The Bear Brook Watershed in Maine (BBWM), USA, and the Fernow Experimental Forest in West Virginia USA, represent unique long-term, paired, whole watershed experimental manipulations focussing on the effects of nitrogen (N) and sulphur (S) deposition on temperate forests. Both experiments began whole-ecosystem additions of N and S as ammonium sulphate in 1989; both are entering their third decade of chronic enrichment of the treated watersheds, while the reference watersheds offer unique opportunities to understand forest watersheds dynamics through time. Because of differences between BBWM and Fernow (atmospheric deposition history, soil properties and forest composition) the response trajectories in stream chemical exports also vary over time. The four watersheds represent a spectrum of N enrichment and retention, ranging from ~ 98% N retention in the reference watershed in Maine to ~ 20 % N retention in the treated watershed in West Virginia. Despite these differences there is evidence that mechanisms of response in base cation leaching and other processes are similar among the four watersheds. At both study sites the two decades of research and monitoring has provided new insights into forest watershed processes not evident in more traditional short-term research.