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Relationships between B-mode Ultrasound Imaging Signals and Suspended Sediment Concentrations

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Abstract: Ultrasound imaging technique is applied to river model test in recent years, but the imaging features and inner relationships of sediments are still waiting for further study. This paper proposes some new relationships between B-mode ultrasound imaging signals and suspended sediment concentrations (SSC) after kinds of model experiments are conducted in a glass flume. And the influences of particle size, sediment material, ultrasonic frequency and flow velocity on the relationships are discussed in practical applications. Results show that the imaging area concentration (IAC), gray area concentration (GAC) and gray energy density (GED) of sediment imaging signals increase with the addition of sediments until images are filled with imaging signals. The GAC is the best one because of the widest variation range and better sensitivity when compared with the IAC. The GED is the most sensitive to the change of SSC, but it is easiest to reach saturation. The relationship between the GAC and actual SSC can be used to estimate unknown SSC and its vertical distribution when the concentration is below 4.0 ‰ with advantages of direct observation and real time.

Key words: B-mode ultrasound device; imaging signal analysis ; river model test; relationship research; suspended sediment concentration.

0 Introduction

With the development of ultrasound imaging technique, some ultrasound imaging devices have been applied to the measurements of experimental parameters in river model test, such as ultrasonic velocimetry of flows [1-3] and imaging measurement of model topography [4]. All of these refer to suspended sediment particles in sediment-laden flow. Understanding the relationship between ultrasound imaging signals and suspended sediment concentration (SSC) is necessary in addressing many problems, such as the analysis of SSC and its vertical distribution [5], which is vital for the research of sediment movement and river model test.

Over the past three decades, the application of acoustics to the measurement of small-scale sediment transport processes has been gaining increasing acceptance. Acoustic instrumentations, including a triple frequency acoustic backscatter system (ABS) [6, 7], an acoustic Doppler velocity profiler (ADVP) [8], a sand ripple imager (SRI) and a sand ripple profiler (SRP), are used to estimate near-bed sediment transport processes and hydrodynamics [9]. Acoustics has the potential ability to measure non-intrusively, with high temporal and spatial resolution, profiles of suspended sediment size and concentration, profiles of flow and bed form morphology [10]. The possibility of focusing images for small sands in sediment-laden flow has come true with the