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Unveiling Tomorrow's Climate: Indus River Basin in Focus - A Comprehensive Assessment using Cutting-edge CMIP6 Data for SSP126 and SSP585 Scenarios

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Indus River Basin supports approximately 268 million inhabitants, covering four different countries, including Pakistan, India, China and Afghanistan. Most countries situated in this basin are highly vulnerable to the impacts of climate change, even though their emissions are low. The basin has a large agriculture-based economy; therefore, we are interested in assessing the impacts of climate change on agriculture under best- and worst-case scenarios. In this study, a mean ensemble of four CMIP6 climate models was used with a resolution of 50km, and the analysis was conducted on a subbasin scale through delineation of the entire Indus basin. The climate indices estimated are extreme maximum temperature (TXx), extreme minimum temperature (TNn), heat stress (TR), maximum 5-day precipitation (RX5day), 95th percentile of precipitation (R95pTot), consecutive dry days (CDD), growing season length (GSL), and heat sum (HS). The climate indices data was analyzed spatially and temporally by estimating trends, their significance, areal mean time series and plotting Hovmuller diagrams. Temperature-based indices TXx and TNn show a significant increase across the basin, while TR seems to increase mostly in the Lower Indus Basin plain. This may lead to crop failure due to excess heat and put more pressure on available water resources. Precipitation-based indices RX5day and R95pTot show a rise in flood risks in the eastern subbasins, while the number of CDD will vary across the region. The Hovmuller diagrams show that spatial precipitation patterns will be irregular across the basin, making it difficult to follow traditional agricultural practices. A significant increase in GSL and HS is noted in the Upper Indus Basin, making the region more suitable for agriculture, and the seasonal differences plot showed that the summer months of July, August & September will have the largest increase in extreme precipitation with high spatial variability. To conclude, climate adaptation measures are necessary, and a nexus-based resource management approach should be considered in the decision-making process.