Estimation of Non-stationary Design Flow in the Upper Green River Basin under Climate Change Scenarios

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Abstract. We estimate the non-stationary design flow in the Upper Green River Basin (UGRB), WY by applying a moving window to the 21st century climate projections. Reliable estimates of streamflow are necessary for planning, design, and operation of infrastructure to reduce the risk of economic loss, environmental damage, and loss of life. The design flow is generally estimated by the flood frequency analysis of historical streamflow under the assumption of stationarity, which means that the historical flood distribution is similar to the future flood distribution. However, climate change is evident and we need to consider non-stationarity of the future streamflow in determining the design flow.

We use the 112 bias-corrected spatially downscaled precipitation and temperature projections of the World Climate Research Programme (WCRP) Coupled Model Intercomparison Project phase 3 (CMIP3) datasets. However, they are provided in monthly scale and temporal downscaling from monthly into daily scale is necessary. Using the bias adjusted gamma – gamma transformation and nearest neighboring search, we obtain the 1/8th degree downscaled precipitation and temperature projections of 1950-2099. We estimate streamflow using Variable Infiltration Capacity (VIC) model. We calculate the design flows at each year using a moving window and define their uncertainty ranges using 112 climate projections of three carbon emission scenarios. The non-stationary design flows are estimated for 2, 5, 10, 20, 30, 50, and 100 year return periods using the Gumbel Distribution.

The proposed method is applied to the Upper Green River Basin in Wyoming and we will present the impact of climate change on the design flow and the relationship between the design flow and the moving window size.