Hydrologic Soil Group

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Outline

- Context
- Historical development
- Present condition
- Challenges and conundrums

Context

- Hydrologic Soil Groups are components of some models that estimate direct runoff from rainfall, for example the Curve Number method
- Assumptions:
  - Soil surface is bare
  - Very moist or wet antecedent water state
  - Soil is not frozen
  - Maximum swelling has taken place

History of HSG

- Early mention of a system like HSG is in the 1955 Yearbook of Agriculture in an article by George W. Musgrave called "How Much of the Rain Enters the Soil"
- This article introduces four infiltration classes:
  - A – Highest Group 0.30 to 0.50 inch/hr
  - B – Above Average Group 0.15 to 0.30 inch/hr
  - C – Below Average Group 0.05 to 0.15 inch/hr
  - D – Lowest Group 0 to 0.05 inch/hr
- Based on data for about 115 soil types

History of HSG

- There is some mention of a change to the criteria by Victor Mockus around 1964 in the National Engineering Handbook of the time
- An SCS group was commissioned in 1989 to study the curve number method and in 1991 this group of engineers and hydrologists considered that a soil scientist should participate, with Bob Nielsen being the one
- Nielsen considered that the soil survey database should be used to place soils in an appropriate HSG

History of HSG

- The soil survey database and the way we think of the soil survey database structure underwent a fundamental shift in 1995 when the National Soil Information System (NASIS) came to be
- In 2004, the HSG problem was picked up again by Robert Dobos, working with Don Woodward (until he retired) and then Claudia Hoeft (NRCS engineers)
- The ground rules:
  - The HSG would be calculated for components in NASIS
  - The ksat criteria should be updated
  - More HSGs should go up than down
  - No earth-shattering changes

Present condition

- Since the database is available; texture, structure, rock fragments, and mineralogy have been abandoned and only ksat is used as the water movement criteria
- Depth to restriction critical depths are 50 and 100cm
- Depth to water critical depths are 60 and 100cm
- Ksat criteria versus permeability (but in Chapter 7 of the NEM is referred to as "transmissivity")

Depth to water impermeable layer[1]	Condition	Depth to high water table [2]	Condition	K_{sat}[3]	Hydrologic soil group [4]
<50 cm [<20 in]	—	—	—	—	D
50 to 100 cm [20 to 40 in]	AND	<60 cm [<24 in]	AND	>40.0 µm/s (>5.67 in/h)	A/D
				>10.0 to ≤40.0 µm/s (>1.42 to ≤5.67 in/h)	B/D
				>1.0 to ≤10.0 µm/s (>0.14 to ≤1.42 in/h)	C/D
				≤1.0 µm/s (≤0.14 in/h)	D
>100 cm [>40 in]	AND	<60 cm [<24 in]	AND	>10.0 µm/s (>1.42 in/h)	A/D
				>4.0 to ≤10.0 µm/s (>0.57 to ≤1.42 in/h)	B/D
				>0.4 to ≤4.0 µm/s (>0.06 to ≤0.57 in/h)	C/D
				≤0.40 µm/s (≤0.06 in/h)	D
Depth to water impermeable layer [1]	**Condition**	**Depth to high water table [2]**	**Condition**	**K_{sat}[5]**	**Hydrologic soil group**
50 to 100 cm [20 to 40 in]	OR	60 to100 cm [24 to 40 in]	AND	>40.0 µm/s (>5.67 in/h)	A
				>10.0 to ≤40.0 µm/s (>1.42 to ≤5.67 in/h)	B
				>1.0 to ≤10.0 µm/s (>0.14 to ≤1.42 in/h)	C
				≤1.0 µm/s (≤0.14 in/h)	D
Depth to water impermeable layer [1]	**Condition**	**Depth to high water table [2] (if present)**	**Condition**	**K_{sat}[5]**	**Hydrologic soil group**
>100 cm [>40 in]	AND	>100 cm [>40 in]	AND	>10.0 µm/s (>1.42 in/h)	A
				>4.0 to ≤10.0 µm/s (>0.57 to ≤1.42 in/h)	B
				>0.4 to ≤4.0 µm/s (>0.06 to ≤0.57 in/h)	C
				≤0.40 µm/s (≤0.06 in/h)	D

Challenges and conundrums

- The whole soil world is placed into 4 crisp groups with no fuzziness
  - Fuzziness would be relatively easy to incorporate, but would entail a major shift conceptually in the Curve Number method
- My intent was to look only at the layer ksat data and not consider the component restriction; but the data was too inconsistent to be defensible
  - Fragipan layer ksats are not always very slow
  - Bedrock and Cr ksats are not always populated and was systemic, not error

Challenges and conundrums

- Moderately deep and shallow Cr versus R and ksat
- Runoff versus interflow on a watershed scale
  - Talked with Dr James Lynch about Berks and Weikert soils and he indicated that rainfall is delivered to the stream nearly as rapidly as direct runoff at Leading Ridge
  - Shale bedrock is not very transmissive (is a poor aquifer) despite the high ksat of the Cr and sometimes R horizons
  - The starting point of HSG is a wet condition
  - Areas underlain by shale have a high drainage density which is indicative of low permeability

Challenges and conundrums

- I beseech those of you involved in the Soil Data Join Recorrelation effort to consider how data effects HSG
- HSG is THE MOST requested data on Web Soil Survey/Soil Datamart
- ftp://ftp.wcc.nrcs.usda.gov/wntsc/H&H/NEHhydrology/ch7.pdf

- Questions??
- Thank You!!