Title of the project:
Design water levels due to sea level rise and increased extreme storms due to climate change

Assignment no.: 10.18	**Internal/external:** External
Head graduation committee: Prof.dr. Suzanne Hulscher	**Daily advisor:** Dr. Jord Warmink Dr. Nina Ridder (KNMI)
Name(s) of participating companies or institutes: KNMI	**Start of the project:** a.s.a.p.

Required courses:
Mathematical Physics of Water Systems, Data Analysis, Marine Dynamics, Hydraulic Engineering

Short description and objective of the project:
Climate change will cause sea level rise (e.g. de Vries et al., 2014) and an increase in the severity of extreme wind events (e.g. Feser et al., 2014), which together can aggravate flood risk. In order to protect coastal areas from flooding, we have to prepare ourselves for these future conditions. Currently, dikes and soft defences like dunes are designed to withstand a certain hydraulic load (i.e. normative water levels and wave characteristics) that is determined using the statistical analysis of past extreme events. Thus, safety standards, which are expressed in terms of return periods of a specific water level, rely on the estimate of the likelihood of a specific hydraulic load under past conditions. However, hydraulic conditions will change due to climate change and the dikes that we are designing now will be confronted with these future more extreme conditions. A typical result could be that, storms that are now occurring once in 1000 years causing severe water levels are likely to occur once in 300 years in the year 2100. This constitutes a severe decrease in coastal protection levels if safety standards are not adjusted to the expected new conditions.

At the moment, we are aware that we will have to deal with climate change and sea level rise, which are incorporated in climate scenarios. However, up until now the increase in extreme storms due to climate change is not accounted for explicitly. This MSc-topic will translate future storm scenarios to expected return periods of extreme storm wave conditions and related expected water levels along the Dutch coast and lake Ijssel. This will provide an estimate of the decrease in protection levels if current coastal defences should not be adapted to future conditions.
The prospected student is expected to complete the following tasks:

1. Perform a literature review on the role of storms in the determination of coastal safety levels
2. Get an understanding of how storms develop and how climate change might influence relevant atmospheric processes
3. Evaluate the occurrence frequencies of extreme storms now and in 2100, including uncertainties
4. Translate the change in extreme storm occurrence to coastal water safety level

References
Feser, F., Barcikowska, M., Krueger, O., Schenk, F., Weisse, R. and Xia, L., 2015. Storminess over the North Atlantic and northwestern Europe—A review. *Quarterly Journal of the Royal Meteorological Society*, *141*(687), pp.350-382.

de Vries, H., Katsman, C. and Drijfhout, S., 2014. Constructing scenarios of regional sea level change using global temperature pathways. *Environmental Research Letters*, *9*(11), p.115007.