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A Geomorphological Interpretation of the Power Law Relations Connected with Recession Curves

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By assuming that in the recession phase the flow rate, q, per unit length of the network and the rate, c, at which the length of the drainage network decreases because of its progressive desaturation, are constant in space and time, it has been argued that the exponent α in the power law $-dQ/dt = kQ^{\alpha}$ (where Q is the discharge at the outlet at time t) comes from the geomorphologic power law relationship $N(l) \propto G(l)^{\alpha}$, where $N(l)$ is the number of channel links located at a distance l from their respective channel heads, $G(l)$ is the total length of the channel links in the network located at a distance greater than or equal to l from the channel heads. The parameter k varies from one event to another, implying that there is no unique relationship between discharge and volume of water stored within the basin. We show here that k depends on the hydrograph peak discharge (Q_p) according to a power law: $k \propto Q_p^{-\gamma}$, and the power law exponent γ is found to be linearly related to α. This implies that $-dQ/dt$ vs. Q curves of a basin can collapse into a single curve, say Q^*.

Introducing $n(l) = N(l)/A$ and $g(l) = G(l)/A$, we show that $n(l)$ vs. $g(l)$ plots for different basins collapse onto a single curve. This finding supports the hypothesis made earlier by Shreve that link magnitude or number of first order channels of a basin is linearly related with its area. Also, we find that a similar collapse can be obtained for recession hydrographs of different basins once the specific discharge $u = Q^*/A$ is defined. Our findings provide a rather general observational and theoretical framework to interpret recession curves and their relation with basin morphology.