Estimating Runoff for the Hood River Watershed

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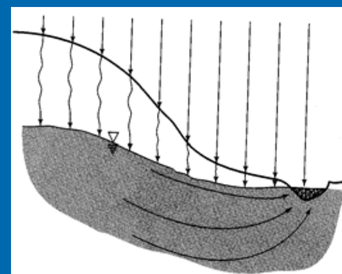
Data

- Soils data from NRCS
- Precipitation data from Prism (OCS)
- Land use data from Oregon Natural Heritage Program (GAP Vegetation)
- Curve number tables from National Engineering Handbook 4 (1985)
- Runoff from USGS (Tucker Bridge Gauging Station, Hood River)

Fundamental Hydrology Concepts

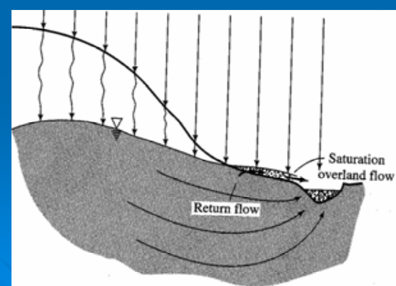
Baseflow

All water entering channel from groundwater



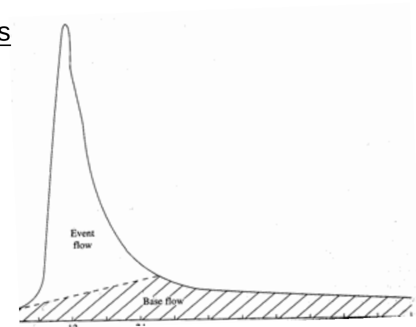
Runoff

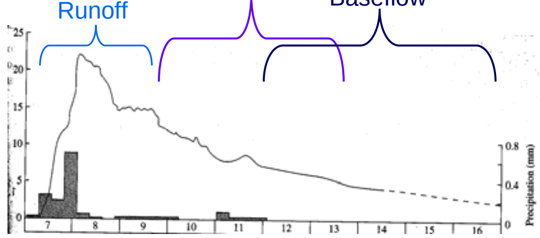
Water entering channel from surface (overland flow) and groundwater



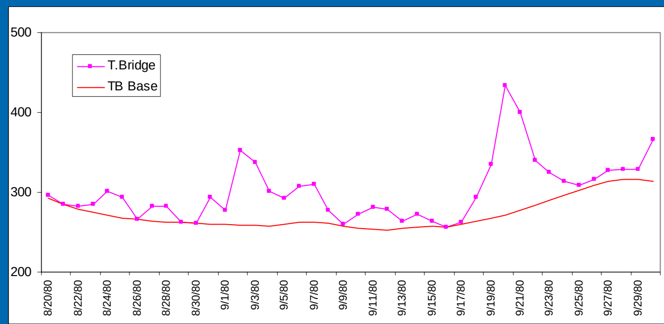
Fundamental Hydrology Concepts

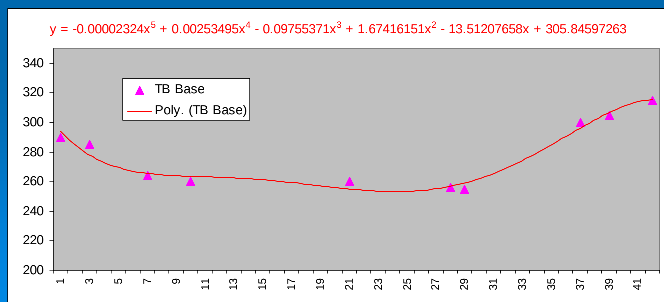
Separating runoff from groundwater input from hydrograph



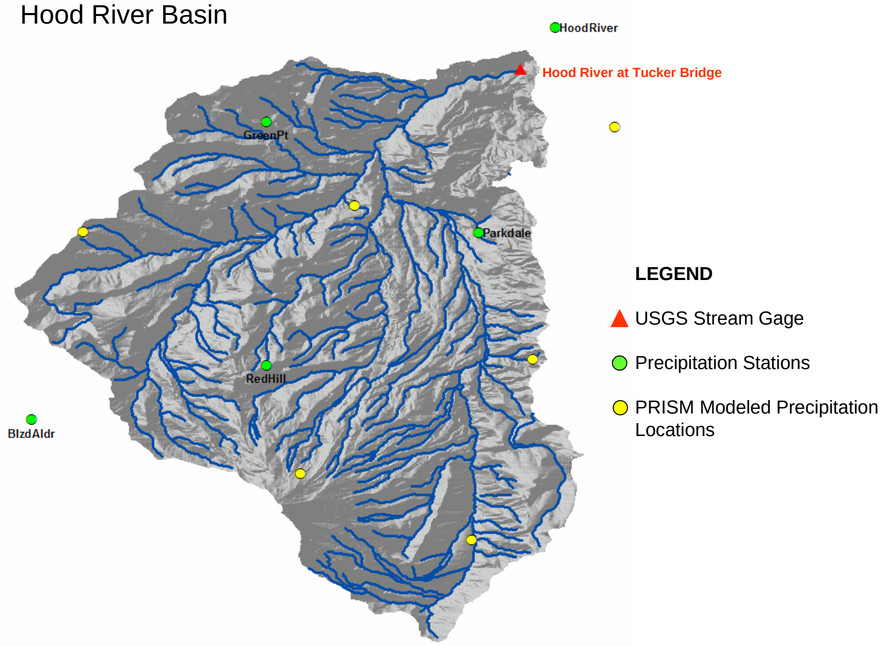


Runoff Determination, Hood River at Tucker Bridge, OR





Hood River Basin



Curve Number

$$Q = \frac{(P - I_a)^2}{(P - I_a) + S}$$

$$S = \frac{1000}{CN} - 10$$

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)}$$

I_a defined as percentage of S

Q = Runoff

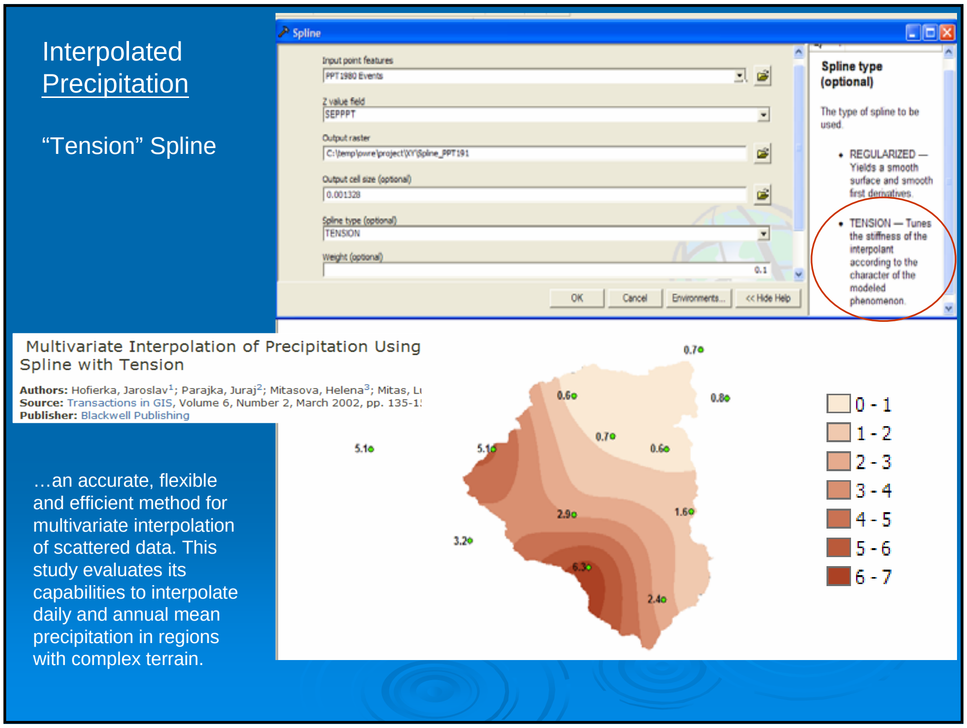
P = Precipitation

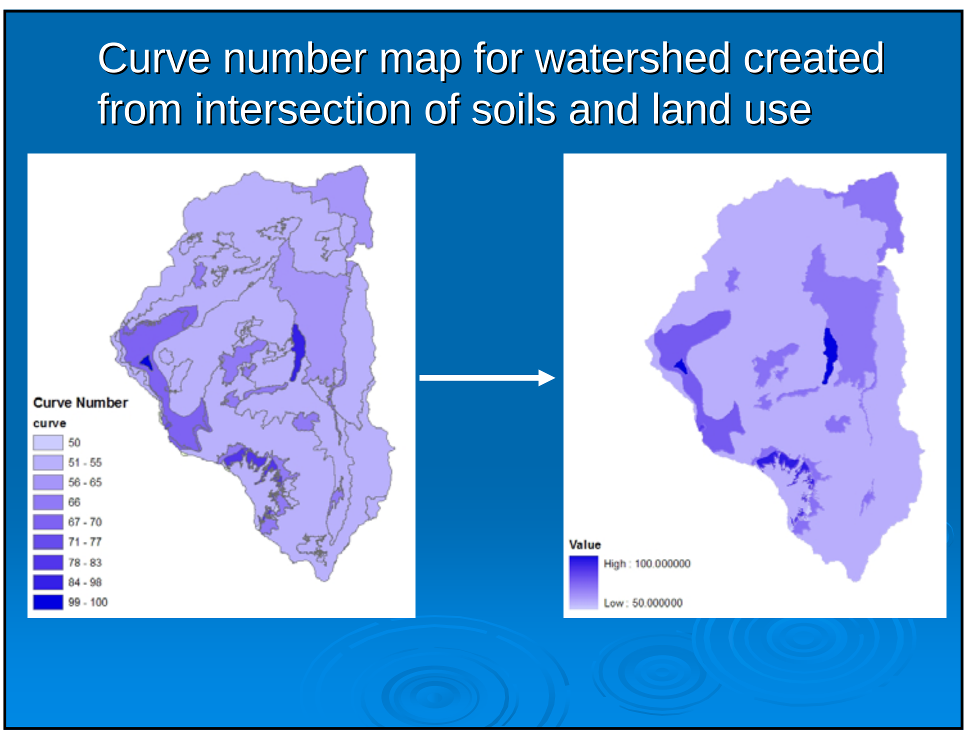
I_a = Initial abstractions

S = Potential maximum retention after runoff begins

Methods

- Create curve number map based on intersection of land use layer and soils layer (hydrologic soil group A-D)
- Convert curve number map to raster
- Interpolate (spline) precipitation data
- Use raster calculator with curve number equation to determine runoff depth from each cell


Interpolated
Precipitation
"Tension" Spline
Spline
Input point features
PPT 1980 Events
Z value field
SEPPPT
Output raster
Output cell size (optional)
0.001328
Spline type (optional)
TENSION
Weight (optional)
0.1
OK
Cancel
Environments...
<< Hide Help
Spline type (optional)
The type of spline to be used.
• REGULARIZED — Yields a smooth surface and smooth first derivatives.
• TENSION — Tunes the stiffness of the interpolant according to the character of the modeled phenomenon.
Multivariate Interpolation of Precipitation Using Spline with Tension
Authors: Hofierka, Jaroslav[1]; Parajka, Juraj[2]; Mitasova, Helena[3]; Mitas, Lu
Source: Transactions in GIS, Volume 6, Number 2, March 2002, pp. 135-15
Publisher: Blackwell Publishing
…an accurate, flexible and efficient method for multivariate interpolation of scattered data. This study evaluates its capabilities to interpolate daily and annual mean precipitation in regions with complex terrain.
0.7
0.6
0.8
5.1
5.1
0.7
0.6
2.9
1.6
3.2
6.3
2.4
0 - 1
1 - 2
2 - 3
3 - 4
4 - 5
5 - 6
6 - 7


Curve number map for watershed created from intersection of soils and land use
Curve Number
curve
50
51 - 55
56 - 65
66
67 - 70
71 - 77
78 - 83
84 - 98
99 - 100
Value
High : 100.000000
Low : 50.000000

Methods

- Use curve number for each cell to create a raster of S-Values for watershed
- Use raster calculator to perform curve number equation, resulting in runoff depth for each cell
- Use Zonal Statistics to get runoff depth in inches for each sub-basin

Methods

- Take runoff totals, divide by the number of cells in each sub-basin, total, convert to feet, multiply by area to get volume
- Divide volume by number of second in a month to get runoff in cfs
- Compare to gaged runoff totals

Methods for Runoff Estimate, 1980, Hood River at Tucker Bridge

VALUE	COUNT (cells)	AREA	MIN	MAX	MEAN	STD	SUM (Q)	SUM (Q) / COUNT	AREA (m^2)	AREA (ft^2)
2225	178598	0.0098	0.0	0.4	0.2	0.1	35503	0.2	109492473	1178567168
2240	193567	0.0106	0.0	0.5	0.1	0.1	20619	0.1	63921597	688046340
2272	229685	0.0126	0.0	2.2	0.1	0.3	26538	0.1	51998324	559705305
2291	156389	0.0086	0.0	4.3	0.8	0.7	131874	0.8	68591736	738315302
2293	134120	0.0074	0.0	2.2	0.1	0.3	13920	0.1	32966650	354850066
2325	202820	0.0111	0.0	4.3	0.7	0.6	134926	0.7	81572678	878040998
2377	108912	0.0060	0.1	4.6	1.1	1.0	116122	1.1	85164440	916702403
2379	143678	0.0079	0.0	4.5	0.6	0.7	84485	0.6	92375767	994324481
2381	68390	0.0038	0.0	0.1	0.0	0.0	317	0.0	74900126	806218241
2432	169759	0.0093	0.0	4.5	0.6	0.8	105261	0.6	97656817	1051169233
						Sum (in)		4.3		
						Sum (ft)		0.4		8165939538
						Runoff Volume (ft^3)				2934322382
						Runoff (ft^3/s)				1132

Actual Runoff = 1051 cfs

Possible Causes of Failure

- Watershed too large for this method
- No curve numbers available for snowfields or lava flows, had to estimate (50 for snowfields, 98 for lava flows); however these were not a large proportion of watershed
- Method works best for single rain event, tried to use for monthly runoff totals

Results

- Model failed to produce reliable results; estimated runoff was often very high or very low
- No trends were observed in results; completely unpredictable
- More research is needed to determine if this method can be applied in a GIS.

Unreliable for Forests

These large uncertainties from two different watersheds establishes the need to analyze additional data from Fernow and other sites in and around West Virginia to be sure that the method is applicable, and then designate how curve numbers should be selected for forested watersheds. The curve number method has not been formally and scientifically adapted to forest hydrology and management and is known to be notoriously unreliable for some forests. When the standard procedure assigns the same curve number of 55 to cut and uncut forests based on sound observations consistent with applying West Virginia best management practices, the need for a formal protocol for the analysis of forest hydrology is also clear. Furthermore, lacking an uncertainty and sensitivity analysis of forest management practices in the southern West Virginia