Pseudo Code Algorithm

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BEGIN
READ RCPs, River characteristics, Bridge characteristics
# Define the input
FOR i = 1 to 3
    INPUT (RCPs[i], Start = Date [2024], End = Date [2095], Frequency =1)
END FOR
OUTPUT RCPs 2.6, RCPs 4.5, and RCPs 8.5
OBTAIN Array (River characteristics)
    INPUT (river width B, bed material size K_4, slope, stream bed condition K_3, and manning's
    coefficient m)
OBTAIN Array (Bridge characteristics)
    INPUT (pier width a, pier shape K_1, foundation depth, and angle of flow K_2)
# Local scour (HEC-18 equation)
FOR i = 1 to 3
    SET n to Length (RCPs[i])
    FOR j = 1 to n
        IF (V_c[j] < V[j]) (9) THEN
            INIT Filling coefficient K_f[j] to 0.9
            ELSE
            INIT Filling coefficient K_f[j] to 1
        END IF
        IF (τ_local[j] (6) > τ_c[j] (8) AND V_b[j] (9) ≥ P_v[j] (10) AND R_e[j] (5) > 2000) THEN
            COMPUTE Local scour dis [RCPs[i]] (γ_s[j]|K_f[j]) (1)
            ELSE Local scour dis [RCPs[i]] (γ_s[j]|K_f[j]) = 0
        END IF
    END FOR
    STORE Local scour dis [RCPs[i]] in Results [Local scour dis]
    FOR j = 1 to n
        IF (Local scour dis [RCPs[i],j] < Foundation depth F_d) THEN
            Local scour [RCPs[i],j] = 0
        ELSE
        Local scour [RCPs[i],j] = Local scour dis [RCPs[i],j]
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                END IF
        END FOR
END FOR
# Stochastic approach
FOR i = 1 to 3
        COMPUTE Mean (Local scour [RCPs[i]]) From Results [Local scour]
        COMPUTE Standard Deviation (Local scour [RCPs[i]]) From Results [Local scour]
        OUTPUT Shocks characteristics [RCPs[i]] (Mean AND Standard Deviation)
END FOR
STORE Shocks characteristics in Results [Shocks characteristics]
SET n to Length (RCPs)
FOR i = 1 to 3
        SET Y [RCPs[i],1] to 0
        FOR j = 1 to n
                IF (Local scour [RCPs[i],j] > Foundation depth F_d) THEN
                        Y [RCPs[i],j+1] = Y [RCPs[i],j]+1
                ELSE
                Y [RCPs[i],j+1] = Y [RCPs[i],1]
                END IF
        END FOR
        Lambda [RCPs[i]] = Y [RCPs[i],j+1] / n
END FOR
FUNCTION (lambda, n, Mean, Standard Deviation)
        SET L[1] to 0
        FOR i = 1 to n
                GENERATE Poisson Process P[i]
                IF (P[i] = 0) THEN
                        F[i] = 0
                        ELSE
                        F[i] = RNORM (Number of observations = n, mean = Mean, sd = Standard
                        Deviation)
                END IF
                L[i+1] = L[i]+F[i]
                RETURN (L)
        END FOR
END FUNCTION
FOR i = 1 to 3
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        FOR x = 1 to 1000
                CALL FUNCTION (lambda, n, Mean, Standard Deviation)
                GENERATE Shocks [RCPs[i],x] (lambda, n, Mean, Standard Deviation) (13)
        END FOR
END FOR
OUTPUT Shocks
STORE Shocks in Results [Shocks]
# System performance
FOR i = 1 to 3
        COMPUTE Number of failures (Shocks [RCPs[i],x])
        COMPUTE Years of failures (Shocks [RCPs[i],x])
        COMPUTE Lifetime frequency (Shocks [RCPs[i],x]) (15)
        COMPUTE Rate of failures (Shocks [RCPs[i],x])
END FOR
# Risk assessment
FOR i = 1 to 3
        COMPUTE Probability of failure (Shocks [RCPs[i],x]) (18)
        COMPUTE Priority Rating (Shocks [RCPs[i],x]) (19)
        COMPUTE Rip-rap stone sizes (max([RCPs[i],x])) (20)
        COMPUTE Long-term availability (lifetime, duration of restoration tasks) (16)
END FOR
END
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Equations (see paper for further details)

$$\gamma_s = 2HK_1K_2K_3K_4K_fK_w\left[\frac{a}{H}\right]^{0.65}Fr^{0.43} \tag{1}$$

$$Fr = \frac{V}{[gH]^{0.5}}\,, \qquad H = \left[\frac{mV}{B[S]^{0.5}}\right]^{\frac{3}{5}} \tag{2}$$

$$K_f = \begin{cases} 0.9, & V_c < V \\ 1, & V_c \geq V \end{cases} \tag{3}$$

$$V_c = k_c H^{\frac{1}{6}} {D_{50}}^{\frac{1}{3}} \tag{4}$$

$$R_e = \frac{V\rho_w R_h}{\text{Ų}} \tag{5}$$

$$\tau_{local} = \left[\frac{mV_l}{k_l}\right]^2 \frac{\rho_w}{H^{1/3}} \tag{6}$$

$$V_l = \frac{1}{n}{R_h}^{\frac{2}{3}}S^{\frac{1}{2}}K_p \tag{7}$$

$$\tau_c = K_s[\rho_s - \rho_w]\,gD_{50} \tag{8}$$

$$V_b = V\left[\frac{m}{K_b}\right]\left[g{R_h}^{-\frac{1}{3}}\right]^{\frac{1}{2}} \tag{9}$$

$$P_v = 1.077[\Delta g D_{50}]^{\frac{1}{2}} \tag{10}$$

$$\Delta = \left[\frac{\rho_s - \rho_w}{\rho_w}\right] \tag{11}$$

$$\left\{\{\gamma_s|t\}\;\middle|\; \begin{matrix} \tau_{local} > \tau_c \\ V_b \geq P_v \\ R_e > 2000 \end{matrix}\right\} \tag{12}$$

$$\gamma_{s,s}(t) = \xi_i, \quad \xi_i \sim N\left(\mu_\xi, \sigma_\xi\right) \tag{13}$$

$$C(t) = max[C_0 - D(t), k^u] \tag{14}$$

$$L = inf\{t \geq 0 : \; C(t)\} \tag{15}$$

$$A_l = \frac{L}{L + R_t} \tag{16}$$

$$P_f(t) = P(L(t)\colon \{C(t) \leq k^u\}) = P(N_t > n) = 1 - P(N_t \leq n) \tag{17}$$

$$P_f(t) = 1 - \sum_{j=1}^{T} \sum_{i=0}^{n} \frac{(\lambda j)^i}{i!} e^{-\lambda j} \tag{18}$$

$$PR = 15 + ln\left[\frac{\gamma_{s,s}}{F_d}\right] + R_T + F_T \tag{19}$$

$$D_{RR} = C_{TI}\left[\frac{{U_{b,V_l}}^2}{2g(s-1)}\right], U_{b,V_l} = 0.87V_l \tag{20}$$

$$C_{TI} = 12.3[TI] - 0.2 \tag{21}$$