Changes in Precipitation Intensity Under Climate Change

The literature provides a Chesapeake watershed-wide estimate of rainfall intensity under climate change conditions. Based on documented changes in intensity and frequency of precipitation events using a century of observations (Groisman et al., 2004; Groisman et al., 2001; Karl and Knight, 1998, Gordon et al., 1992) changes in rainfall intensity for the Chesapeake watershed were placed into deciles. The observed increases in larger precipitation events (Groisman et al., 2004) were the basis for assigning the total percent change in precipitation volume disproportionately to the highest intensity deciles. Following Groisman et al. (2004), the larger share of the increase in estimated precipitation volume due to climate change was placed in the highest decile (90 to 100 percent) of intensity (Figure 1).

Figure 1. Observed changes in rainfall intensity over the last century (based on Figure 10 in Groisman et al., 2004). The equal allocation distribution (blue) is contrasted with the distribution obtained based on observed changes (red).

Changes in Precipitation Volume Under Climate Change

Precipitation trends for model land segments (counties) were developed by analyzing Parameter-elevation Relationship on Independent Slope Model (PRISM, Daly et al., 2008) rainfall data. A linear trend analysis was conducted with annual PRISM rainfall data which is a reanalysis product that uses point data measurements at rain gauges and incorporates a conceptual framework to address spatial variably in rainfall due to orographic and other processes. The long-term PRISM dataset (1895-1980) is modeled at 30 arc second (approx. 800 m) grid cell resolution but then upscaled to provide monthly total rainfall at 2.5 arc minute (approx. 4-km) grid cell resolution for the conterminous U.S. The annual PRISM dataset for the years 1927 to 2014, i.e., 88 years, were used in the linear regression trend analysis. The selection of the 88-year period was made because of easy accessibility of the dataset. For the analysis, gridded PRISM data were first spatially aggregated to each Phase 6 land segment, and then for each segment, a linear trend line was fitted to the annual rainfall data. The extrapolated PRISM observations of precipitation change for the year 2025 are shown in Figure 2.

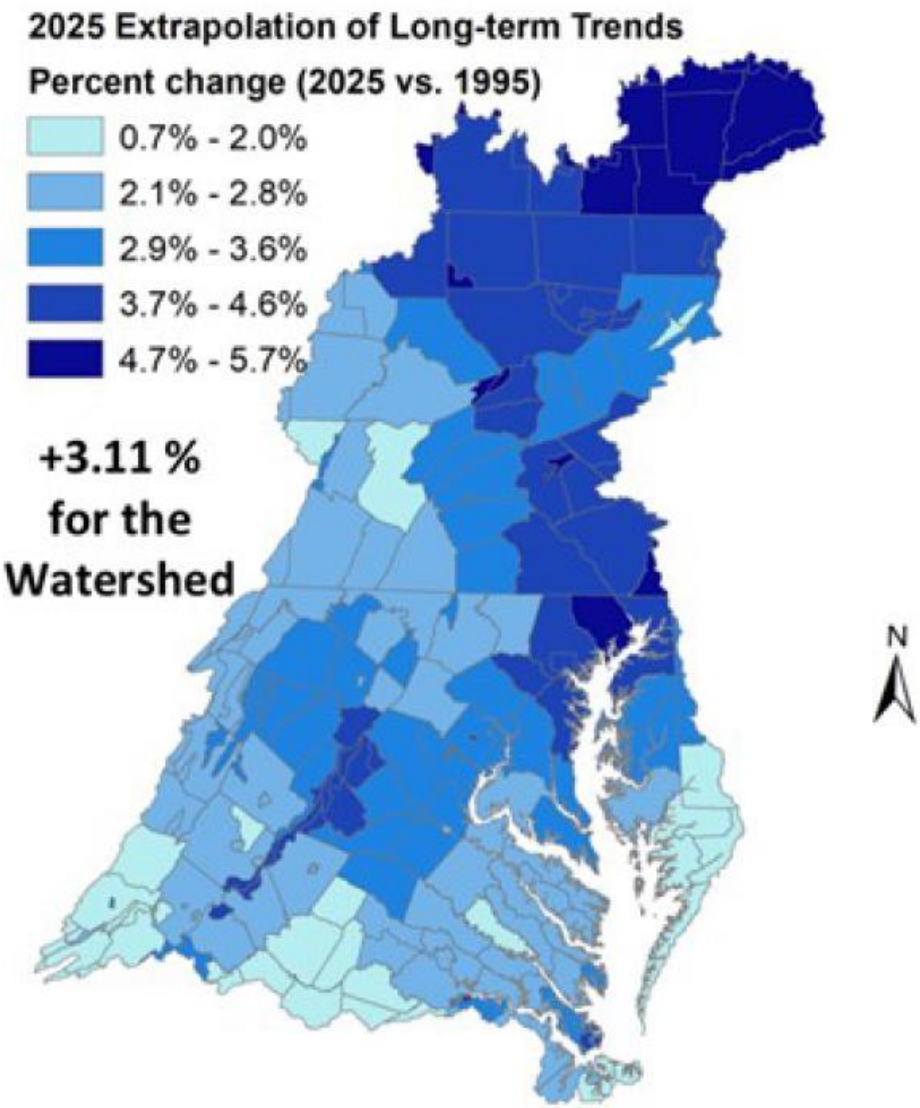

Figure 2. Estimated average annual change in precipitation volume (as percent change) for the land segments (counties) in the Chesapeake Bay watershed are shown for 2025. The change in rainfall volume with respect to 1995 are based on an extrapolation of long-term trends from a century of PRISM rainfall observations.

References

Daly, C., M. Halbleib, J.I. Smith, W.P. Gibson, M.K. Doggett, G.H. Taylor, J. Curtis, and P.P. Pasteris, 2008. Physiographically sensitive mapping of climatological temperature and precipitation across the conterminous United States. International Journal of Climatology: a Journal of the Royal Meteorological Society 28, no. 15: 2031-2064.

Gordon, H.B., Whetton, P.H., Pittock, A.B., Fowler, A.M. and Haylock, M.R., 1992. Simulated changes in daily rainfall intensity due to the enhanced greenhouse effect: implications for extreme rainfall events. *Climate Dynamics*, *8*(2), pp.83-102.

Groisman, P.Y., R.W. Knight, and T.R. Karl, 2001. Heavy Precipitation and High Streamflow in the Contiguous United States: Trends in the Twentieth Century. *Bulletin of the American Meteorological Society* DOI: https://doi.org/10.1175/1520-0477(2001)082<0219:HPAHSI>2.3.CO;2 Page(s): 219–246

Groisman, P.Y., R.W. Knight, T.R. Karl, D.R. Easterling, B. Sun, and J.H. Lawrimore. 2004. Contemporary Changes of the Hydrological Cycle over the Contiguous United States: Trends Derived from In Situ Observations. *Journal of Hydrometeorology* **5**: 64– 85.

Karl, T.R., and R.W. Knight, 1998. Secular Trends of Precipitation Amount, Frequency, and Intensity in the United States. *Bulletin of the American Meteorological Society* 79:2 DOI: https://doi.org/10.1175/1520-0477(1998)079<0231:STOPAF>2.0.CO;2 pp: 231–242 <https://journals.ametsoc.org/view/journals/bams/79/2/1520 0477_1998_079_0231_stopaf_2_0_co_2.xml> Accessed September 18, 2021.