



Subsurface Flow Paths and Summer Low Flows:

Simulating Network Dynamics & Flow Permanence

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NSF

How do you know when a stream channel has water?

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Surface

Subsurbee

Surface

Substities

Q_{stream} amount exceeding subsurface capacity

Q_{subsurface} maximum capacity for down valley flow

 $\begin{array}{c} \mathbf{Q}_{\mathsf{total}} \\ \mathsf{total} \ \mathsf{down} \ \mathsf{valley} \ \mathsf{flow} \\ (\mathsf{Q}_{\mathsf{stream}} + \mathsf{Q}_{\mathsf{subsurface}}) \end{array}$

How do you know when a stream channel has water?

Surface

Subsurbee

Surge

Substition

Q_{stream} amount exceeding subsurface capacity

Q_{subsurface} maximum capacity for down valley flow

$\mathbf{Q}_{\mathsf{total}}$

total down valley flow (Q_{stream} + Q_{subsurface})

How can you estimate total down valley flow at any point in network?



Upslope Accumulated Area = 20 ha

How can you estimate total down valley flow at any point in network?



H. J. Andrews Experimental Forest Watershed 1







amount exceeding subsurface capacity

maximum capacity for down valley flow

total down valley flow $(Q_{stream} + Q_{subsurface})$

How can you estimate subsurface capacity at any point in network?



How can you estimate subsurface capacity at any point in network?

 $Q_{subsurface \ capacity}$ $Q = -kA(\Delta h/\Delta X)$

Q ≈ -k(w*d)(slope)











Flowing Channel Length and Contiguous Channel Length



- Stormactivated during wet conditions
- Often flowing but not connected to outlet
- Step-change in Q at confluence
- Network contraction at seasonal lowflow
- Rapid expansion in response to a small storm.



Flowing & connected length expand and contract by hundreds of meters in response to diurnal fluctuations



Hopefully – a better conceptual image of flow dynamics in headwater watersheds

- Might be difficult to apply in most situations:
 - Most streams are ungaged
 - Q ≈ -k(w*d)(slope); but k & d hard to measure
- Model captures expected behavior of watershed
 - Expansion & contraction with changes in Q
 - Threshold behavior when

Q_{total} ≈ Q_{subsurface capacity} difficult to predict extent of wetted network

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Advances in Water Resouces 2018 114:64-82

Advances in Water Resources 114 (2018) 64-82



Contents lists available at ScienceDirect

Advances in Water Resources

journal homepage: www.elsevier.com/locate/advwatres

Simulation of dynamic expansion, contraction, and connectivity in a mountain stream network



Advance: in Water Resources

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