Lesson 12: Infiltration
Potential Infiltration Equations: Horton & Philips

Horton's Equation

The potential infiltration is given by:

$$f^*(t) = f_c + (f_0 - f_c)e^{-kt}$$

where f_0 is initial infiltration rate, f_c is a constant (final) infiltration rate (apparent saturated conductivity), and k is an exponential decay rate. By integration:

$$F^*(t) = f_c t + \frac{(f_0 - f_c)}{k}(1 - e^{-kt})$$

Ponding time t_p for constant rainrate i:

$$t_p = \frac{1}{ik}\left[f_0 - i + f_c \ln\left(\frac{f_0 - f_c}{i - f_c} \right)\right], \quad \text{for } f_c < i < f_0$$

Equivalent time origin t_0:

$$t_0 = t_p - \frac{1}{k}\ln\left(\frac{f_0 - f_c}{i - f_c} \right)$$

Philip's Equation

The cumulative potential infiltration is given by:

$$F^*(t) = St^{1/2} + Kt$$

where S is the soil sorptivity (depends on soil water diffusivity) and K is the saturated hydraulic conductivity. By differentiation:

$$f^*(t) = \frac{dF(t)}{dt} = \frac{1}{2}St^{-1/2} + K$$

Ponding time t_p for constant rainrate i:

$$t_p = \frac{S^2(i - K/2)}{2i(i-K)^2}, \quad \text{for } i > K$$

Equivalent time origin t_0:

$$t_0 = t_p - \frac{1}{4K^2}\left(\sqrt{S^2 + 4KF_p} - S\right)^2$$

where F_p is the cumulative infiltration at ponding time ($F_p = it_p$).