Title of the MSc project:
Quantify uncertainty in the assessment result for macro stability

Assignment no.: 04.19	**Internal/external:** External (BZIM)
Head graduation committee: K.M. Wijnberg (AD)	**Daily advisor:** Jord Warmink Wouter Zomer (BZIM)
Name(s) of participating companies or institutes: BZ Ingenieurs & Managers	**Start of the project:** Medio 2019

Required courses:
Data Analysis, Hydraulic Engineering

Short description and objective of the project:
In 2017 new water safety norms have been implemented in The Netherlands. With these new water safety norms some new assessment methods have been introduced as well. This was done to be able to include uncertainties in an explicit way. Roelofs (2018) concluded that a fully probabilistic approach for the piping failure mechanisms can result in more quantitative insight in the level of uncertainty in the assessment, and how these uncertainties can be reduced. It is however unknown if this method could also be applied for the macro-stability failure mechanism.

Assessing a dike on the macro-stability failure mechanism implies an iterative method to determine critical slip circles, which can make probabilistic methods more complicated. A guide to perform a fully probabilistic assessment is in further development than for example the piping mechanism(see: is Handreiking faalkansanalyse macrostabiliteit). One can explicitly account for uncertainties, however, it is unknown how large the uncertainties are in the final result. A dike manager (*'dijkbeheerder*') gets one answer from the calculations. Input based on point measurements can go along with a relative high level of spatial uncertainty. For macro stability, uncertainty in phreatic lines, soil strength parameters and soil geometry can cause the determination of the resistance of a dike against macro instability.

This and other uncertainties are not presented in the assessment result. Therefore, a dike that does in reality comply with the norms could be decried and a dike that should be decried could comply with the norms according to the calculations. The MSc-thesis of Bink (2017) showed that dike managers want an assessment result that is as certain as possible. The result is accepted as it is calculated, while there still remains uncertainty in the assessment result. Dike managers don't always seem to be aware of this remaining uncertainty.

The goal of this research is to acquire insight in the individual and combined effect of uncertainty of different origin in the final result of the assessment of a dike for the mechanism macro instability and depict this in a clear and understandable way.

The research can be broken down in several steps:

1. Quantitatively determine the level of uncertainty in the assessment result for macro stability using probabilistic methods.
2. Develop a tool, based on these uncertainties, to present the uncertainty for a calculated result (if possible broken down per type of uncertainty)

3. Quantitatively determine what level of uncertainty would be acceptable and can this be achieved/reached

Such a tool (as mentioned in step 2) could be used to present uncertainty to dike managers and other experts to determine which situations and levels of uncertainty they find acceptable.
A secondary goal of the research is on the one hand to develop a tool with which uncertainty in the assessment result can be presented, and on the other hand to determine what level of uncertainty (quantitatively) is acceptable.

References

Bink, J. (2017). *Flood safety: What is an acceptable level of uncertainty in the safety assessment of piping.* Deventer: University of Twente/BZIM.

Roelofs, S. (2018) Quantification and reduction of uncertainty in the piping assessment: a comparrison of uncertainty reducing strategies. Deventer: University of Twente/BZIM.

Schweckendiek, T., van der Krogt, M., Rijneveld, B., Teixeira, A.M., Handrieiking Faalkansen analyse Macrostabileit: groene versie (2017). Deltares