Streams are classified into perennial, intermittent, and ephemeral streams based on flow durations. Perennial stream is the basic network, while intermittent or ephemeral stream is the expanded network. Connection between perennial stream and base flow at the mean annual scale exists since one of the hydrologic functions of perennial stream is to deliver runoff even in low flow seasons. The partitioning of precipitation into runoff and evaporation at the mean annual scale, on the first order, is captured by the ratio of potential evaporation to precipitation (Ep/P called climate aridity index) based on Budyko hypothesis.

The primary focus of this thesis is the relationship between base flow and perennial stream density (Dp) in the Budyko framework. In this thesis perennial stream density is quantified from the high resolution National Hydrography Dataset for 185 watersheds, the climate control (shown by climate aridity index) on perennial stream density and on base flow is examined, and the correlation between base flow and perennial stream density is analyzed.

Perennial stream density declines monotonically with climate aridity index, and an inversely proportional function is proposed to model the relationship between Dp and Ep/P. This monotonic trend of perennial stream density reconciles with the Abrahams curve since perennial stream density is only a small portion of the total drainage density. The ratio of base flow to precipitation (Qb/P) follows a complementary Budyko-type curve. The correlation coefficient between the ratio of base flow to precipitation and perennial stream density is found to be 0.74. The main finding of this research is the perennial stream density is one component of co-evolution of climate, vegetation, soil, and landscape at the mean annual scale.

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The public is welcome to attend.