

# Die Beeinflussung der Dynamik der Tideästuare durch Flüssigschlick


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der Bundeswehr  
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## On the Interaction of Turbulence and Non-Newtonian Fluid Mud

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### Introduction and motivation

1. Fluid mud is a high concentrated mixture of water, clay-sized particles and organic material. It is characterized by both density and concentrations up to 1500 kg/m<sup>3</sup> and 200 g/l, respectively. Furthermore, it is driven by a 1-m-Halftidezeit, mostly under strong flow behavior. In estuaries, coasts and reservoirs fluid mud causes ecological and economic damage. A better understanding of the fluid mud flow behavior and the implementation in numerical models is necessary.




### The 1DV model

2. A vertical profile in a suspended sediment flow is described by a fine concentrated suspension at the top and very high concentrated suspension at the bottom. The different sediment content over depth causes different flow behavior - there turbulent flow at the top is rheological, laminar flow at the bottom. The continuous modeling approach takes the effective viscosity as the part of the turbulent and the rheological viscosity to describe the whole vertical system in a continuous way.




### Results of the 1DV model

3. Within a MATLAB based vertical 1D model, the one-dimensional Reynolds equation, the transport equation & reaction- & turbulence model and a parameterized formulation of the rheological viscosity were implemented. The effects of density stratification on the velocity profile and the velocity profiles are visible. However, a fine turbulence damping within the mud layer could not be simulated with the applied turbulence model.



### Discussion & Outlook

4. The 1DV model is part of the BSWP project 'Muddywater' and is used as a coupling element between experiments and numerical 3D investigations. The numerical and the rheological approaches can be tested easily with the model. However, the model is being further extended, especially to test more suitable formulations for the turbulence modeling.



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## Concentration measurement by acoustic backscattering with an ADV probe

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### Introduction and motivation

1.

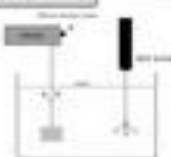
The ADV probe (Acoustic Doppler Velocimetry) consists of an experimental investigation of the turbulent velocity in varying concentrated suspensions. The suspension mass concentrations, which are also discussed within this report, are also measured within this report. Therefore it is necessary to measure the velocity fluctuations and the concentration. Most reliable measurements are expected when measuring both quantities at the same time and location and as highly resolved as possible.



### Experimental set-up

2.

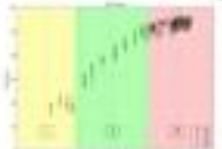
The ADV probe (Acoustic Doppler Velocimetry) and ADV probe (Acoustic Doppler Velocimetry) are able to measure turbulent velocity fluctuations on a high temporal resolution. The measurement principle is based on backscattering of acoustic waves. By means of the ADV (Acoustic Doppler Velocimetry) the backscattered signals can be processed to the volume particle concentration. Other particle concentrations were measured in our different studies and the ADV can measure.



### Results of the measurements

3.

The same equation for underwater detection can be derived to find a relation between the ADV and the particle concentration. With increasing concentration, the ADV increases as well due to the suppression of background noise by the particles. Up to 7 g/l of high-order distribution can be measured, sound attenuation by the particles can be neglected. For higher concentrations, an iterative solution is necessary, which accounts for particle sound attenuation.



### Parameter fitting

4.

Results have shown in dependency of the signal to the different aspects due to the measurement height. For the log-linear part, a logarithmic function could be fitted using MATLAB's Curve Fitting Tool. The linear equation can be expanded by a linear equation for measuring the higher concentration part. With this method, ADV probe concentrations up to 10 g/l can be measured at high temporal resolutions and at the same time and location as the velocity fluctuations are measured.

