The main goal of this dissertation develops a unified model structure for runoff generation based on observations from a large number of catchments. Furthermore, obtaining a comprehensive understanding of the physical controlling factors that control daily, monthly, and annual water balance models. Meanwhile, applying the developed Unified model on different climate conditions, and comparing it with different well-known models. The proposed model was compared with a similar timescale model (HyMOD, and abcd) and applied on 92 catchments from MOPEX dataset across the United States. The HyMOD and abcd are a well-known daily and monthly hydrological model used on a variety of researchers. The differences between the new model and HyMOD, and abcd include 1) the distribution function for soil water storage capacity is different and the new distribution function leads to the SCS curve number method; and 2) the computation of evaporation is also based on the distribution function considering the spatial variability of available water evaporation.

The performance of all models along with parameters used is examined to understand the controlling factors. The generated results were calibrated and validated using the Nash-Sutcliffe efficiency coefficient (NSE), indicating that the Unified model has a moderate better performance against the HyMOD at a daily time scale, and abcd model at a monthly timescale. The proposed model using the SCS-CN method shows the effect of improving the performance.

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The public is welcome to attend.