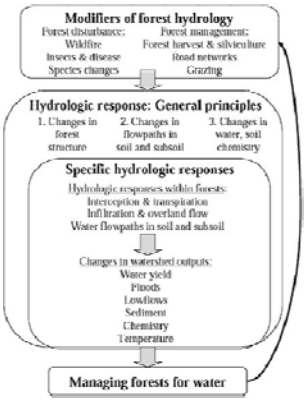
The hydrologic response is the function of the disturbance severity

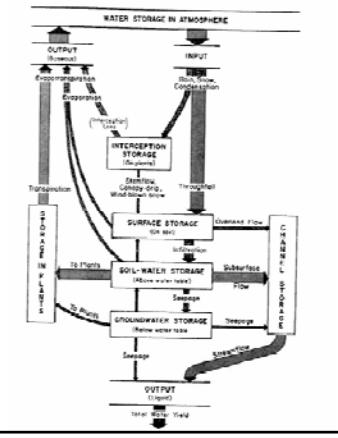
The more biomass that is removed the greater the potential change, but what changes is influenced by what biomass is removed.

Overstory } Annual Water Yield
Understory } Low Flows

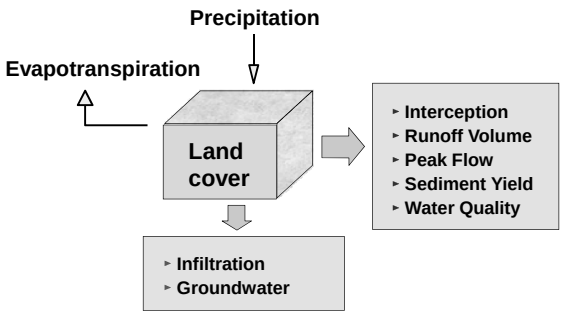
Herbaceous } Flooding
Ground Cover } Sediment

The observed response is also influenced by the amount and type of precipitation.



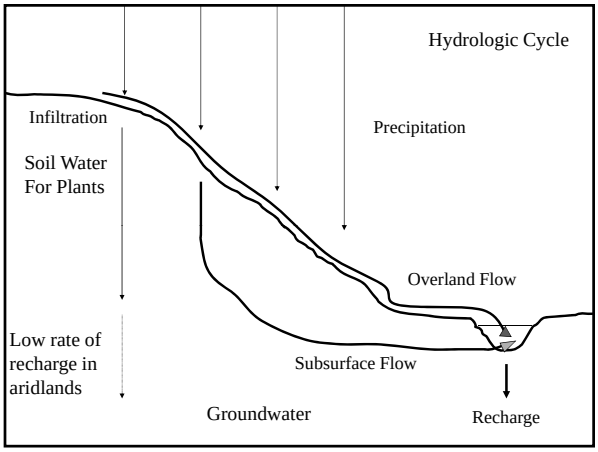


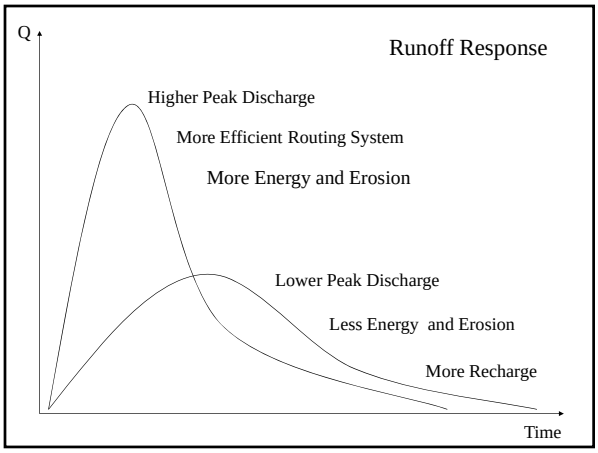
Principle Effects of Land Cover on Watershed Response



Water Yield and Vegetation Management

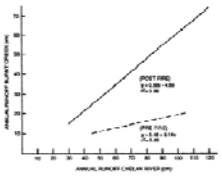
- Land Cover and Land Use has the most direct effect on:
  - Interception
  - Evapotranspiration
  - Snow Accumulation
  - Infiltration and Overland Flow





Fire

- Vegetation Removal and Mortality
  - Sever Fires can have 100% Mortality
  - Modification of hydrology cycle
    - Decrease in ET and interception
    - Increase in snow accumulation
  - Increase soil water availability
- Removal of Surface Material
  - Creation of bare soil
  - Increase potential for overland flow
- Modification of Surface Soil
  - Destruction of surface soil aggregates
    - Increase in bulk density
    - Decrease in porosity
  - Create soil hydrophobicity
    - Soil Sealing (raindrop impacts, ash)
    - Water Repellent Layers



Paired watersheds in Cascade Range in E. WA

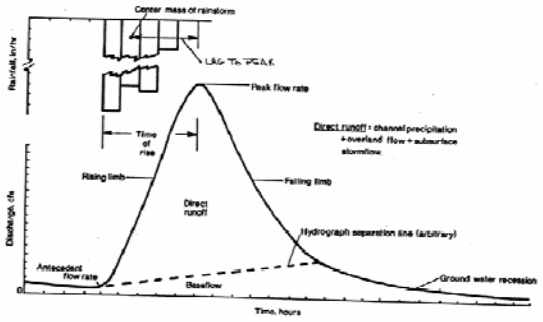
Arizona Example: Ponderosa Pine

	Unburn	Moderate	Severe
Area (ha)	17.7	4.0	8.1
Exposed Soil (%)	7	36	70
ROE (1973-75) (%)	0.8	2.8	3.6
# of Rain/Runoff Events (1973-75)	6	15	25
Largest Peak Discharge (cfs)	6.1	21.5	<336 (5400% change)
Infiltration (cm/hr)	6.9	3.7	2.6

Fire Effects Research

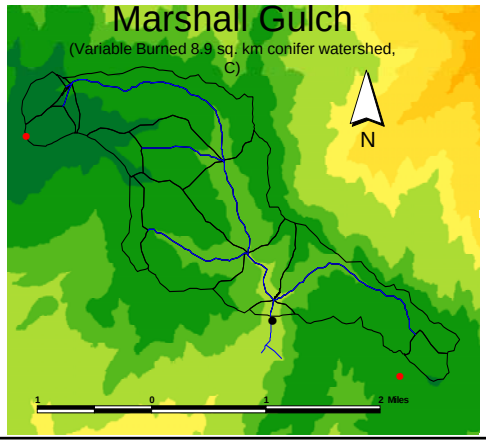
- Marshall Gulch, Aspen Fire, Arizona
- Starmer Canyon, Cerro Grande Fire, New Mexico
- Canfield, H.E., Goodrich, D.C., Burns, I.S. 2005. Selection of parameter values to model post-fire runoff and sediment transport at the watershed scale in southwestern forests. Proc. ASCE Watershed Manage. Conf., July 19-22, Williamsburg, VA.
- Goodrich, D.C., H. E. Canfield, I.S. Burns, D.J. Semmens, S.N. Miller, M. Hernandez, L.R. Levick, D.P. Guertin, and W.G. Kepner. 2005. Rapid Post-Fire Hydrologic Watershed Assessment using the AGWA GIS-based Hydrologic Modeling Tool. Proc. ASCE Watershed Manage. Conf., July 19-22, Williamsburg, VA.

Direct Runoff Hydrograph

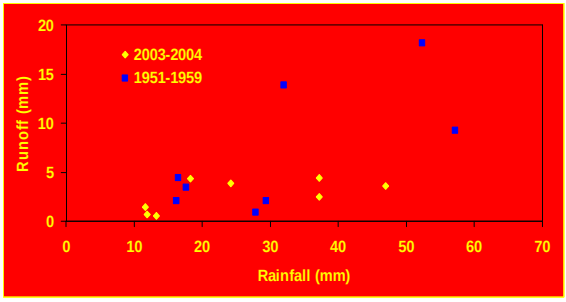


Marshall Gulch

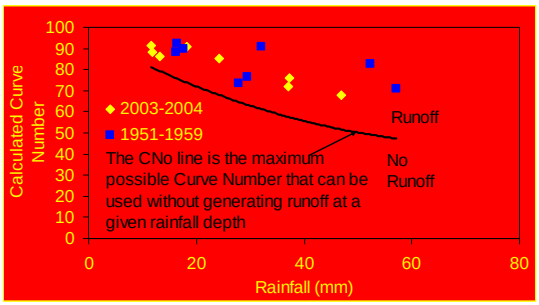
(Variable Burned 8.9 sq. km conifer watershed, C)



Runoff vs Rainfall for Marshall Gulch (8.6 sq.km.) Before and After Aspen Fire

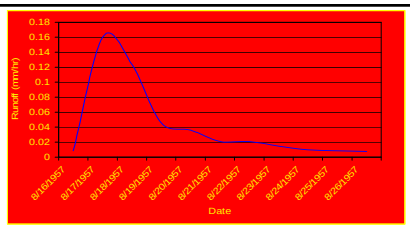


Calculated Curve Numbers for Before and After Aspen Fire

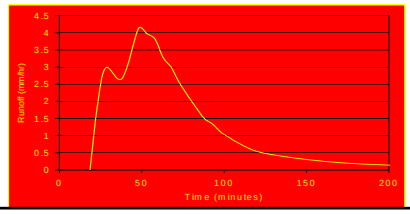


The impact on runoff volume is relatively small. This result has been reported by other (Springer & Hawkins 2005; McLin et al. 2001).

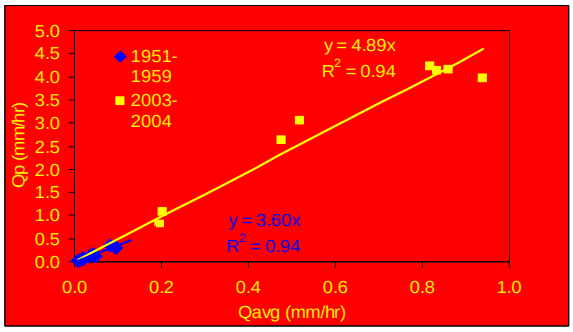
Pre- Fire Hydrograph



Post - Fire Hydrograph



Post Fire Peak vs Average Discharge At Marshall Gulch Before and After Aspen Fire



Parameterization of SWAT

- CN is based on cover. Assume a reduction in cover of:
  15% - low severity
  32% - moderate severity
  50% - high severity
- CN values lower then typically using in post-fire assessments Assume no change.

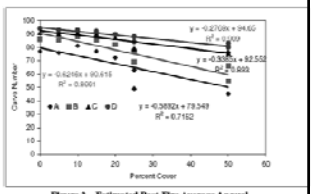
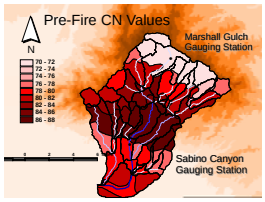
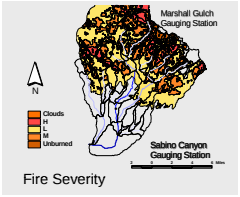


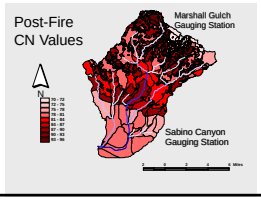
Figure 2 – Estimated Post-Fire Average Annual Runoff over a 10 Year Simulation Period (mm)

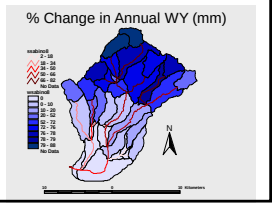
- Fix the roughness factor for overland flow to equal bare soil (n = 0.011). Selection of this value allows for more than an order of magnitude change in extremely rough environments, such as conifer forests.

Aspen Fire: Post-Fire Assessment







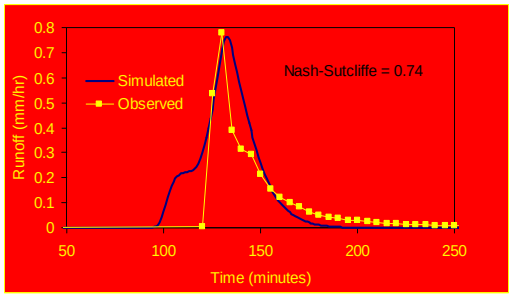


Optimal Hillslope Roughness, Saturated Hydraulic Conductivity and Channel Roughness for KINEROS2 at Starmer Canyon following Cerro Grande Fire

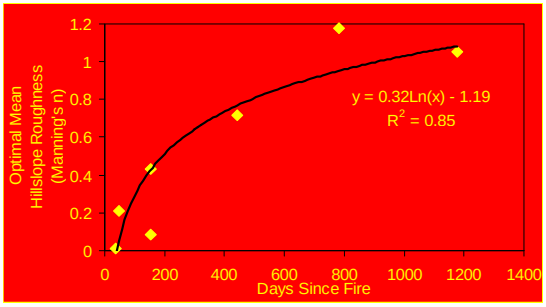
Event	Rainfall Depth (mm)	Days Since Fire	Ks (mm/hr)	n Channnel	n Hillslope	Nash-Sutcliffe
6/28/2000	11.3	37	3.361	0.193	0.014	0.89
7/9/2000	14.3	48	0.390	0.013	0.213	0.74
10/22/2000a	14.1	154	1.183	0.151	0.430	0.85
10/22/2000b	12.3	154	0.866	0.150	0.087	0.85
8/9/2001	9.8	444	2.172	0.008	0.716	0.88
7/14/2002	9.8	783	3.312	0.041	1.175	0.95
8/11/2003	22.6	1176	7.540	0.117	1.053	0.90

Canfield, H.E., Goodrich, D.C., Burns, I.S. 2005. Selection of parameter values to model post-fire runoff and sediment transport at the watershed scale in southwestern forests. Proc. ASCE Watershed Manage. Conf., July 19-22, Williamsburg, VA.

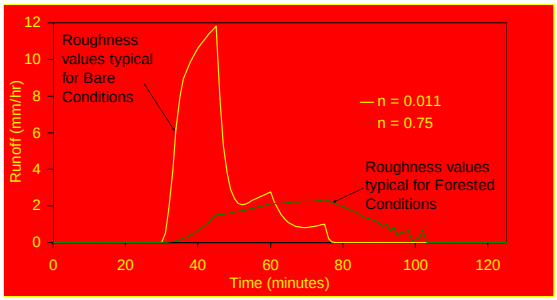
Calibrated Hydrograph for Most-poorly Fit Event



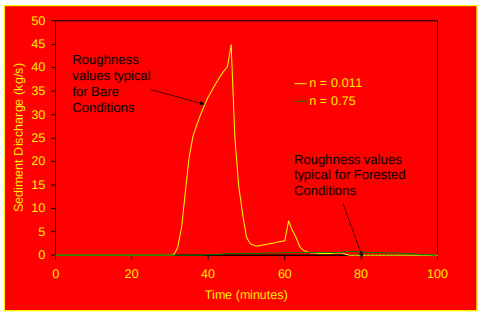
Optimal Hillslope Roughness vs Time at Starmer Canyon



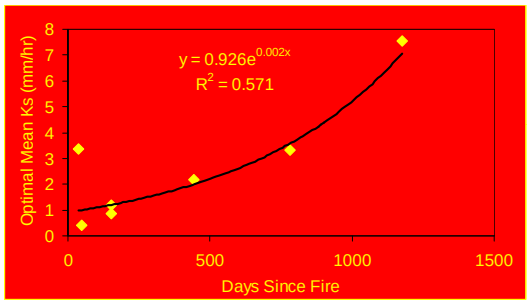
Simulated Effect of Roughness on Hillslope Runoff



Simulated Effect of Roughness on Hillslope Sediment Discharge



Calibrated Hydraulic Conductivity vs Time at Starmer Canyon



Summary

- Burned watersheds are more efficient at moving water off hillslopes and through drainage networks resulting in higher peak flows and more erosion.
- Changes in roughness can explain much of the post-fire hydrologic and erosion response.