RETURN PERIOD OF LOW WATER PERIODS IN THE RIVER RHINE

The water level measured in the Rhine river has never been as low as in the year 2018. August 2018 even passed the previous record year 1976 for a few days in precipitation deficit. Due to climate change, such low water events are expected to increase in the future. However, how extreme this event was is currently unknown. The goal of this study is to quantify the return period for the 2018 low flows and determine the effect of climate change on low flow return periods on the Rhine at Lobith. Low flow return periods are important for shipping applications or risk assessments concerning water availability and to prevent salinisation.

Discharge data from 1901 to 2020 are gained from Rijkswaterstaat, the Dutch water authority. The block method is used to define annual minimal discharges. Low Flow Frequency Curves (LFFC) are constructed by fitting the Generalized Extreme Value distribution on these annual minima to be able to extrapolate to larger return periods. Duration of low flows is also a factor of the severity of the situation. Therefore, several durations are taken into account: 1, 7, 30, 90 and 180 days. An average discharge over this duration gives the severity of the low flow.

Results of the 95%-confidence interval show that a Weibull is the best fit for all the different durations. Furthermore, the LFFCs show little difference between the 1- and 7-day fit, but generally the larger the duration the higher the discharges. Figure 1 provides the opportunity to determine the return period for an average discharge over different durations for the current climate.

A 1-day discharge of 732 m^3/s, which was the minimum of 2018, is likely to occur once every 17.6 years. However, due to climate change this can occur once every 6.5 to 22.6 years in 2085 based on the KNMI'14 scenarios and the GRADE model. In 2085, a 1-day event that will occur once every 17.6 years will have a discharge between 655 and 753 m^3/s. This shows that whether an event similar to 2018 is likely to become more or less common, depends on which climate scenario evolves to be more realistic.

The drought of 2018 was severe due to the length of the event, as the discharges for the longer durations had larger return periods. It is recommended to use this studie's return periods in risk assessments concerning the shipping industry or for water allocation.

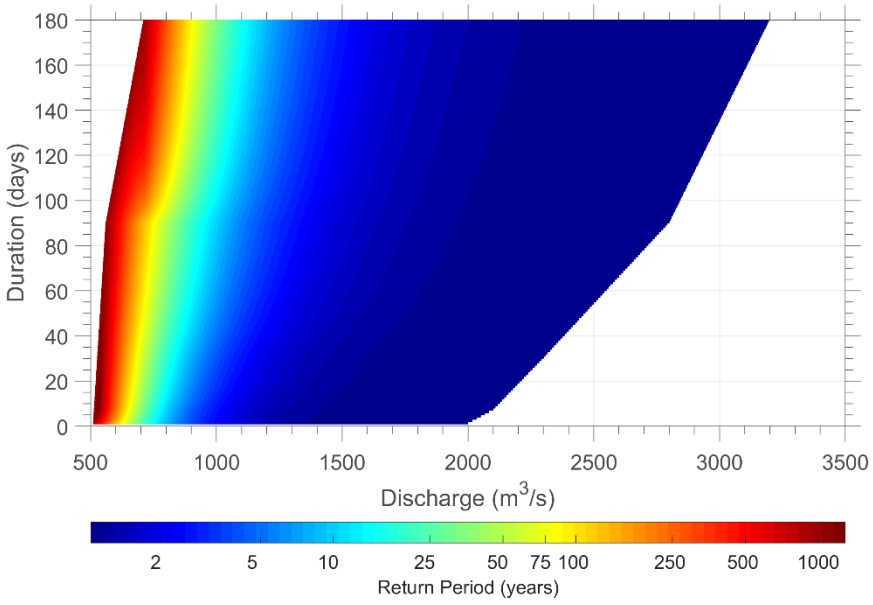

Figure 1: Return period of low flow events in the current climate based on discharge and duration, interpolated from fitted LFFCs on the discharge data from Rijkswaterstaat for a duration of 1, 7, 30, 90 and 180 days.

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