

Hydraulic Geometry of Rivers

This worksheet calculates the wetted perimeter, cross-sectional area, and hydraulic radius of a river channel cross-sectional survey measurements and the water surface elevation.

Given:

WS:= 45 Water surface elevation
 STA:=(0 5 8 12 45 57 71 78) Horizontal stationing across river (any size!)
 z:=(50.5 49 49 40.3 38.1 42 44.8 51) Channel bottom elevation at station (any size!)

Find: The wetted perimeter, cross-section (flow) area and hydraulic radius. Note that all 3 values are calculated within the channel bounds but below the water surface.

STA:= STA^T Stationing vector is transposed for convenience
 z:= z^T Elevation vector is transposed for convenience
 n:= if length(STA)-length(z)=0
 length(STA) Solution can handle any number of data points
 else but STA and z must be equal size
 "error"

Solution:

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P:= p:= 0 Wetted perimeter function
for i ∈ 1..n-1
  if (zi > WS) ∧ (zi+1 < WS)
    STAinterp := (WS - zi) · (STAi+1 - STAi) / (zi+1 - zi) + STAi
    dpi := √((STAi+1 - STAinterp)2 + (zi+1 - WS)2)
  else
    if (zi < WS) ∧ (zi+1 > WS)
      STAinterp := (WS - zi) · (STAi+1 - STAi) / (zi+1 - zi) + STAi
      dpi := √((STAinterp - STAi)2 + (WS - zi)2)
    else
      if (zi > WS) ∧ (zi+1 > WS)
        dpi := 0
      else
        if (zi ≤ WS) ∧ (zi+1 ≤ WS)
          dpi := √((STAi+1 - STAi)2 + (zi+1 - zi)2)
        else
          P:= "error"
    p:= dpi + p
P:= p

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A:= | a:= 0
    | for i ∈ 1 .. n-1
    |   | if (zi > WS) ∧ (zi+1 < WS)
    |   |   | STAinterp := (WS - zi) ·  $\frac{(STA_{i+1} - STA_i)}{(z_{i+1} - z_i)}$  + STAi
    |   |   | dai :=  $\frac{(STA_{i+1} - STA_{interp}) \cdot (WS - z_{i+1})}{2}$ 
    |   |   | else
    |   |   |   | if (zi < WS) ∧ (zi+1 > WS)
    |   |   |   |   | STAinterp := (WS - zi) ·  $\frac{(STA_{i+1} - STA_i)}{(z_{i+1} - z_i)}$  + STAi
    |   |   |   |   | dai :=  $\frac{(STA_{interp} - STA_i) \cdot (WS - z_i)}{2}$ 
    |   |   |   |   | else
    |   |   |   |   |   | if (zi > WS) ∧ (zi+1 > WS)
    |   |   |   |   |   |   | dai := 0
    |   |   |   |   |   |   | else
    |   |   |   |   |   |   |   | if (zi ≤ WS) ∧ (zi+1 ≤ WS)
    |   |   |   |   |   |   |   |   | dai :=  $\frac{(STA_{i+1} - STA_i) \cdot ((WS - z_{i+1}) + ((WS - z_i)))}{2}$ 
    |   |   |   |   |   |   |   |   | else
    |   |   |   |   |   |   |   |   |   | A:= "error"
    |   |   |   |   |   |   |   |   |   | a:= dai + a
    |   |   |   |   |   |   |   |   |   | A:= a

```

Cross-sectional flow area
function

$$R := \frac{A}{P}$$

Hydraulic radius function

Results:

P = 65.443	Wetted Perimeter
A = 278.3007	Cross-sectional Flow Area
R = 4.2526	Hydraulic Radius