It's Never the Same Watershed Twice…

Using GIS Technology Responsibly With Engineering Judgment

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Agenda

1. NRCS Method and Its Role in Stormwater
2. Calculating the CN with ArcGIS Applications
3. Calculating TC with GIS-based Applications
4. Professional Judgment
5. Examples
6. Conclusions

CN Method and its role in Stormwater

Soil Data

Land Use

Drainage Area

Time of Concentration

USDA

United States Department of Agriculture

Natural Resources Conservation Service

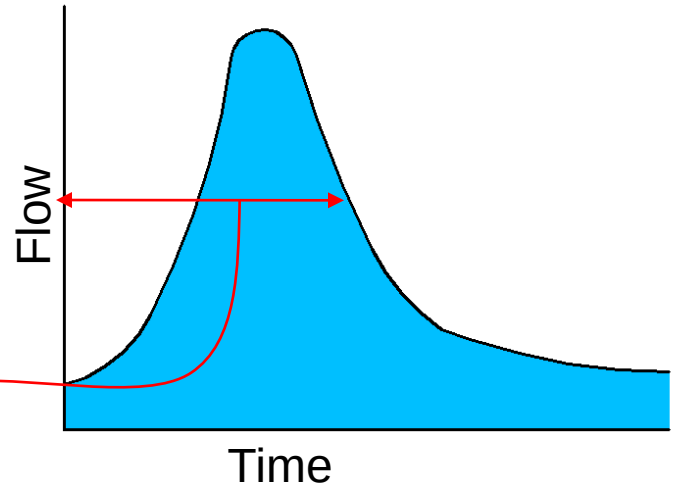
Conservation Engineering Division

Technical Release 55

June 1986

Urban Hydrology for Small Watersheds

TR-55



CN Method and its role in Stormwater

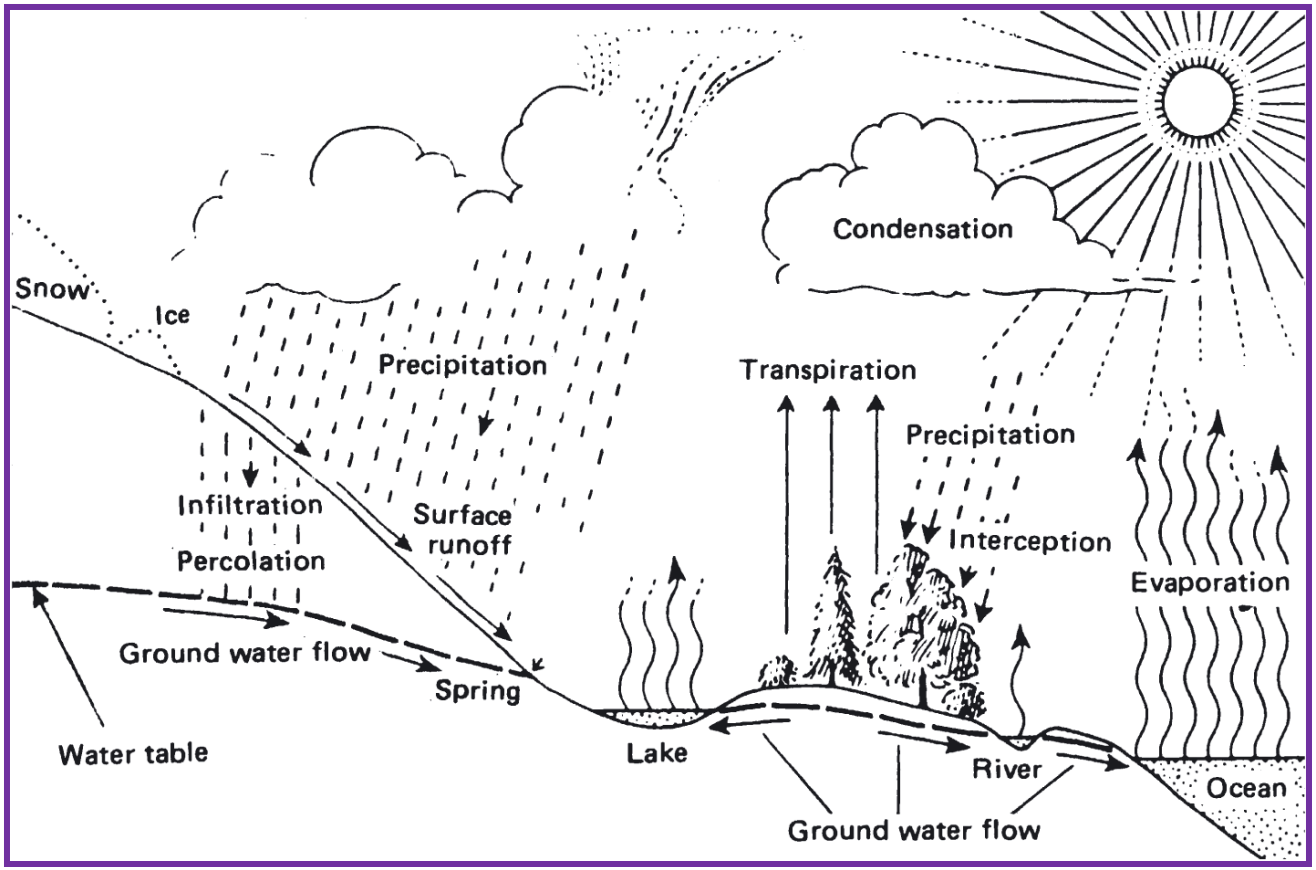
- Pre-development

  CN = 58
  - Low runoff potential

- Post-development

  CN = 85
  - High runoff potential

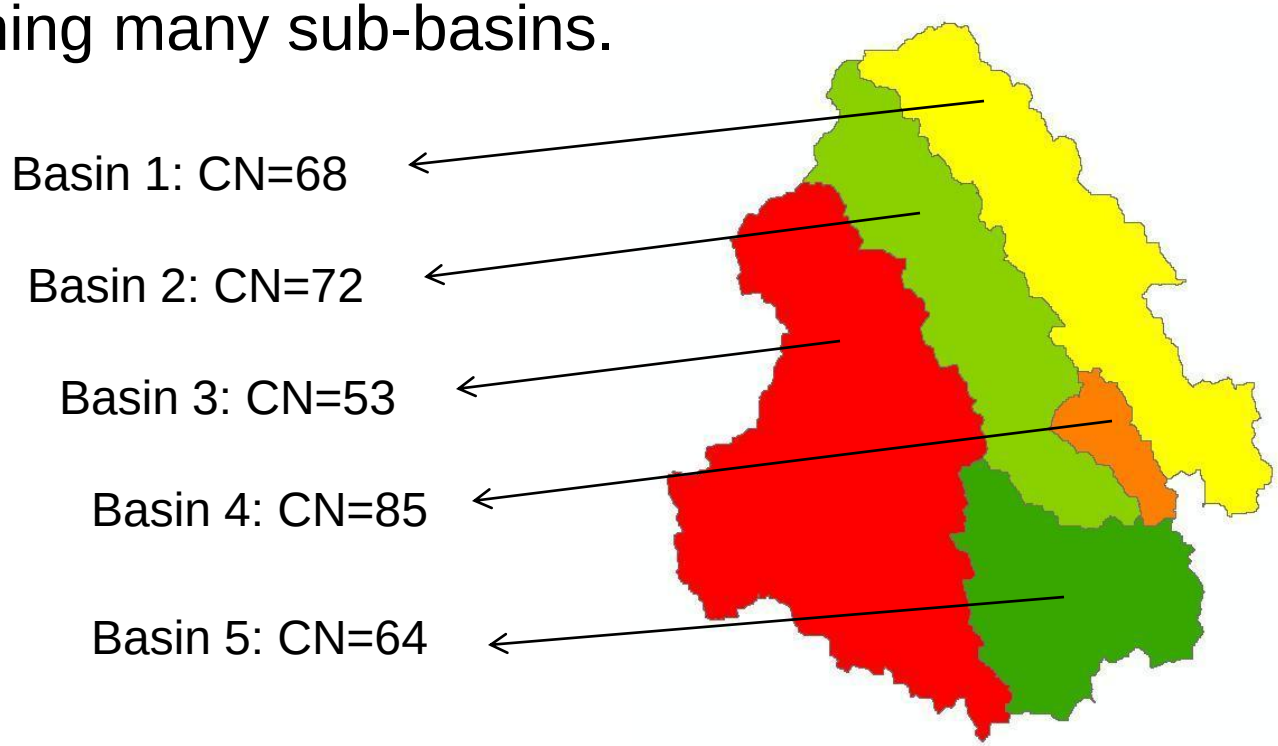
CN Method and its role in Stormwater



Source: http://www.wahyd.tu-berlin.de/content/mitarbeiter/tbusse/eigener_bereich/projects/hsm/hsm-en.html

CN Method and its role in Stormwater

ArcGIS Model Builder can be used to create a tool that will do the curve number calculations for a watershed containing many sub-basins.

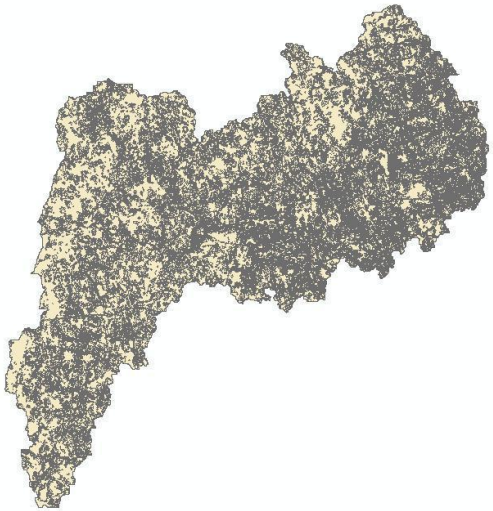


Why Automated Geoprocessing?

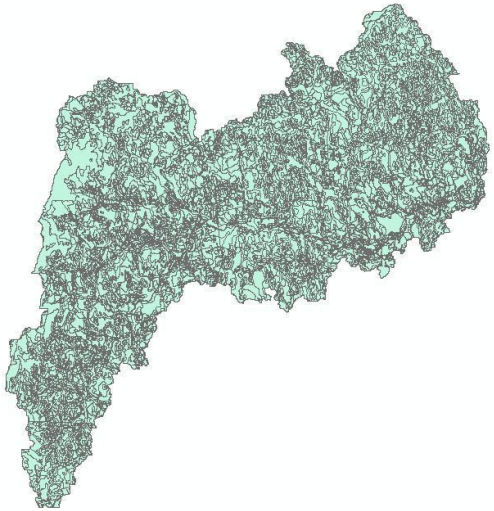
- Ease - The curve number calculation can be tedious and labor intensive when done manually.
- Efficiency - The model is pre-programmed with the correct types of fields to create, and the specific calculations to be performed on those fields.
- Data management - Models use scratch workspaces, which allow for automatic management of intermediate datasets.

Required Data

Basin Shapefile (Obtained from USGS StreamStats)



Land Use Shapefile (Obtained from USGS Seamless)



Soil Shapefile (Obtained from NRCS Soil Data Mart)

OID	Soil_LU	CN
0	A2	81.48
1	A3	50.8
2	A4	72
3	A5	39
4	A6	30
5	A7	39
6	A8	39
7	A9	39
8	A10	30
9	A11	30
10	A12	30
11	A13	30
12	A14	30
13	A15	30
14	A16	30
15	A17	72.04

Lookup Table (May be Customized By User)

Data Preparation

- Basins
  - Each sub-basin must be attributed with a unique identifier to distinguish it from the others.
- Soils
  - An “HSG” field is provided in the SURRGO Microsoft Access database.
- Land Use
  - Each area must contain a value corresponding to a land use type, such as NLCD gridcodes.

Customizing the Lookup Table

Table 9–1 Runoff curve numbers for agricultural lands [1/] — Continued

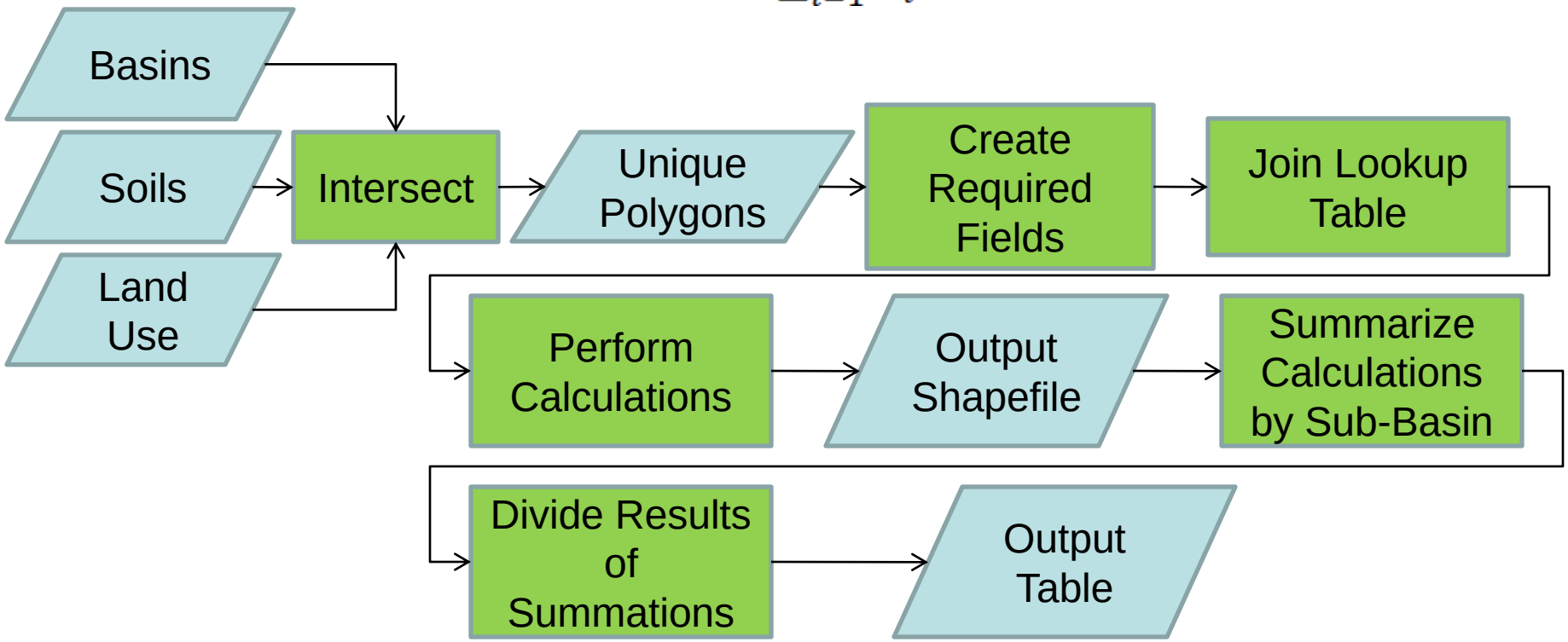
Cover description: covertype	treatment [2/]	hydrologic condition [3/]	CN for hydrologic soil group: A	B	C	D
Pasture, grassland, or range-continuous forage for grazing [4/]		Poor	68	79	86	89
		Fair	49	69	79	84
		Good	39	61	74	80
Meadow-continuous grass, protected from grazing and generally mowed for hay		Good	30	58	71	78
Brush-brush-forbs-grass mixture with brush the major element [5/]		Poor	48	67	77	83
		Fair	35	56	70	77
		Good	30 [6/]	48	65	73
Woods-grass combination (orchard or tree farm) [7/]		Poor	57	73	82	86
		Fair	43	65	76	82
		Good	32	58	72	79

http://directives.sc.egov.usda.gov/media/pdf/H_210_630_9.pdf

Calculation Process

ArcGIS Model Builder can be used to string together geoprocessing tools that mimic the curve number calculation for a basin.

$$CN_{aw} = \frac{\sum_{i=1}^{n}(CN_i * A_i)}{\sum_{i=1}^{n} A_i}$$



Results

Shapefile Results

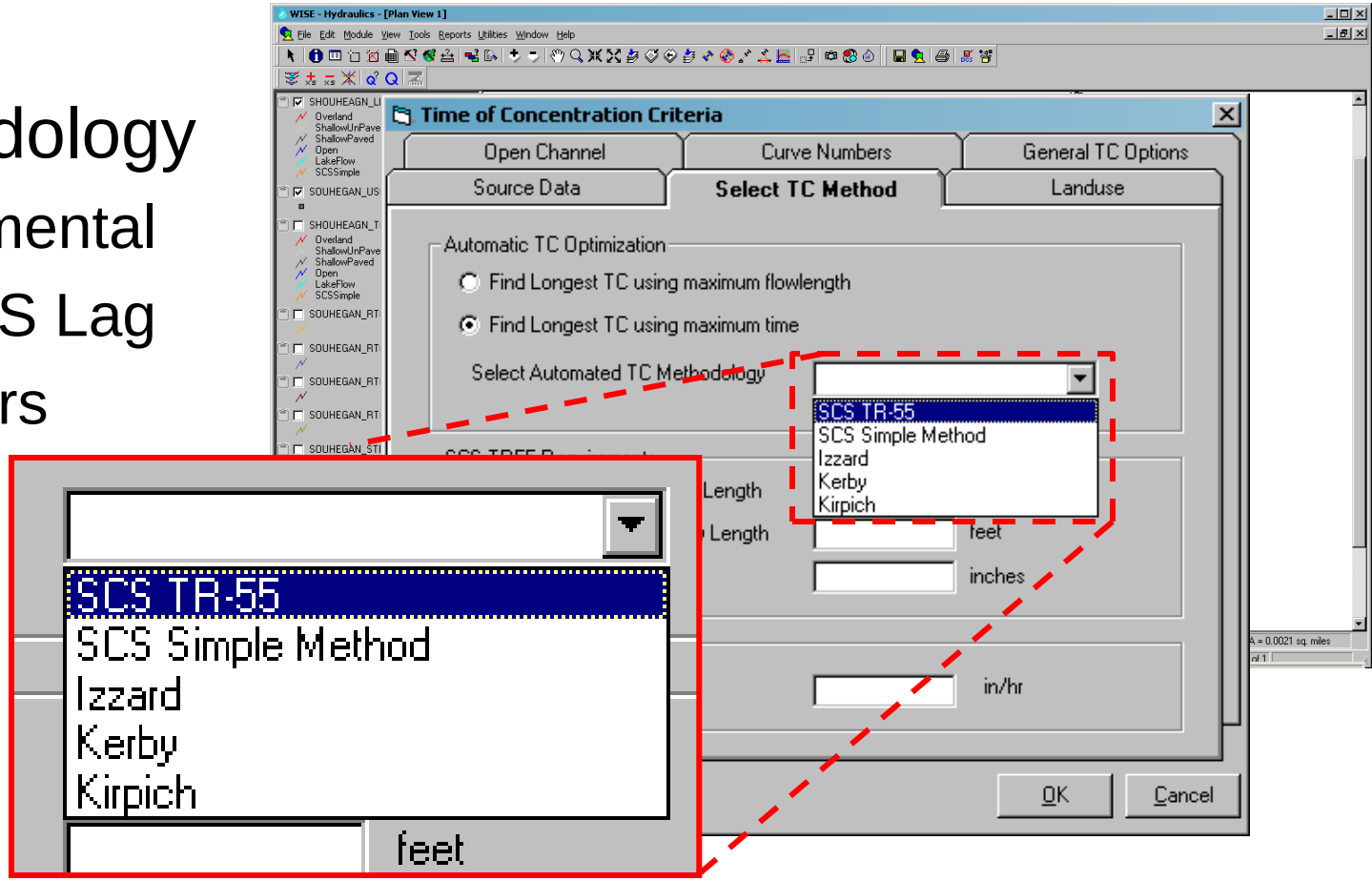
Basin_ID	Area	Land_Use	HSG	Soil_LU	CN	Area_CN
BASIN48	8585.67	9	B	B9	61	523725.87
BASIN48	19122.24	5	C	C5	74	1415045.76
BASIN48	38976.69	5	B	B5	61	2377578.09
BASIN48	9683.16	11	C	C11	71	687504.36

Table Results

Basin_ID	FREQUENCY	SUM_Area	SUM_Area_C	Basin_CN
BASIN10	131	2957499.98	200463957.98	68
BASIN100	194	7582499.95	535815663.03	71
BASIN101	6236	165017500.36	9529834932.36	58
BASIN102	252	5989999.99	444240095.20	74

Time of Concentration

- Methodology
  - Segmental
  - NRCS Lag
  - Others



Time of Concentration

- Methodology
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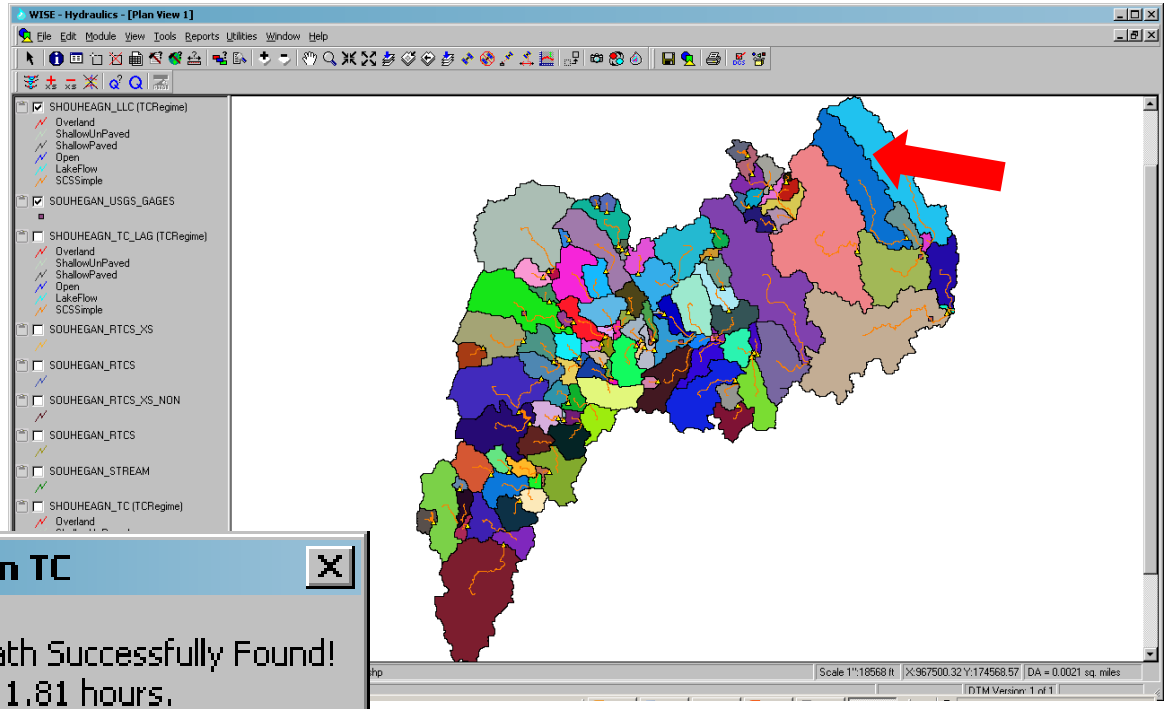
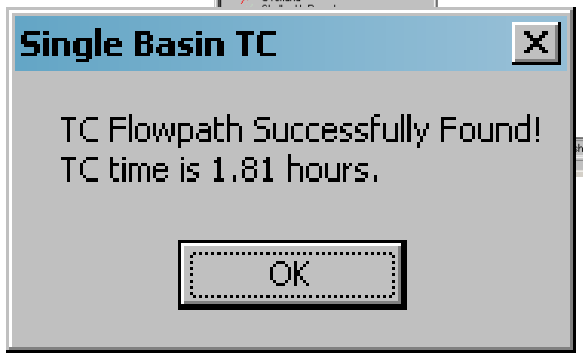




HEC-HMS

Professional Judgment

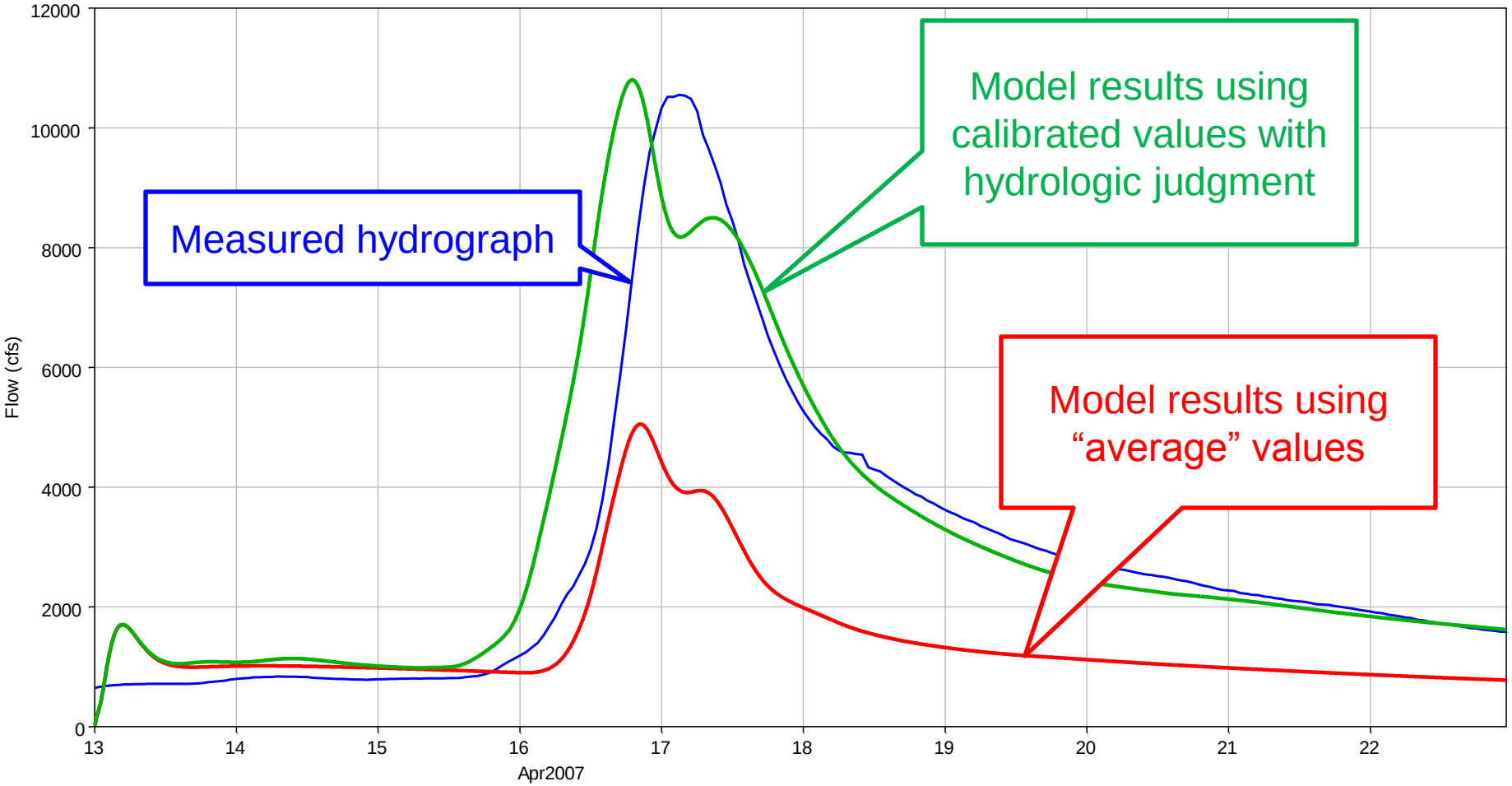
http://www.medway.gov.uk/print/flooding.jpg

It is important to note that the default curve number values are not always appropriate for every situation.

These types of tools are useful in performing calculations, but careful judgment must be used by the end user.

Cold weather example: April 2007

- Souhegan River Basin, New Hampshire
- Long periods of small rainfall amount prior to storm
- 3.3” of rainfall over 24 hour period (2 year event)
- Peak discharge of 10,550 cfs (~50 year event)


12000
10000
8000
6000
4000
2000
0
Flow (cfs)
13
14
15
16
17
18
19
20
21
22
Apr2007
Measured hydrograph
Model results using calibrated values with hydrologic judgment
Model results using "average" values

Conclusions

- Automated geoprocessing tools are valuable for eliminating redundant and tedious calculations.
- Widely available datasets, combined with these automated tools, make it relatively quick and easy to get first order estimates.
- Tools such as these can serve as an aid, but areas remain where professional judgment should not be hidden by automation.