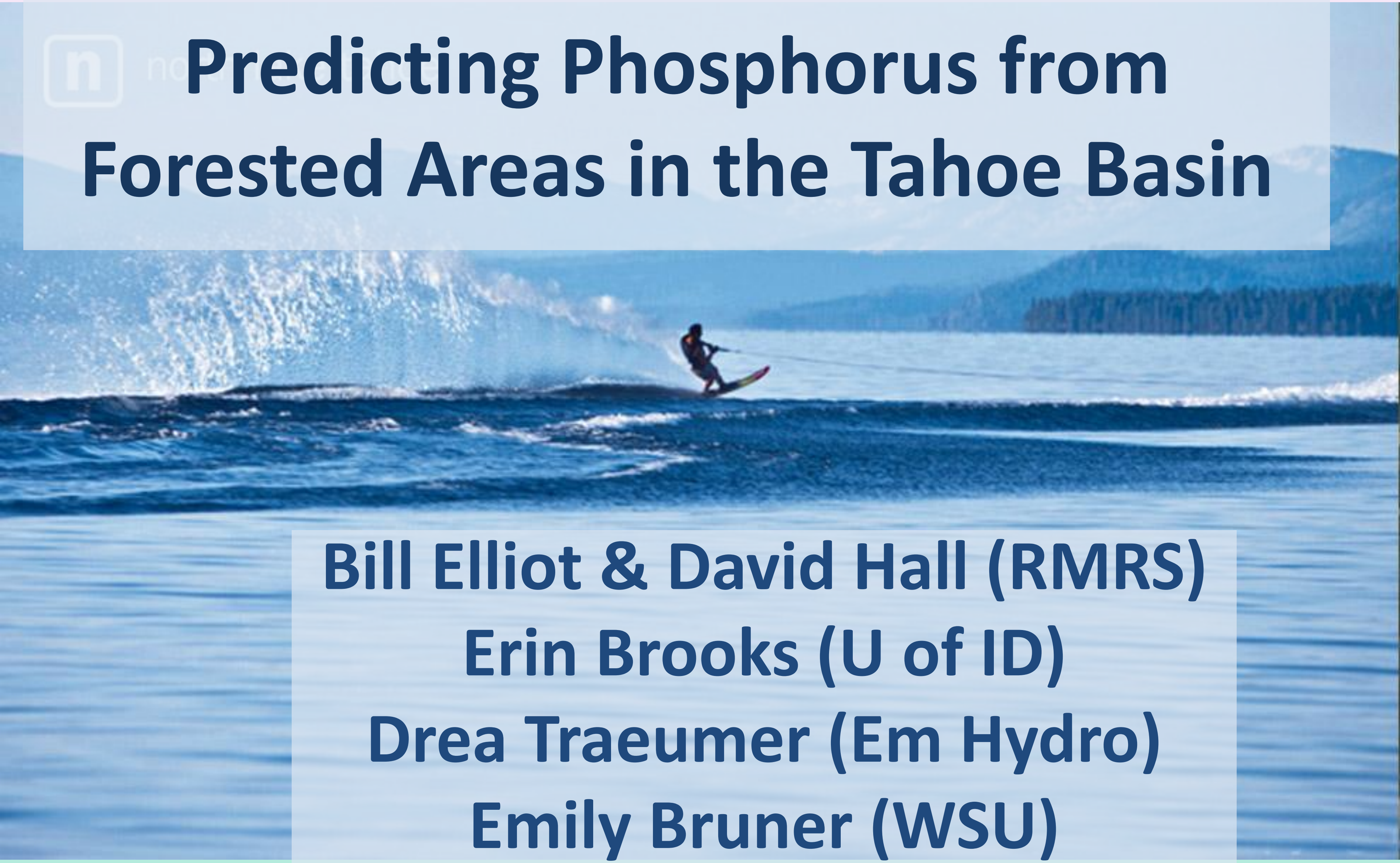
Predicting Phosphorus from Forested Areas in the Tahoe Basin



Bill Elliot & David Hall (RMRS)

Erin Brooks (U of ID)

Drea Traeumer (Em Hydro)

Emily Bruner (WSU)

Washington State University

Rocky Mountain Research Station

USDA ARS

Outline

- A bit of background
- Phosphorus pathways
- WEPP Hydrologic Framework
- Modeling Phosphorus delivery with WEPP

Why worry about Phosphorus Prediction?

- Lake Tahoe clarity is important to many
- An increase in phosphorus leads to an increase in algal growth
- An increase in algal growth leads to a decrease in lake clarity

PETERSPAIN.COM

WASHINGTON STATE UNIVERSITY

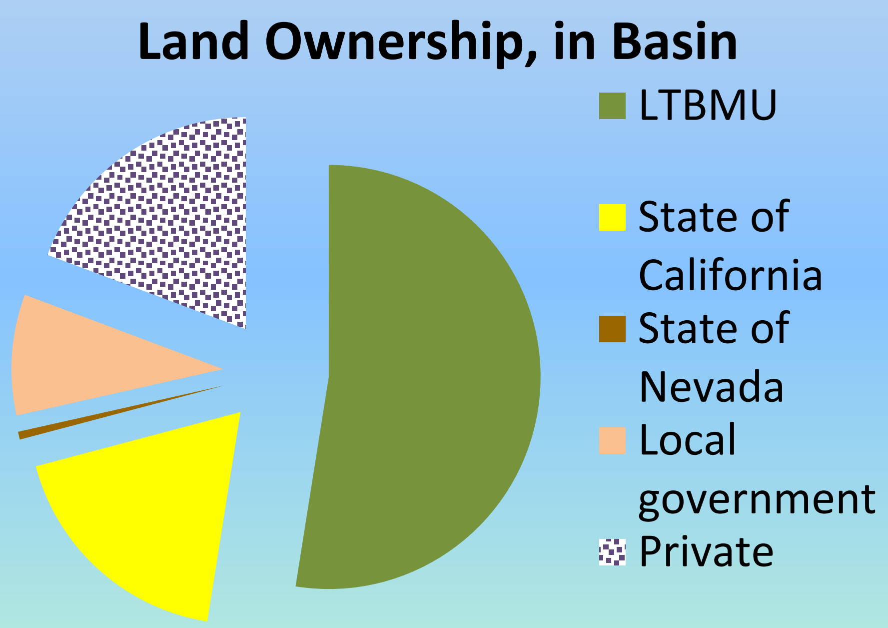
Rocky M

Why worry about Phosphorus Prediction?

- Lake Tahoe clarity is a important to many
- An increase in phosphorus leads to an increase in algal growth
- An increase in algal growth leads to a decrease in lake clarity
- If we can predict phosphorus delivery associated with forest management, we can evaluate alternative management practices to reduce delivery

Why worry about forests?

- Generally, **P** delivery is associated with human activity
- Forest covers > 80% of basin



Rocky Mountain Research Station

Why worry about forests?

- Generally, **P** delivery is associated with human activity
- Forest covers > 80% of basin
- With the increased need to reduce fire risk in basin, fuel management activities are increasing

Washington State University

Rocky Mountai

Why worry about forests?

- Generally, P delivery is associated with human activity
- Forest covers > 80% of basin
- With the increased need to reduce fire risk in basin, fuel management activities are increasing
- **What are the effects of different forest management practices on P delivery?**

Washington State University

Rocky Mou

How Does P get from forestland to the water?

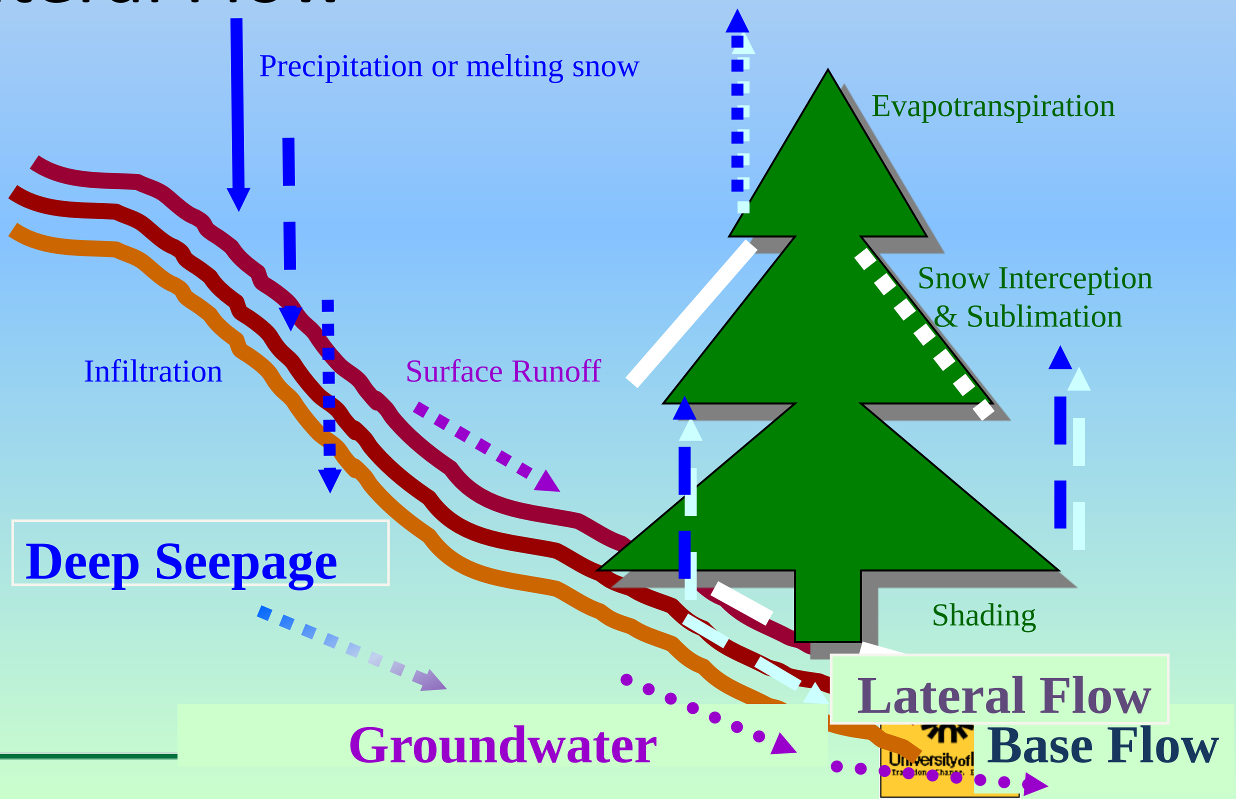
- Surface Runoff
  - Generally from roads or after wildfire

How Does P get from the land to the water?

- Surface Runoff
- Eroded sediments

How Does **P** get from the land to the water?

- Surface Runoff
- Eroded sediments
- Subsurface Lateral Flow
- Groundwater



Some Typical **P** Concentrations: Surface Processes: Sediment

Source	**P Concentration Observed**	**Rainfall Simulation**
<u>Sediment</u>		
Granitic	4 – 22 mg/kg	475 mg/kg
Volcanic	9 – 13 mg/kg	159 mg/kg
Alluvial		333 mg/kg
Suspended sediment	1500 – 4500 mg/kg	

Note that for suspended sediment, the “fines,” carry the **P**

WASHINGTON STATE UNIVERSITY

Rocky Mountain Research Station

University of Idaho Tradition. Change. Excellence.

Some Typical **P** Concentrations: Surface Processes: Runoff

Source	P Concentration Observed	Rainfall Simulation
<u>Sediment</u>		
Granitic	4 – 22 mg/kg	475 mg/kg
Volcanic	9 – 13 mg/kg	159 mg/kg
Alluvial		333 mg/kg
Suspended sediment	1500 – 4500 mg/kg	
<u>Surface Runoff</u>		
Snow melt	0.05 – 0.3 mg/l, typically 0.09	
Simulation Study		
Volcanic		1.28 mg/l
Granitic		0.89 mg/l
Alluvial		0.25 mg/l

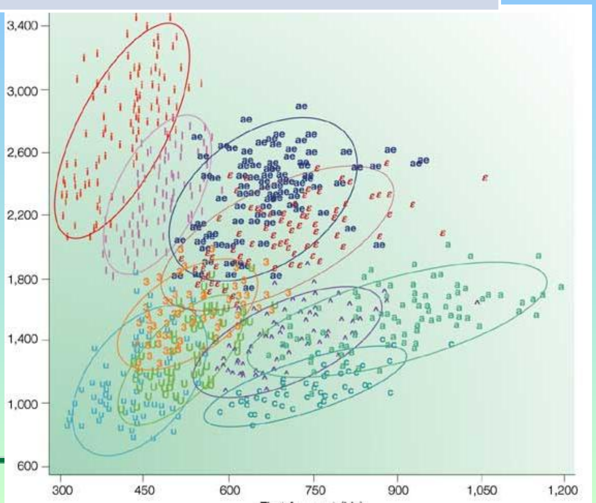
Note that snowmelt concentrations lower than simulation

Some Typical **P** Concentrations: Subsurface Processes

Source	P Concentration
Soil Water @ depth 0 - 5 cm 5 – 20 20 – 50 > 50 Nr Moscow ~130 cm	 4 - 10 mg/l 7.8 mg/l 0.02 – 5.6 mg/l 3.6 mg/l 0.4 – 1.4 mg/l
Interflow	0.002 – 11.1 (Median 4.3) mg/l
Base Flow	0.008 – 0.125 mg/l

Comments: High variability

Wally said this would be interesting



Some Typical **P** Concentrations: Runoff & Management

Source	P Concentration mg/1000 cm^2
Surface/Interflow runoff	
Undisturbed	0.02
Harvested	0.01
Burned, no harvest	0.01
Harvest and burn	0.01

Question: Is there a nutrient buildup in fire-suppressed forests?
What about those concentration units?

Some Typical **P** Concentrations: Runoff & Management

Source	P Concentration
Surface/Interflow runoff	
Undisturbed	0.02 mg/l
Harvested	0.01
Burned, no harvest	0.01
Harvest and burn	0.01
Jackpot burn simulator runoff	
Forest	0.37 mg/l
Unmopped pile	2.15 mg/l
Mopped pile	0.36 mg/l

Comment: “Mopping” a burn pile may be a good idea…

WEPP Hydrologic Framework

- WEPP does a daily water balance
  - Precipitation, snow melt, infiltration and runoff
  - Evapotranspiration
  - Soil water content
  - Lateral flow
  - Deep seepage

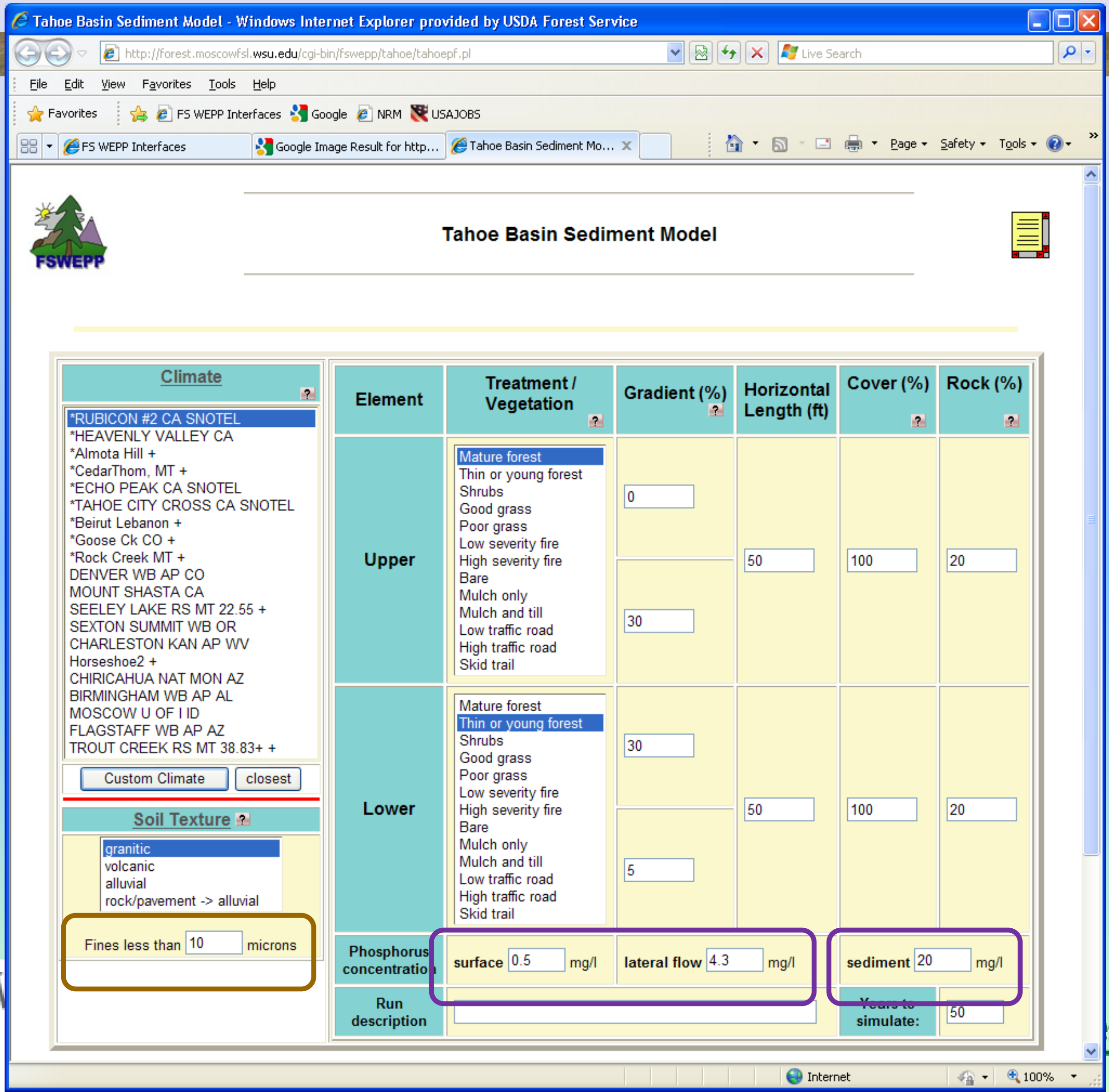
WEPP Hydrologic Framework

- WEPP does a daily water balance
  - Precipitation, snow melt, infiltration and runoff
  - Evapotranspiration
  - Soil water content
  - Lateral flow
  - Deep seepage
- For runoff events
  - Rill and interrill erosion
  - Sediment delivery with surface area enrichment

To predict **P** Delivery, we have tapped into specific WEPP outputs

- WEPP does a daily water balance
  - **Runoff**
  - **Lateral flow**
  - Deep seepage for linear flow model
- For runoff events
  - **Sediment delivery**
  - **Surface area enrichment**

The Prototype Interface



- Input fields are being added
  - Fine sediment
  - P concentrations

The Output

Precipitation, runoff, erosion, phosphate for 50 years

Precipitation, runoff, erosion, phosphate, fines analyses

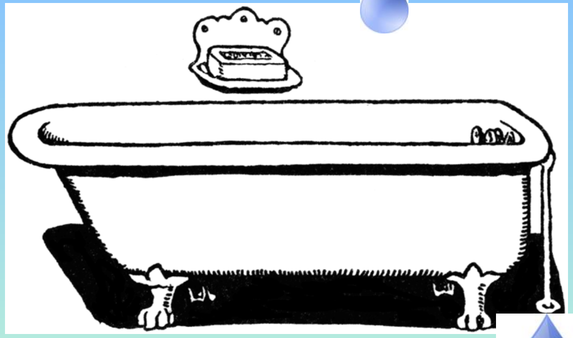
	Total for 50 years	Average annual	Phosphate Analysis: Concentration	Phosphate Analysis: Delivery
Precipitation	4841 storms	62.66 in.		
Runoff from rainfall	130 events	0.17 in.	0.5 mg/l	0.002 lb/ac
Runoff from snowmelt or winter rainstorm	50 events	0.31 in.		
Lateral flow	177.36 in.	0.59 in.	4 mg/l	0.021 lb/ac
Upland erosion rate (0.052 kg m^{-2})		0.231 t ac^{-1}		
Sediment leaving profile (3.43 kg m^{-1} width)		0.169 t ac^{-1}	20 mg/kg	0.003 lb/ac
			Total	0.027 lb/ac

Fines analysis	Ratio	Delivery
Clay	0.07	0.01 lb/ac
Silt	0.31	0.05 lb/ac
Silt < 10 microns	10.85	1.83 lb/ac
Total < 10 micron		0.05 lb/ac
SSA enrichment ratio leaving profile	1.10	

Lateral flow dominant pathway for **P** delivery (Observed 0.04 – 1 lb/a)

What about the Base Flow?

- Necessary for modeling watershed processes
- The Brooks Linear Flow Model:
  – Sponge and leaky tub, or
  – Soil => temporary reservoir
     => base flow and losses

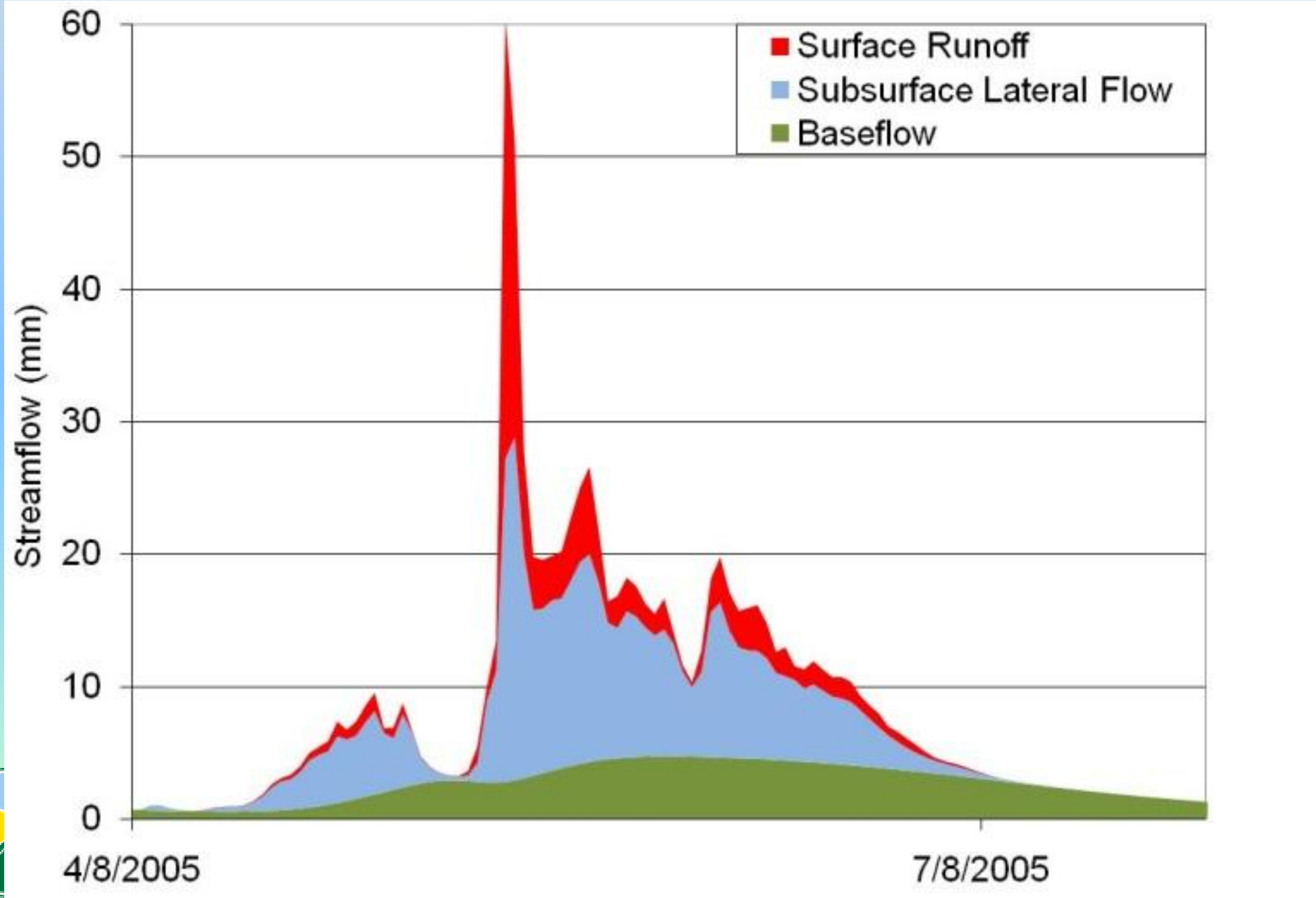


What about the Base Flow?

- The Brooks Linear Flow Model:
  - Set up a dynamic groundwater reservoir
  - Recharge with deep seepage
  - Every day:
    Base flow = K1 x depth in reservoir, and
    Groundwater losses = K2 x depth in reservoir

Base Plus Surface and Lateral Flow

- Adding it all up: runoff hydrograph
- **P** graph will follow




Questions or Comments?