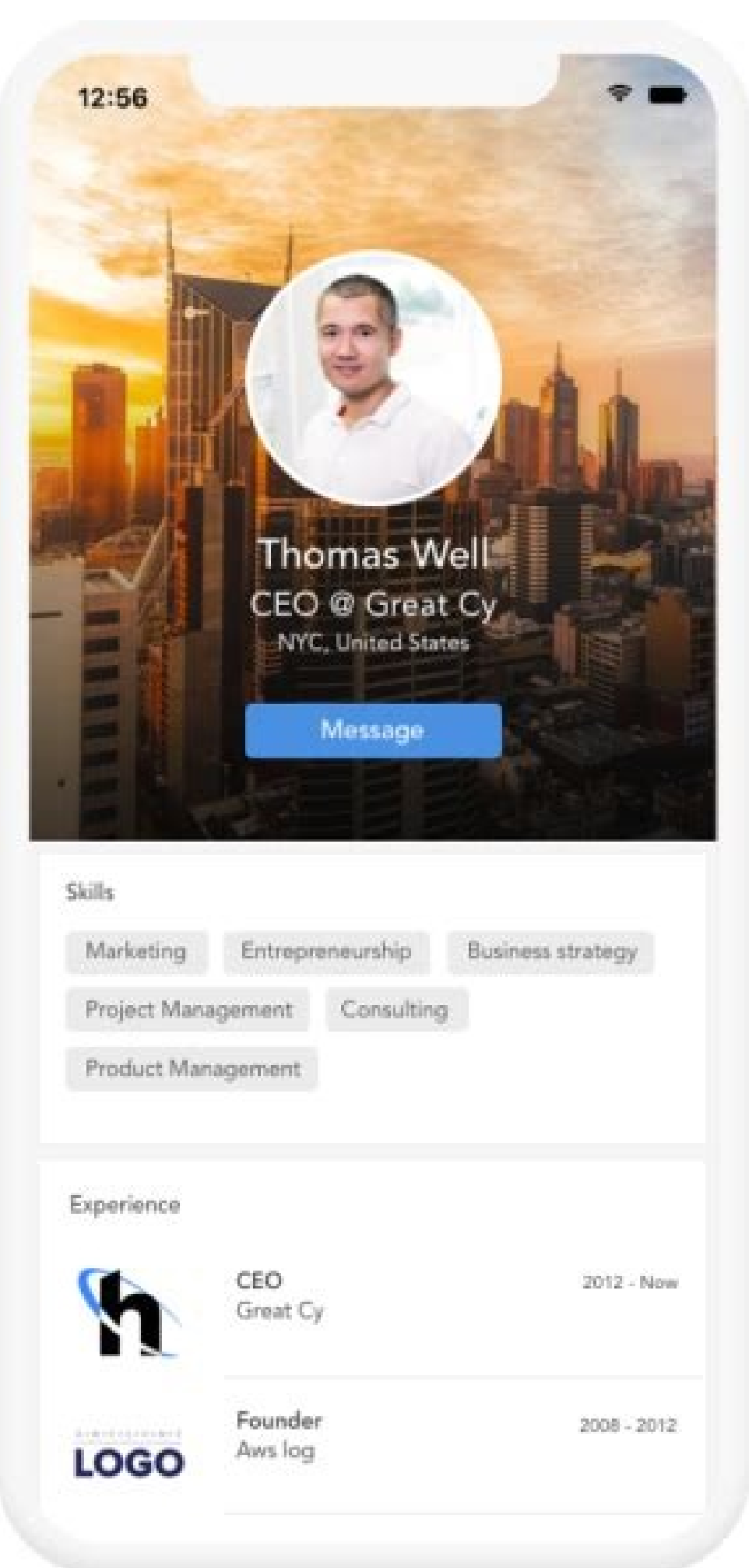


I'm not robot!



▷ $V_i - V_o = \Delta S$

V_i = inflow volume of water

V_o = outflow volume of water

ΔS = change in mass storage

▷ Water budget equation

$$P - R - G - E - T = \Delta S$$

where P = precipitation,

R = surface run off,

G = net ground water flow from the catchment,

E = evaporation,

T = transpiration,

ΔS = change in storage.

▷ Optimum number of stations,

$$N = \left(\frac{C_v}{E} \right)^2$$

where C_v = coefficient of variation of the rainfall values at the existing station (%)

E = allowable degree of error in the estimate of mean rainfall

$$C_v = \frac{100 \times \sigma_{m-1}}{P}$$

$$\sigma_{m-1} = \sqrt{\frac{\sum_{i=1}^m (P_i - \bar{P})^2}{m-1}}$$

= standard deviation

$$\bar{P} = \frac{1}{m} \sum_{i=1}^m P_i = \text{mean precipitation.}$$

▷ When the normal annual precipitate at various station are within about 10% of the normal annual precipitation at station x , then

$$P_x = \frac{1}{m} [P_1 + P_2 + \dots + P_m]$$

▷ If normal precipitate vary considerably, then

$$P_x = \frac{N_x}{M} \left[\frac{P_1}{N_1} + \frac{P_2}{N_2} + \dots + \frac{P_m}{N_m} \right]$$

▷ Arithmetical mean method

$$\bar{P} = \frac{P_1 + P_2 + \dots + P_i + \dots + P_n}{n}$$

$$= \frac{1}{N} \sum_{i=1}^N P_i$$

$$\triangleright \bar{P} = \frac{P_1 A_1 + P_2 A_2 + P_n A_n}{A_1 + A_2 + \dots + A_n} = \sum_{i=1}^n P_i \frac{A_i}{A}$$

▷ Isohyetal method ;

$$a_1 \left(\frac{P_1 + P_2}{2} \right) + a_2 \left(\frac{P_2 + P_3}{2} \right) + \dots + a_{n-1} \left(\frac{P_{n-1} + P_n}{2} \right)$$

$$\bar{P} = \frac{\quad}{A}$$

▷ Received interval (return period)

$$T = \frac{1}{P}$$

$$P_{rn} = \frac{n!}{(n-r)! r!} P^r Q^{n-r}$$

(Probability of occurrence of the event
r times in n successive years)

where r = number of time and
n = number of years.

▷ Probability of the event not occurring at all in n successive years

$$P_{o,n} = Q^n = (1 - P)^n$$

▷ Probability of the event occurring at all once in n successive years

$$P_i = 1 - Q^n = 1 - (1 - P)^n$$

▷ Probable maximum precipitation

$$PMP = \bar{P} + K\sigma$$

where $\bar{P}$ = mean of annual maximum rainfall

σ = standard deviation of the series

K = frequency factor.

▷ Evaporation loss

$$E_L = C (e_w - e_a) \text{ in mm/day}$$

c = a constant

e_w = saturation vapour pressure at the water temperature

e_a = actual vapour pressure

▷ Analytical methods of evaporation estimate :

(a) Water budget method

$$P + V_{is} + V_{ig} = -V_{os} + V_{og} + EL + \Delta S + T_L$$

where P = daily precipitation,

V_{is} = daily surface inflow,

V_{ig} = daily ground water inflow,

V_{os} = daily seepage outflow,

E_L = daily lake precipitation,

ΔS = increase in lake storage in a day,

T_L = daily transpiration loss

(b) Energy Budget method

$$E_L = \frac{H_n - H_g - H_s - H_i}{\rho L(1 + \beta)}$$

where H_n = net heat energy received by the water surface

H_g = heat flux into the ground

H_s = heat stored in water body

H_i = net heat conducted out of the system by water flow

β = Bower's ratio

▷ Horton expression for decay of the infiltration capacity with time

$$f_{ct} = f_{cf} + (f_{co} + f_{co} - f_{cf}) e^{-kht}$$

$$\triangleright W = \frac{P - R - I_a}{t_e}$$

where R = runoff,

P = precipitation (cm),

I_a = initial loss,

t_e = duration of rainfall,

W = average rate of infiltration.

$$\triangleright N = 0.83 A^{0.2} \text{ (days)}$$

$\triangleright$ Peak value of runoff,

$$Q_p = CA_i \quad \text{for } t \geq t_e$$

C = coefficient of runoff = runoff/rainfall,

A = area of catchment,

i = intensity of rainfall.

For field application,

$$Q_p = \frac{1}{3.6} C (i_{tc, p}) A$$

$i_{tc, p}$ = the mean intensity of precipitation

$\triangleright$ When the flow is parallel to stratification,
Equivalent permeability,

$$K_e = \frac{\sum_1^n K_i B_i}{\sum_1^n B_i}$$

The transmissibility of the formation,

$$T = K_e \Sigma B_i = \sum_1^n K_i B_i$$

$\triangleright$ When the flow is normal to stratification,

$$K_e = \frac{\sum_1^n L_i}{\sum_1^n (L_i / K_i)}$$

$$\triangleright q = \frac{(h_0 - h_1)}{L} KB$$

B = depth of aquifer

$\triangleright$ Flow without recharge

$$q = \frac{(h_0^2 - h_1^2)}{2L} K$$

$\triangleright$ Steady flow into a well :

Confined aquifer ;

$$Q = \frac{2\pi T (S_1 - S_2)}{I_n \frac{r_2}{r_1}}$$

At the edge of zone of influence,

$$S = 0, r_2 = R, h_2 = H,$$

At the well wall, $r_1 = r_w$, $h_1 = h_w$ and $S_1 = S_w$

$$Q = \frac{2\pi T S_w}{I_n R / r_w}$$

$\triangleright$ Unconfined flow :

$$Q = \frac{\pi K (h_2^2 - h_1^2)}{I_n \frac{r_2}{r_1}}$$

(i) Coefficient of variation of rain fall,

$$C_v = \frac{100 \times \text{standard deviation}}{\text{mean}}$$

(ii) The equilibrium discharge (S curve)

$$Q_s = \left(\frac{A}{D} \times 10^4 \right) \text{ m}^2/\text{h}$$

where A = area of catchment in km^2 ,

D = duration in hours of ER of the unit hydrograph.

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