LONG TERM RECORDS PROVIDE INSIGHTS ON THE RELATIVE INFLUENCE OF CLIMATE AND FOREST COMMUNITY STRUCTURE ON WATER YIELD IN THE SOUTHERN APPALACHIANS

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In forested watersheds, changes in climate and forest structure or age can affect water yield; yet few long-term observational records from such watersheds exist that allow an assessment of these impacts over time. In this study, we used long-term (~80 yrs) observational records of climate and water yield in six reference watersheds at the Coweeta Hydrologic Laboratory in the southern Appalachian mountains of North Carolina to determine whether water yield has changed over time, and examine and attribute the causal mechanisms of change. These six reference watersheds are unmanaged with only successional dynamics and natural disturbances altering the forest structure since the 1920s. AutoRegressive, Integrated Moving-Average (ARIMA) time series modeling revealed significant ($p<0.05$) decreases in annual water yield (Q) and runoff ratio (Q/precipitation (P)) for lower elevation watersheds beginning in 1973; but no significant change in P was identified. These results suggest that water loss to evapotranspiration (ET) has been increasing since this time. Further, departures in cumulative water yield from that expected given data prior to 1973 could not be explained by P alone in low elevation watersheds, providing additional evidence of a change in ET. A monthly timestep water balance model, WaSSI, along with our long-term climate record, was used to estimate the impact of changes in other climatic variables on water yield. This approach allowed us to separate the influence of climate from that of changes in forest structure and composition. These simulations revealed that changes in water yield in some watersheds could not be explained by climate alone, suggesting that vegetation dynamics have also contributed to the changes in ET. Lastly, we combined species composition, stem diameter and stem density data from long term permanent plot surveys with tree water use by species and diameter derived from sap flux measurements. With these data, we estimated changes in ecosystem water use that corroborate the changes in ET and Q not explained by climate alone for the six reference watersheds. Our results suggest that natural disturbances and successional vegetation dynamics can induce significant changes in water yield even in unmanaged forested watersheds, a conclusion only made possible because long-term records were valued and maintained over 80 years. Our results could have significant implications for water supply in the region and may inform forest management strategies to mitigate climate change impacts on water resources, as well as emphasize the importance of maintaining long term monitoring networks.

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