reduce the size of the depth cells for higher resolution and thirdly to optimise the Bottom Track for the short distances involved in shallow waters.

Measurement of discharge in shallow water presents some unique problems; any small error in determining the cross-section depth and width or flow reversal can lead to large errors in discharge calculation. So any changes to the cross-section area of the stream by erosion of deposition have to be accounted for by bathymetry in fine detail.

The Workhorse Rio Grande â€˜ZedHedâ€™ ADP recently introduced by RD Instruments has all of these features. It operates with a frequency of 1,200 KHz, and allows reliable discharge measurements in water depths as shallow as 30cm. This opens up many new applications for the ADP.

Manned and unmanned boats, or a specially designed Trimaran float, may serve as platform for the instrument. The centre hull of the Trimaran contains not only the Rio Grande ZedHed ADP, but also a 12V battery and a radio modem in a watertight compartment. This configuration makes an autonomous discharge measurement system, transmitting the data to a Laptop PC on shore in real time. The Trimaran can either be hooked up to existing cable ways, or towed from bridges by rope. The completely assembled system fits into any station wagon and is easily transported from site to site. It represents a real breakthrough because two persons are now able to perform discharge measurements in just minutes.

The first demonstration tour in Europe concentrated on â€˜difficultâ€™ rivers in Germany, Switzerland, The Netherlands, Spain and France. Comparison of the results obtained with the new ZedHed ADP with discharge estimates from the stage and rating curve relationships at well-established sites showed differences of under 1 per cent. The graphs display typical â€˜WinRiverâ€™ data, and results from various river sites visited. The agreement in the comparison is convincing, bearing in mind how much time and labour goes into conventional discharge measurements with propeller-type current meters.

The ADP is a mobile current meter system which can also be used in flood situations. When the river Elbe flooded recently, the Trimaran and ZedHed ADP were towed from a bridge in the city of Dresden, Germany. Peak discharge was measured to be over 4,500 m3/s, compared with the average high water of 326 m3/s at the same location.