The influence of flocculation on the development of a sediment plume

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Boskalis

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by

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Preface

September 2011 I started my Bachelor Civil Engineering and with this thesis I want to finish my Master Hydraulic engineering. The last nine months I spent writing this thesis. Overall it was a great adventure with lots of ups and downs. Before you lies the final outcome of nine months of hard work. I hope you enjoy reading it.

At the end of March 2018, I had the unique opportunity to join a scientific cruise in the Chatham Rise, Pacific Ocean, New Zealand. The main goal of this cruise was to investigate the impact of sediment plumes on the deep-sea benthic environment by undertaking a sediment disturbance experiment. After several days of sea sickness I had a wonderful time with a very steep learning curve. I want to thank both Boskalis and NIWA for this amazing opportunity. The main topic of my Msc. thesis was the disturbing experiment. Unfortunately, the objectives of this cruise were not met and back in the Netherlands I had to change my research topic. With the help of my committee I changed my Msc. topic to "The influence of flocculation on the development of a sediment plume". Hereby thank you for the flexibility.

At first the change of topic was difficult but with the help of Claire Chassagne I could made a relatively fast start. In the laboratory at Deltares I spent many hours doing my experiments. I want to thank Deltares, and especially Saskia Huisman, for the hospitality to work in their laboratory.

I want to thank my parents for their support during the whole period of studying at the TU Delft. I want to thank my co-graduations students/friends for all the coffee's, lunches and all the discussions, related to this or not.

Furthermore, I want to thank my whole committee, Cees van Rhee, Claire Chassagne, Mark Biesheuvel and Frans van Grunsven, for their time and help the past nine months. Thanks for the discussions, critical reading and all the help.

Tim Evert Horst
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Abstract

A lot of uncertainties exist about the impact of deep-sea mining on the Benthic environment. One of these uncertainties concerns the sediment plumes created by the mining operation. The return slurry released above the sea floor creates a large plume of sediments. With numerical models the behavior of such plumes is modelled in order to minimize these uncertainties. Particle size distributions in these plume models are currently based on individual particle sizes. In situ, at the bottom of the ocean in an salt water environment, flocculation can occur. Flocculation can have effects on the particle size distribution, settling rates and floc structure. The objective of this research is to investigate the significance of flocculation on the settling behavior and if it should be taken into account in these plume models. Shear rate and particle concentration, as function of time, are the most governing processes that have effect on the flocculation behavior. The influence of these parameters on the flocculation process are investigated. Different methods are used in the search for a suitable technique to measure the in situ particle size distribution. Next to the particle size distribution the floc shapes, structure and settling rates are measured under the influence of the factors mentioned above.

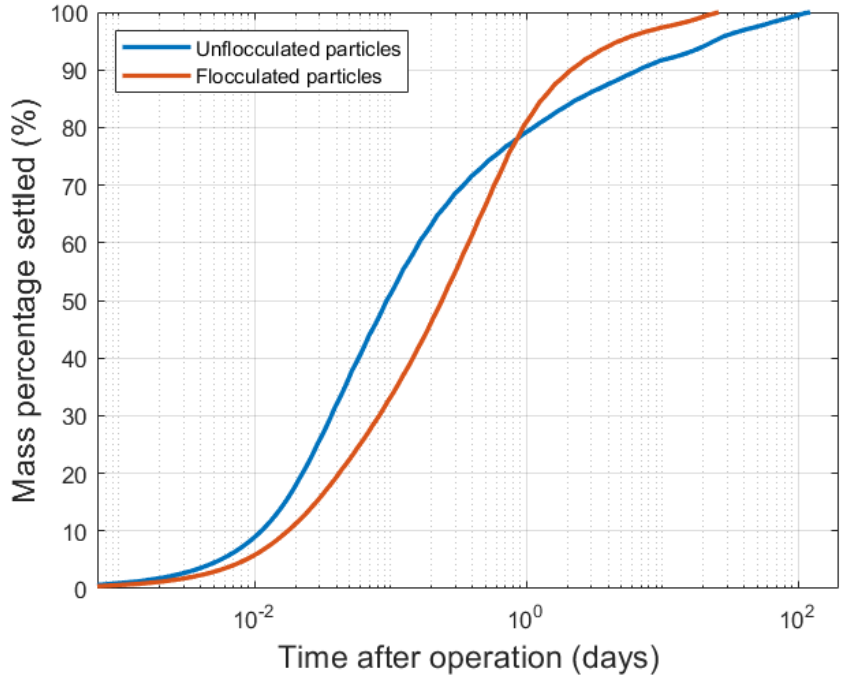

Figure 1: Settled mass percentage over time from a height of 10 meters. Two samples: demineralized (unflocculated) and salt (flocculated) water

In the shear range of 6 s-1 and particle concentration of 0.7 to 40 g/l flocculation does occur and has a large impact on the settling behavior of the sediment. Flocculation at other shear rates and particle concentrations remain unknown. Figure ?? shows the time until 100 % of the mass is settled when the suspension is released at a height of 10 m. This graph shows the difference in settling time between a suspension in demi and salt water. A settling time difference of 85 days (25 days for salt water and 110 days for demi water) shows the importance of including flocculation behavior in plume models.