Design Life Level: quantifying risk in a changing climate

Holger Rootzén
Department of Mathematical Statistics
Chalmers and Gothenburg University, Sweden

Richard W. Katz,
National Center for Atmospheric Research
Boulder, CO 80307, USA

Abstract: In the past, the concepts of return levels and return periods have been standard and important tools for engineering design. However, these concepts are based on the assumption of a stationary climate and do not apply to a changing climate, whether local or global. In this talk I discuss a refined concept, Design Life Level, which quantifies risk in a non-stationary climate and can serve as the basis for communication. In current practice, typical hydrologic risk management focuses on a standard (e.g., in terms of a high quantile corresponding to the specified probability of failure for a single year). Nevertheless, the basic information needed for engineering design should consist of: (i) the design life time period (e.g., the next 50 yrs., say 2015-2064); and (ii) the risk (e.g., 5% chance) of a hazardous event (typically, in the form of the hydrologic variable exceeding a high level) occurring during the design life time period. Capturing both of these design characteristics, the Design Life Level is defined as an upper quantile (e.g., 5%) of the distribution of the maximum value of the hydrologic variable (e.g., water level) over the design life time period. We relate this concept and variants of it to existing literature and illustrate how they, and some useful complementary plots, may be computed and used. One practically important consideration concerns quantifying the statistical uncertainty in estimating a high quantile under non-stationarity.

Key words and phrases: design criteria, climate change, non-stationary, extreme value statistics, return level, return period, exceedance risk