Model

Computation of daily ET-deficit, soil moisture anad infiltration at a point feature:

Inputs : soil cover layer, LULC, slope, daily rainfall, K_c, ET_0

1. PET = K_c * ET_0
2. Set up values by lookup and/or derivation so that they are used in daily results computation:
   1. Slope layer :
      1. slope
   2. Soil cover layer :
      1. texture
         1. Hydrologic Soil Group (HSG)
         2. Percentages of sand, clay and gravel
         3. Bulk density
            1. Sat = (1 - Bulk Density) / 2.65
         4. Wilting Point (WP) = 0.4 * Bulk Density * Clay fraction(i.e. percentage/100)
         5. Available Water Capacity (AWC)
         6. Field Capacity(FC) = WP + AWC
         7. Ksat
            1. Ksat_day = Ksat * 24
      2. depth type
         1. depth
            1. if depth < ROOT LEVEL : SM1 = depth – 0.01, SM2 = 0.01
               else SM1 = ROOT LEVEL, SM2 = depth - ROOT LEVEL
      3. Sat_depth = Sat * depth * 1000
         WP_depth = WP * depth * 1000
         FC_depth = FC * depth * 1000
         (1000 because converting to metres to mm?)
   3. LULC layer :
      1. + HSG -> Curve Number(CN)
   4.
      1. $$CN3 = \frac{(23 \times CN)}{(10 + 0.13 \times CN)}$$
      2. $$CN\_S = CN \quad \text{if slope < 5}$$
         $$= \left(\frac{CN3 - CN}{3}\right) \times (1 - 2 \cdot \exp(-13.86 \times 0.01 \times slope)) + CN \quad \text{otherwise}$$
      3. $$CN1\_S = CN\_S - \frac{20 \times (100 - CN\_S)}{(100 - CN\_S + \exp(2.533 - 0.0636 \times (100 - CN\_S)))}$$
      4. $$CN3\_S = CN\_S \times \exp(0.00673 \times (100 - CN\_S))$$
      5. $$Smax = \frac{25.4 \times 1000}{CN1\_S} - 10$$
      6. $$S3 = \frac{25.4 \times 1000}{CN3\_S} - 10$$

7. $$W2=\frac{\left(\begin{array}{l}\log\left(\dfrac{FC\_depth-\mathrm{WP}\_depth}{1-\dfrac{S3}{Smax}}-\left(FC\_depth-\mathrm{WP}\_depth\right)\right)\\ -\log\left(\dfrac{Sat\_depth-\mathrm{WP}\_depth}{1-\dfrac{2.54}{Smax}}-\left(Sat\_depth-\mathrm{WP}\_depth\right)\right)\end{array}\right)}{\left(Sat\_depth-\mathrm{WP}\_depth\right)-\left(FC\_depth-\mathrm{WP}\_depth\right)}$$

8. $$W1=\log\left(\frac{FC\_depth-\mathrm{WP}\_depth}{1-\dfrac{S3}{Smax}}-FC\_depth-\mathrm{WP}\_depth\right)+W2\times\left(FC\_depth-\mathrm{WP}\_depth\right)$$

9. $$TT\_perc=\frac{Sat\_depth-FC\_depth}{Ksat}$$

10. $$daily\_perc\_factor=1-\exp\left(\frac{-24}{TT\_perc}\right)$$

11. depletion_factor = 0.5
12. SM1_fraction = WP
13. layer2_moisture = WP

3. Daily Results Computation :
   1. $$ini\_sm\_tot=\left(SM1\_fraction\times SM1+layer2\_moisture\times SM2\right)\times 1000$$
   2. $$S\_swat=Smax\times\left(1-\frac{ini\_sm\_tot-\mathrm{WP}\_depth}{\left(ini\_sm\_tot-\mathrm{WP}\_depth\right)+\exp\left(W1-W2\times\left(ini\_sm\_tot-\mathrm{WP}\_depth\right)\right)}\right)$$
   3. $$Cn\_swat=\frac{25400}{S\_swat+254}$$
   4. $$Ia\_swat=0.2\times S\_swat$$
   5. $$Swat\_RO=\begin{cases}\dfrac{\left(rain-Ia\_swat\right)^2}{rain+0.8\times S\_swat} & \text{if } rain>Ia\_swat\\ =0 & \text{otherwise}\end{cases}$$
   6. infiltration = rain – Swat_RO
   7. if SM1_fraction < WP
      KS = 0
      else if $SM1\_fraction>\left(FC\times\left(1-depletion\_factor\right)+depletion\_factor\times\mathrm{WP}\right)$
      KS = 1
      else
      $$KS=\frac{\dfrac{SM1\_fraction-\mathrm{WP}}{FC-\mathrm{WP}}}{1-depletion\_factor}$$
   8. $$AET=KS\times PET$$
   9. $$SM1\_before=\frac{SM1\_fraction\times SM1+\dfrac{infiltration-AET}{1000}}{SM1}$$
   10. R_to_second_layer
       = 0 if SM1_before < FC
       $$=min\left(\begin{array}{c}\left(Sat-layer2\_moisture\right)\times SM2\times 1000,\\ \left(SM1\_before-FC\right)\times SM1\times 1000\times daily\_perc\_factor\end{array}\right)$$
       if layer2_moisture < Sat
       = 0 otherwise
   11. sec_run_off

$$= \left(\frac{SM1\_fraction \times SM1 + \frac{infiltration - AET - R\_\text{to}\_second\_layer}{1000}}{SM1} - \text{WP} \right) \times 0.1 \times 1000$$

$$\text{if} \quad \frac{SM1\_fraction \times SM1 + \frac{infiltration - AET - R\_\text{to}\_second\_layer}{1000}}{SM1} > Sat$$

$$= 0 \quad \text{otherwise}$$

12. $$SM1\_fraction = min\left(\frac{\frac{SM1\_before \times SM1 \times 1000 - R\_\text{to}\_second\_layer}{SM1}}{1000}, Sat \right)$$

13. $$SM2\_before = \frac{\frac{layer2\_moisture \times SM2 \times 1000 + R\_\text{to}\_second\_layer}{SM2}}{1000}$$

14. $$perc\_\text{to}\_GW = max\left(\left(SM2\_before - FC \right) \times SM2 \times daily\_perc\_factor \times 1000, 0 \right)$$

15. $$layer2\_moisture = min\left(\frac{\frac{SM2\_before \times SM2 \times 1000 - perc\_\text{to}\_GW}{SM2}}{1000}, Sat \right)$$