

A man with a grey beard, wearing a yellow fire jacket and a yellow helmet with goggles, stands in a forest of green trees. He is pointing towards a tree on the left. The background shows a dense forest of similar trees under a clear sky.

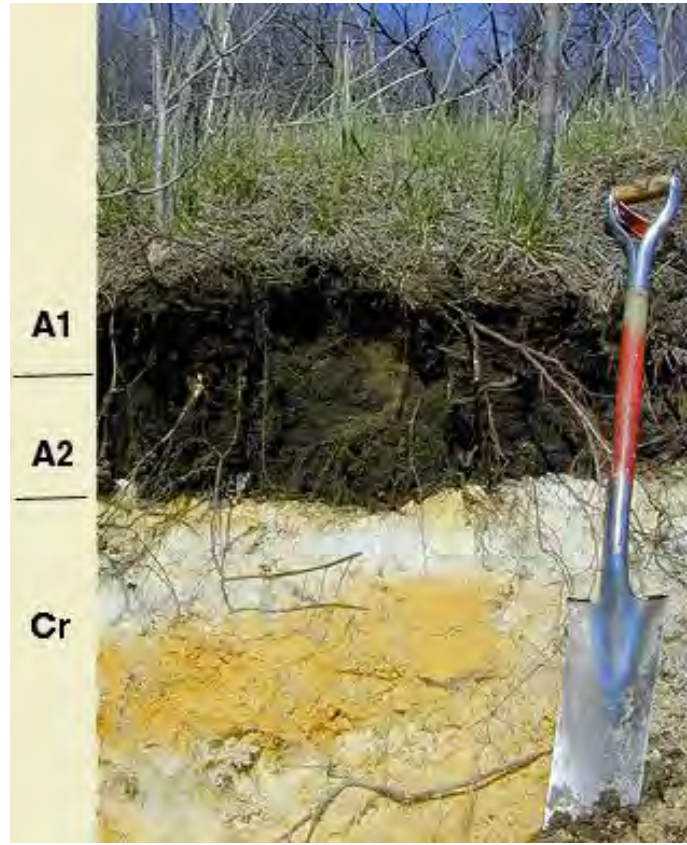
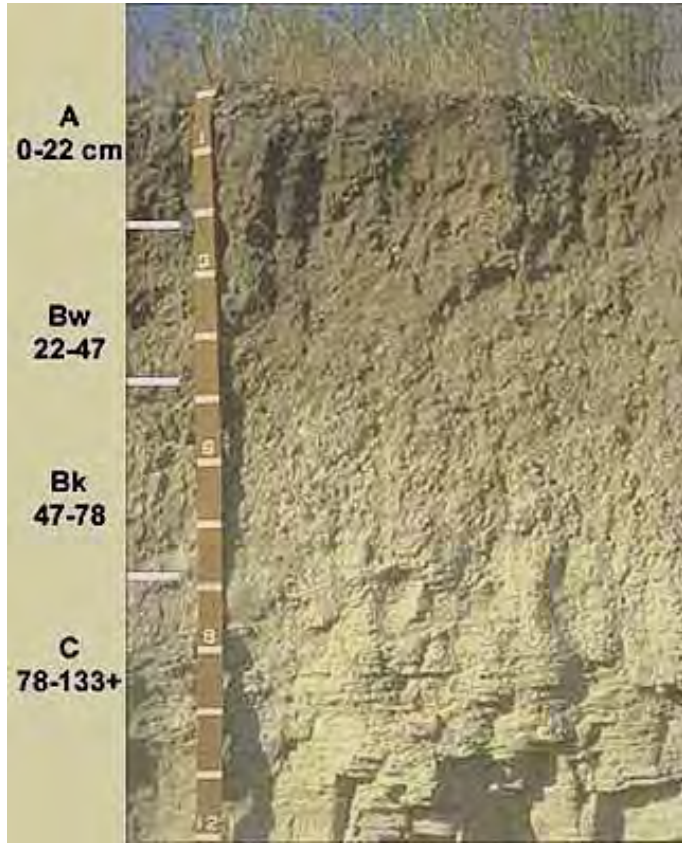
DAN NEARY
SENIOR SOIL SCIENTIST

Soils Filter Rainfall for Fresh Water Supplies – But What Changes After Natural Disasters?

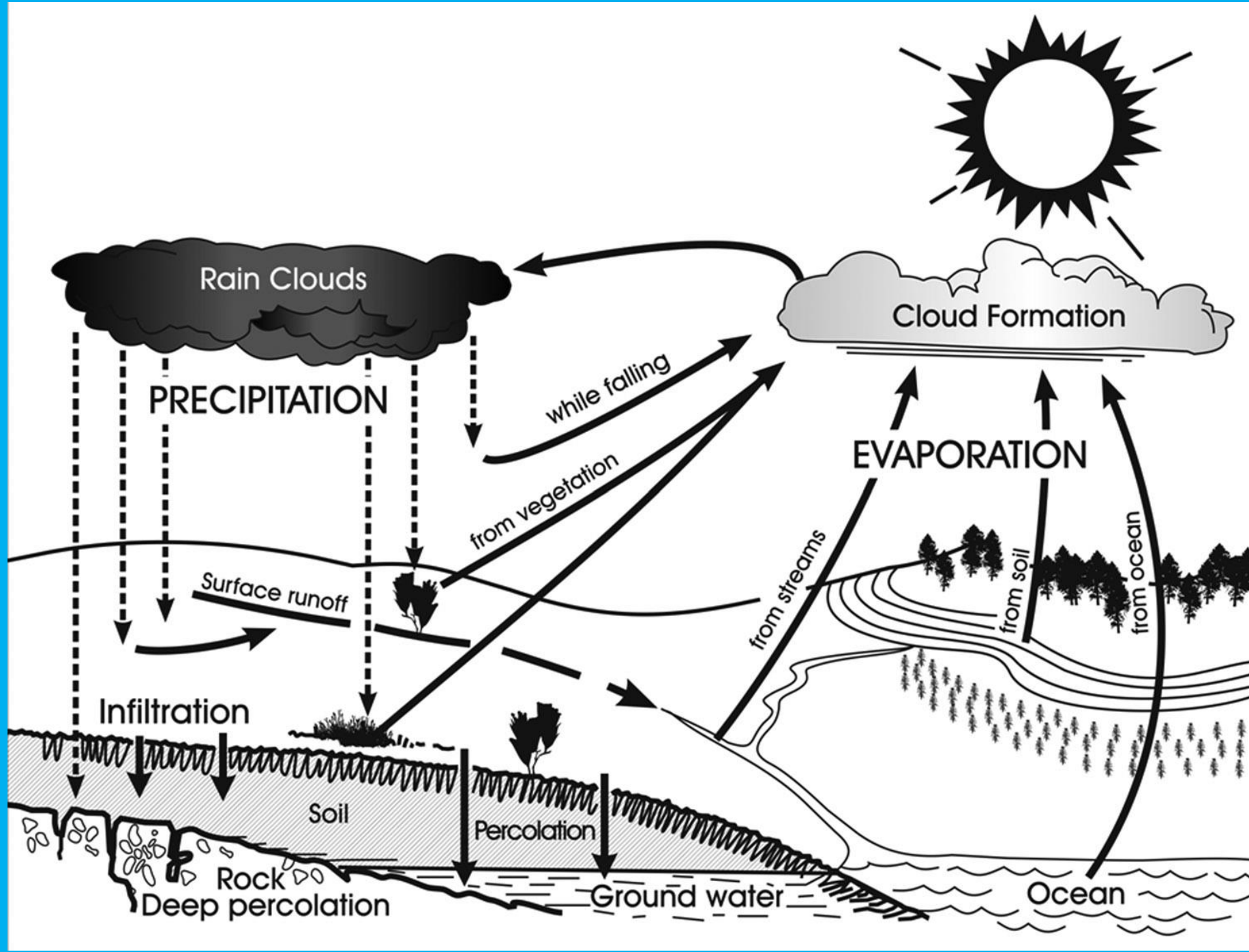


Dr. Dan Neary
USDA Forest Service

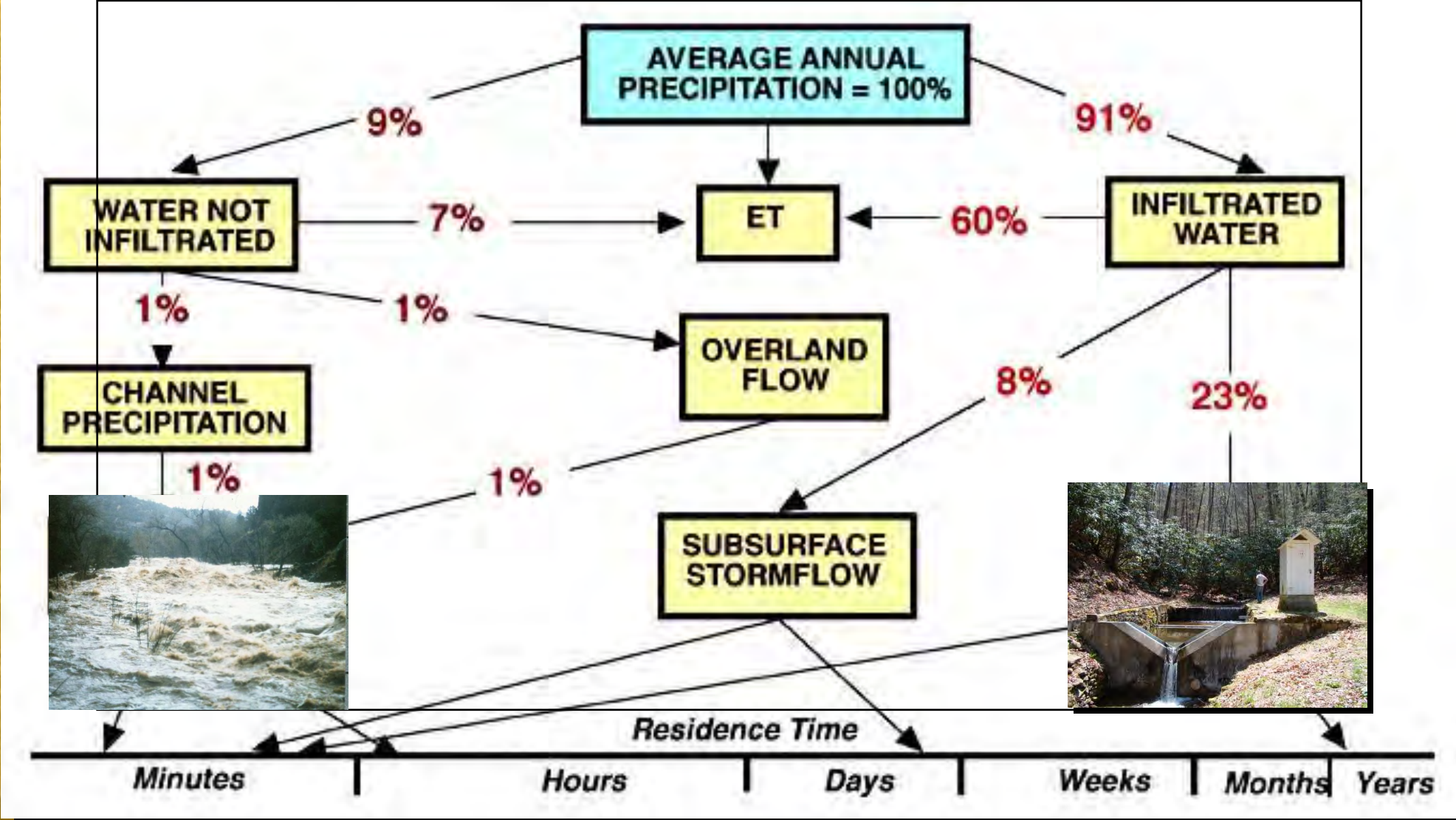




FOREST & GRASSLAND SOILS



WATER BALANCE

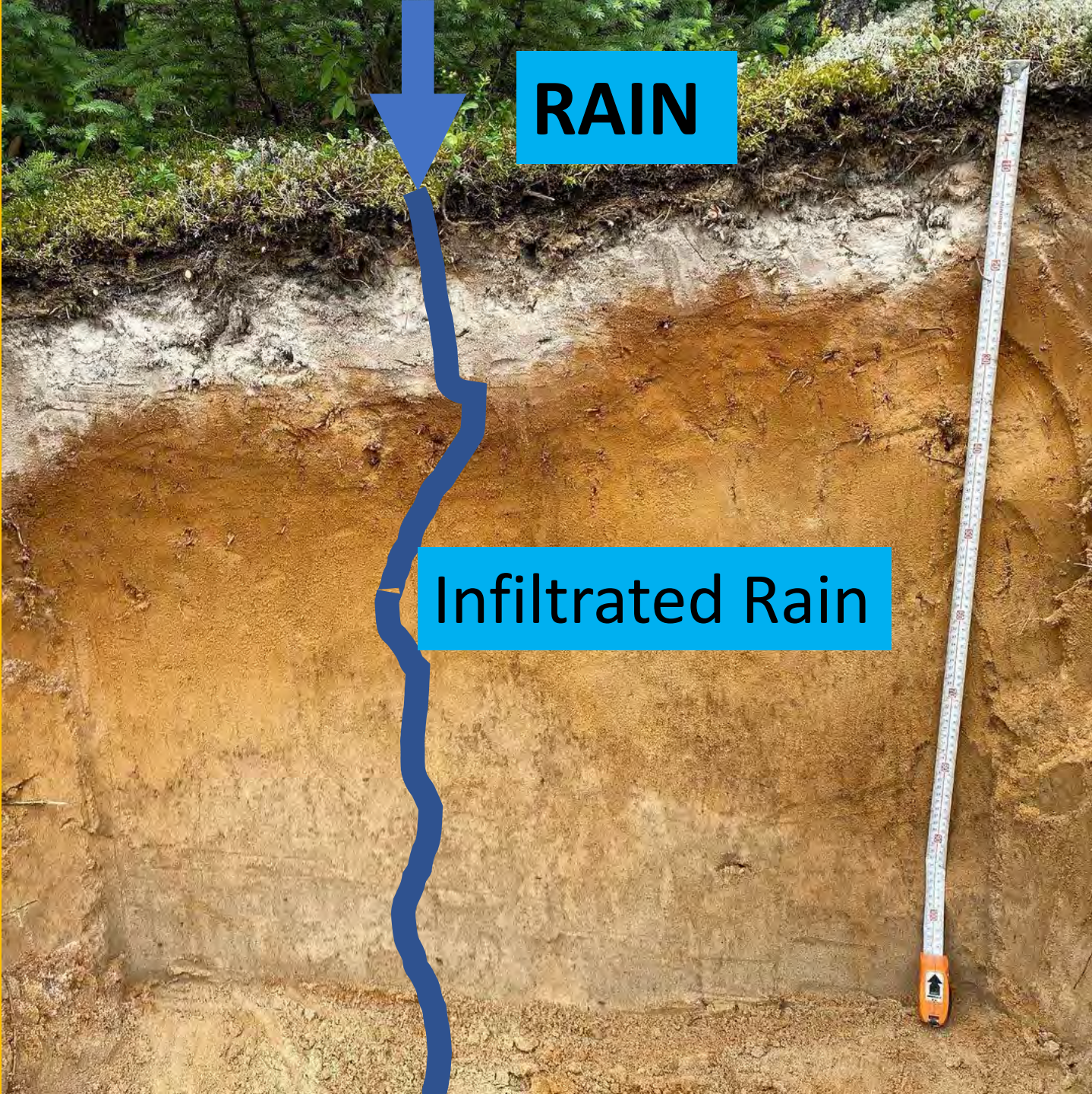


MINUTES	HOURS	DAYS	WEEKS	MONTHS	YEARS
POOR WATER SUPPLY		FAIR WATER SUPPLY		GOOD WATER SUPPLY	

RAIN



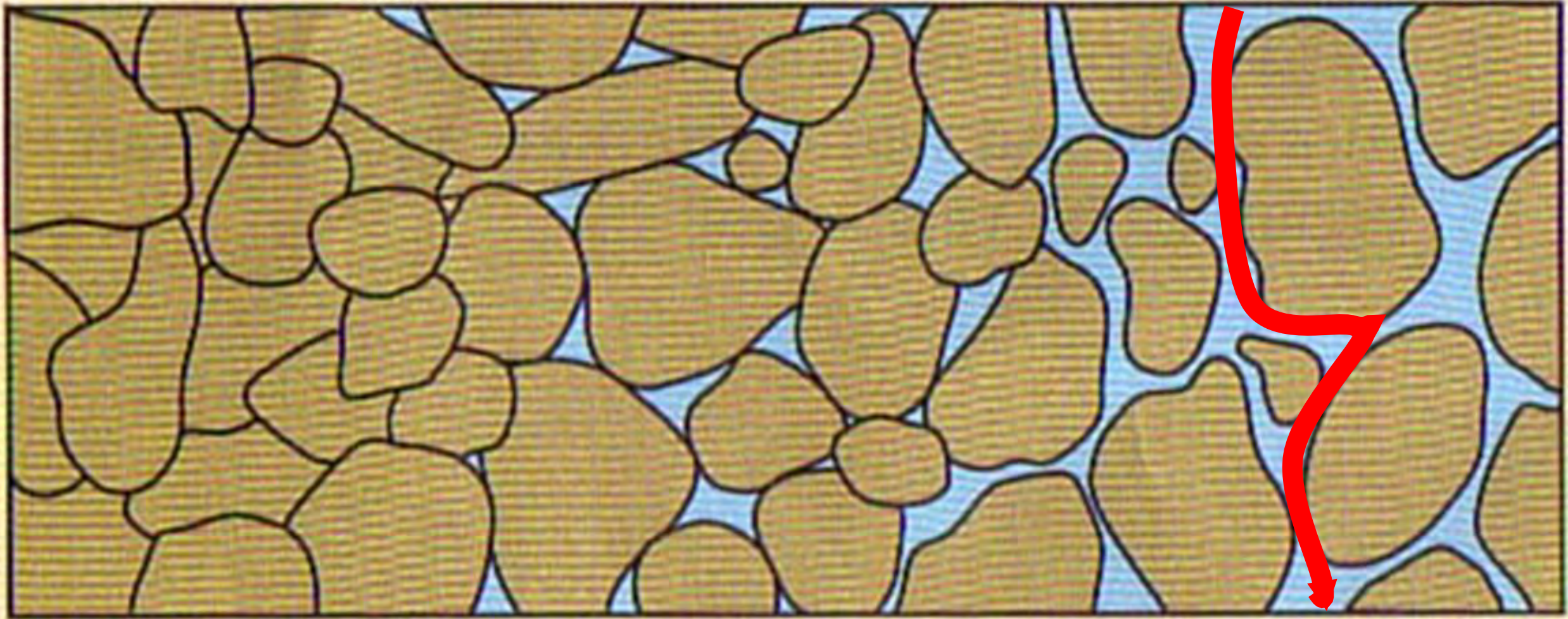
Infiltrated Rain



no
pore spaces

unconnected
pore spaces

connected
pore spaces



non-porous
non-permeable

porous
non-permeable

porous
permeable

IMPORTANCE OF FORESTED WATERSHEDS



WATER SUPPLY FROM FORESTED LANDS - USA

- WESTERN USA – 3,000+ MUNICIPALITIES
- WESTERN USA OTHER TYPES – 2,000+





EASTERN USA RESERVOIRS

LARGE WESTERN RESERVOIRS

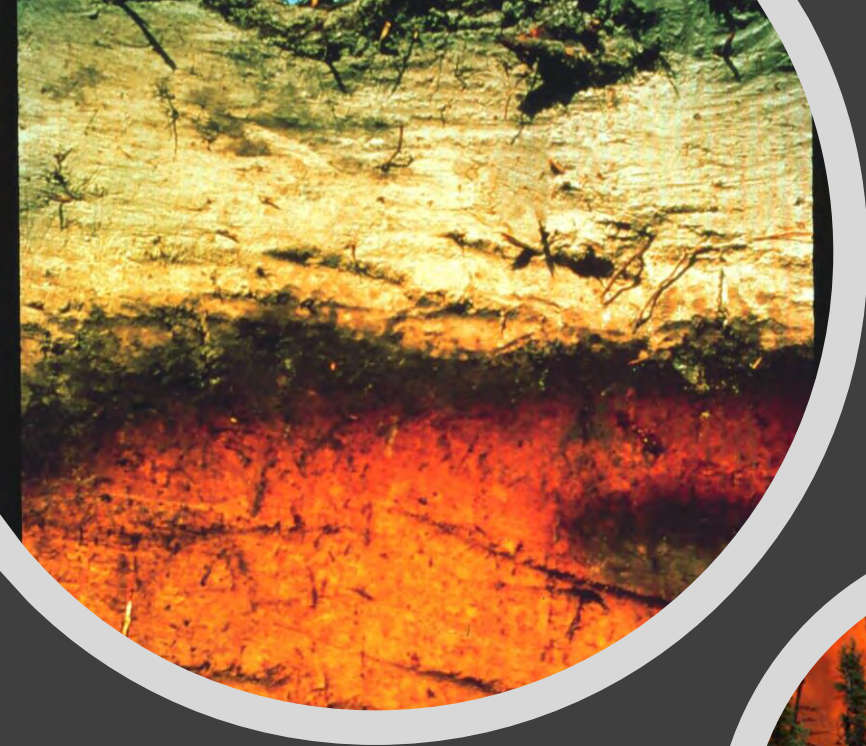


**Lake Mead Hits Lowest
Level in History**



NATURAL DISASTERS AFFECTING SOILS

- WILDFIRES
- EROSION
- LANDSLIDES
- FLOODS
- DROUGHT
- WIND STORMS



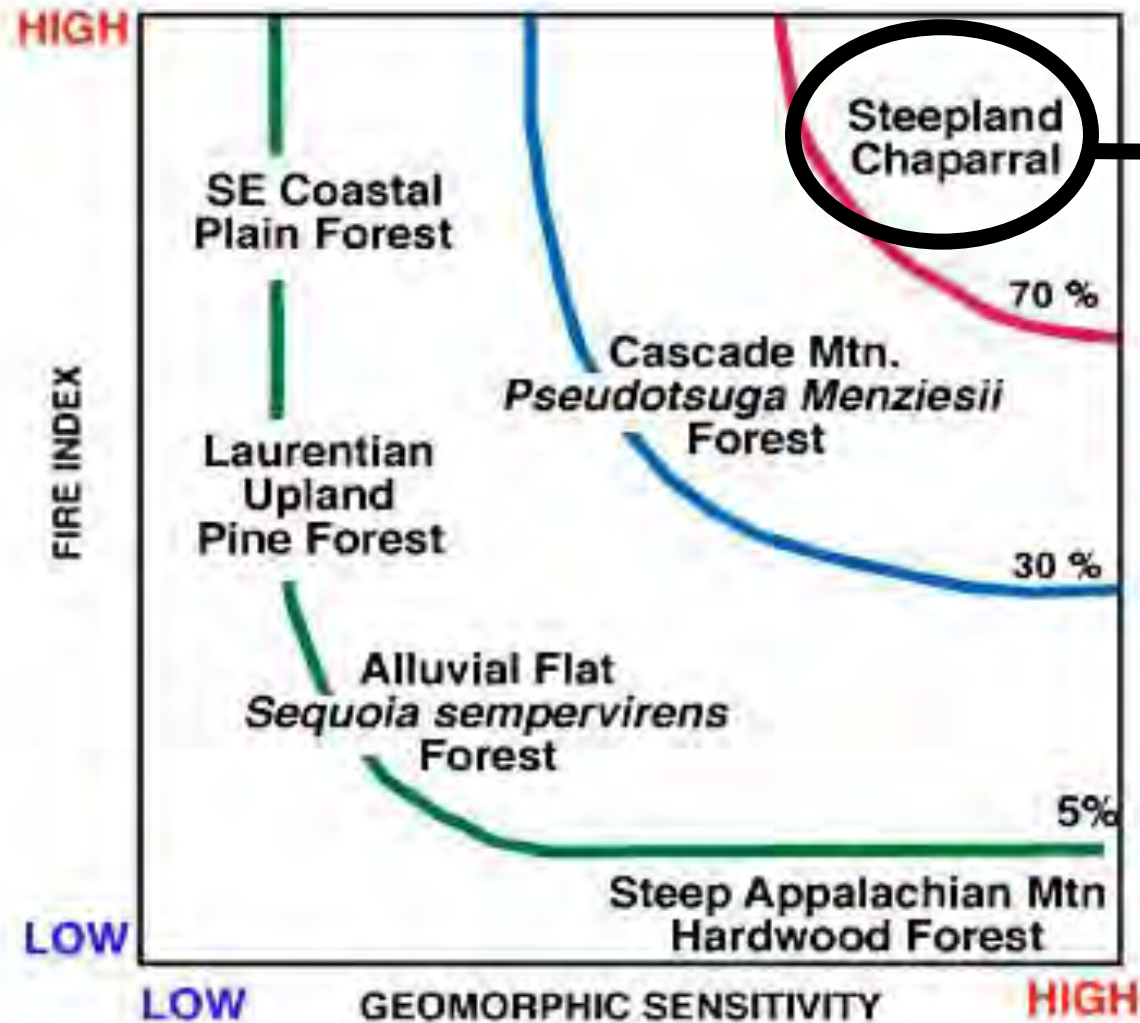
WILDFIRE DISASTER



WHY IS THIS IMPORTANT TO UNDERSTAND

- **SOILS ARE CRITICAL FOR GOOD WATER SUPPLY**
- **SOIL LOSS IN EROSION CAN'T BE REPLACED**
- **FLOODING LEADS TO REDUCED WATER QUALITY**
- **RESERVOIRS GET FILLED WITH SEDIMENT**
- **DESERTIFICATION* IS INCREASED**
(*loss of forest ecosystem function)
- **FOREST ECOSYSTEM SUSTAINABILITY IS AT RISK**
- **INFRASTRUCTURE IS DAMAGED OR DESTROYED**

FIRE INDUCED SEDIMENT YIELD



SW USA

FIRE - INDUCED PORTION
OF TOTAL SEDIMENT YIELD





MEGA FIRES

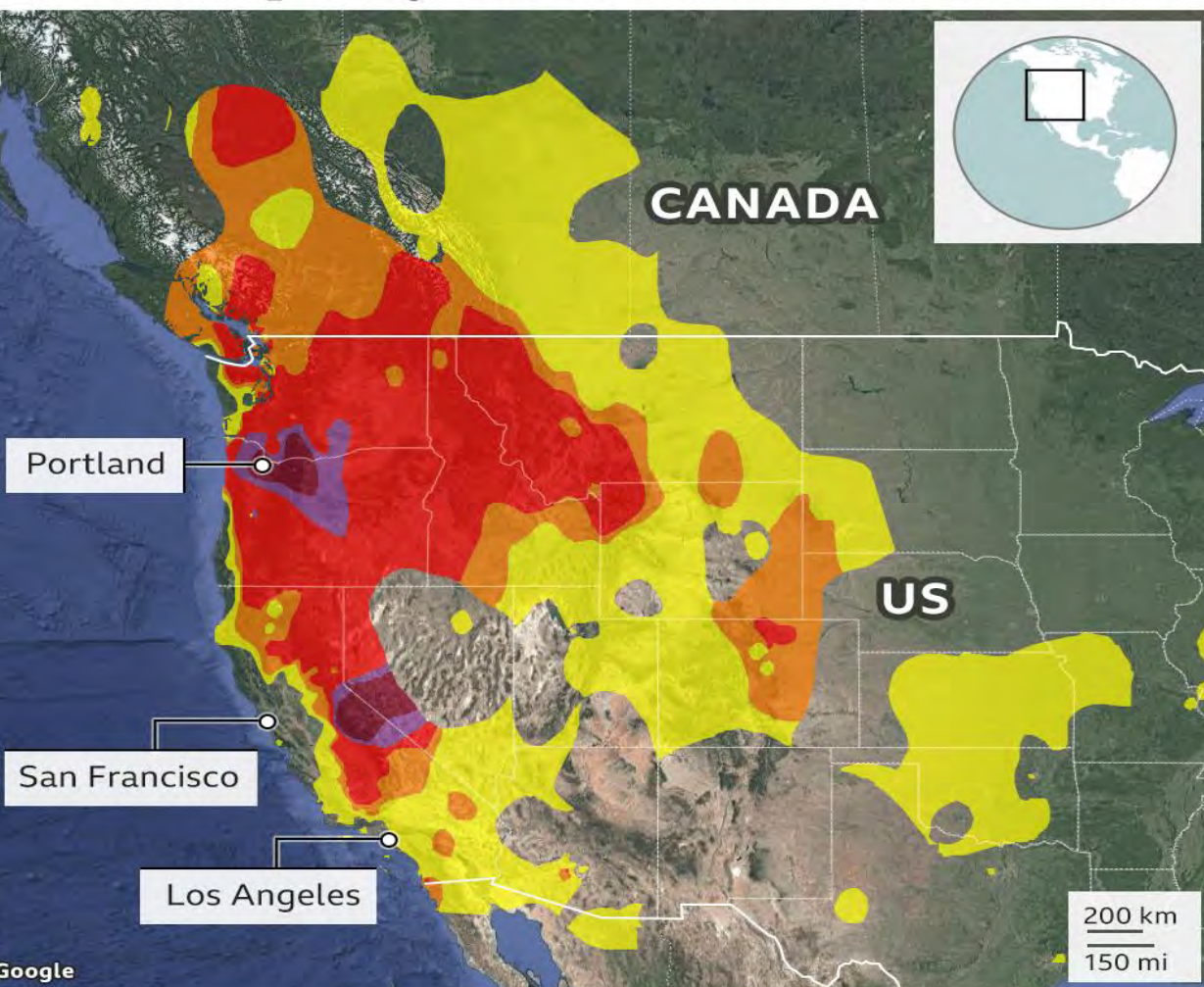
- Williams and Hamilton 2005
- >30,000 ha
- High Complexity
- Landscape Fires
- Difficult to Control
- Increasing Frequency
- Record Set 2020



2020 FIRE SEASON

- **10.2 MILLION ACRES BURNED**
- **46 FATALITIES**
- **\$16.6 BILLION IN DAMAGES**
- **COLORADO: 3 LARGEST WILDFIRES ON RECORD**
- **CALIFORNIA:**
 - **PREVIOUS RECORD SET IN 2018**
 - **2020 MORE THAN DOUBLE 2018**

Worst air quality on record for US West Coast



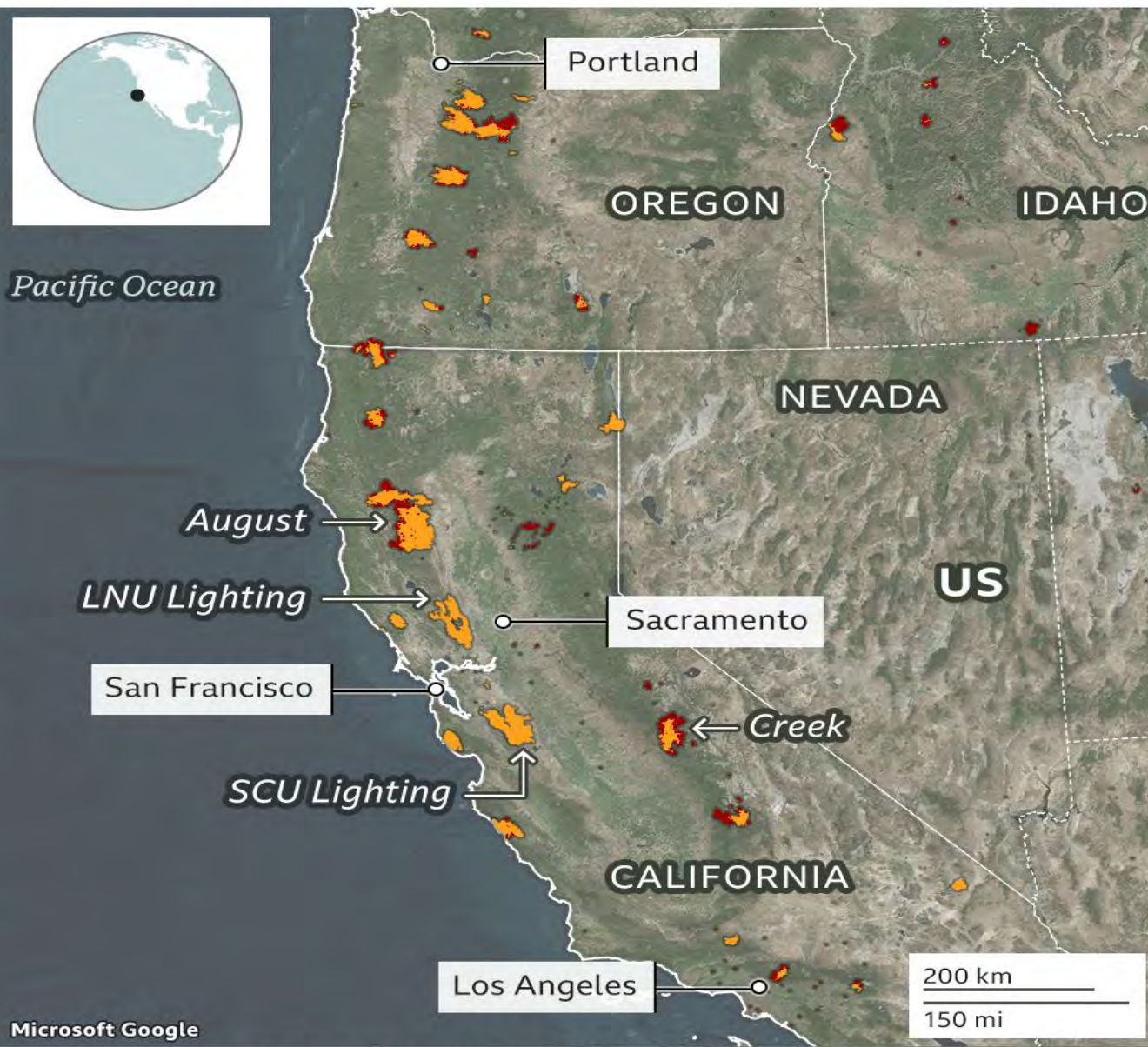
Air Quality Index: levels of pollution including particulate matter

- Moderate 51-100
- Unhealthy for sensitive groups 101-150
- Unhealthy 151 - 200
- Very unhealthy 201-300
- Hazardous 300 -500

Source: AirNow

Wildfires in California and Oregon

- Current fires (last 48 hours)
- Burned areas since 1 September



Microsoft Google

Source: National Interagency Fire Center, NASA FIRMS

FIRE SIZE

VALUE	AREA	FIRE NAME	STATE/PROV	FIRE SIZE
	ha			ha
MICRO	10 ⁻⁴	"THE STUMP"		
ZONE OF Rx FIRE				
A & B	<0.1 -4			
C, D, & E	4 – 404			
ZONE OF SMALL WILDFIRES				
F & G	404 – 4,049			
H	4,049 – 20,234	Schultz Fire 2010 Cerro Grande Fire	AZ NM	6,100 19,425
I	20,234 – 40,469	Okanagon Park 2003	BC	25,600
ZONE OF MEGA WILDFIRES				
J	40,469 – 202,347	Chelaslie River 2014 Rodeo-Chediski 2002 Rim Fire 2013	BC AZ CA	133,098 485,700
K	202,347 – 404,694	Wallow Fire 2012 Biscuit Fire 2002	AZ CA	217,741 229,057
ZONE OF GIGA WILDFIRES > 0.4 M HA or 1M ACRES				
L	>404,694	August Complex 2020 Taylor Complex 2004 Yellowstone Fire 1988 Great Fire of 2010 Peshtigo Fire 1871 Miramichi Fire 1825	CA AK ID/MT ID/MT WI NB	526,111 528,580 1,011,750 1,214,100

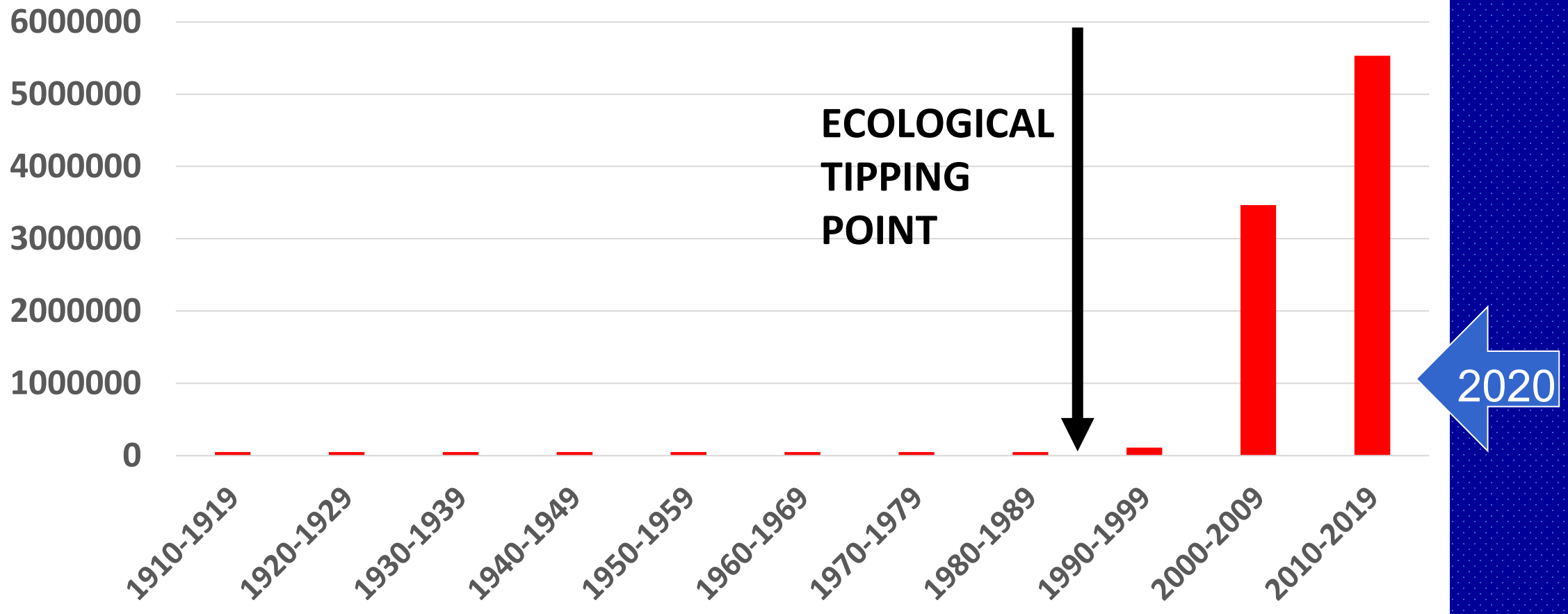


ZONE OF GIGA WILDFIRES > 0.4 M HA or 1M ACRES

L	>404,694 ha	August Complex 2020	CA	417,635
		Taylor Complex 2004	AK	526,111
		Yellowstone Fire 1988	ID/MT	639,413
		Peshtigo Fire 1871	WI	1,011,750
		Great Fire of 2010	ID/MT	1,214,057
		Miramichi Fire 1825	NB	1,214,100

WILDFIRE TRENDS SOUTHWEST FIRE OUT OF BOUNDS

ACRES BURNED BY DECADE SW USA



FIRE NEXUS: SEVERITY, SCALE, RAINFALL, SLOPE

THERE ARE
CONSEQUENCES



SLOPE



SEVERITY



RAINFALL



SCALE & FUELS



FIRE EFFECTS ON SOILS



WHAT FIRES DO TO SOIL HYDROLOGY

- Burn Off the Organic Horizon
- Expose Mineral Soil
- Create Water Repellency
- Create Ash That Clogs Pores
- NET EFFECT:
 - Reduce Infiltration
 - Increase Water Runoff

A large fire with a white arrow pointing up and a white arrow pointing down, with the text 'HEAT FLUX' in a white box in the center.

HEAT FLUX

SEVERITY SPECTRUM

LOW



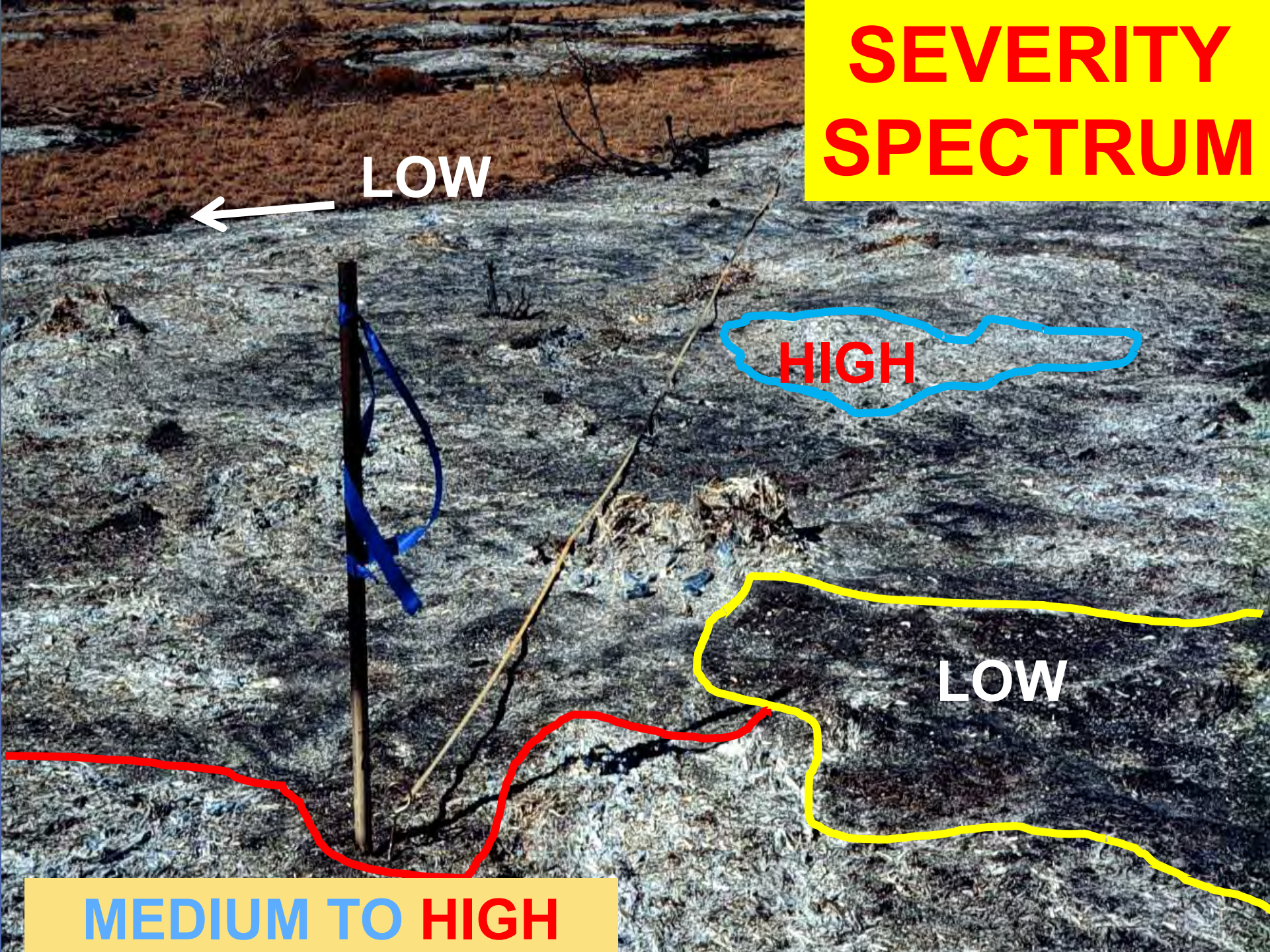
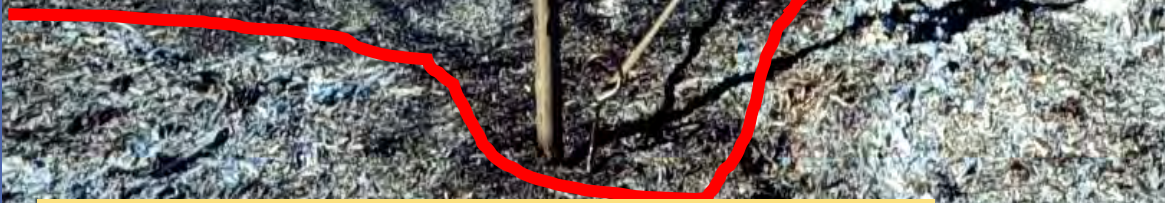
HIGH



LOW



MEDIUM TO HIGH





LOW SEVERITY FIRE

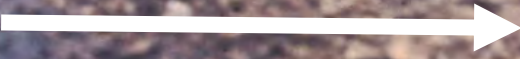


HIGH SEVERITY FIRE

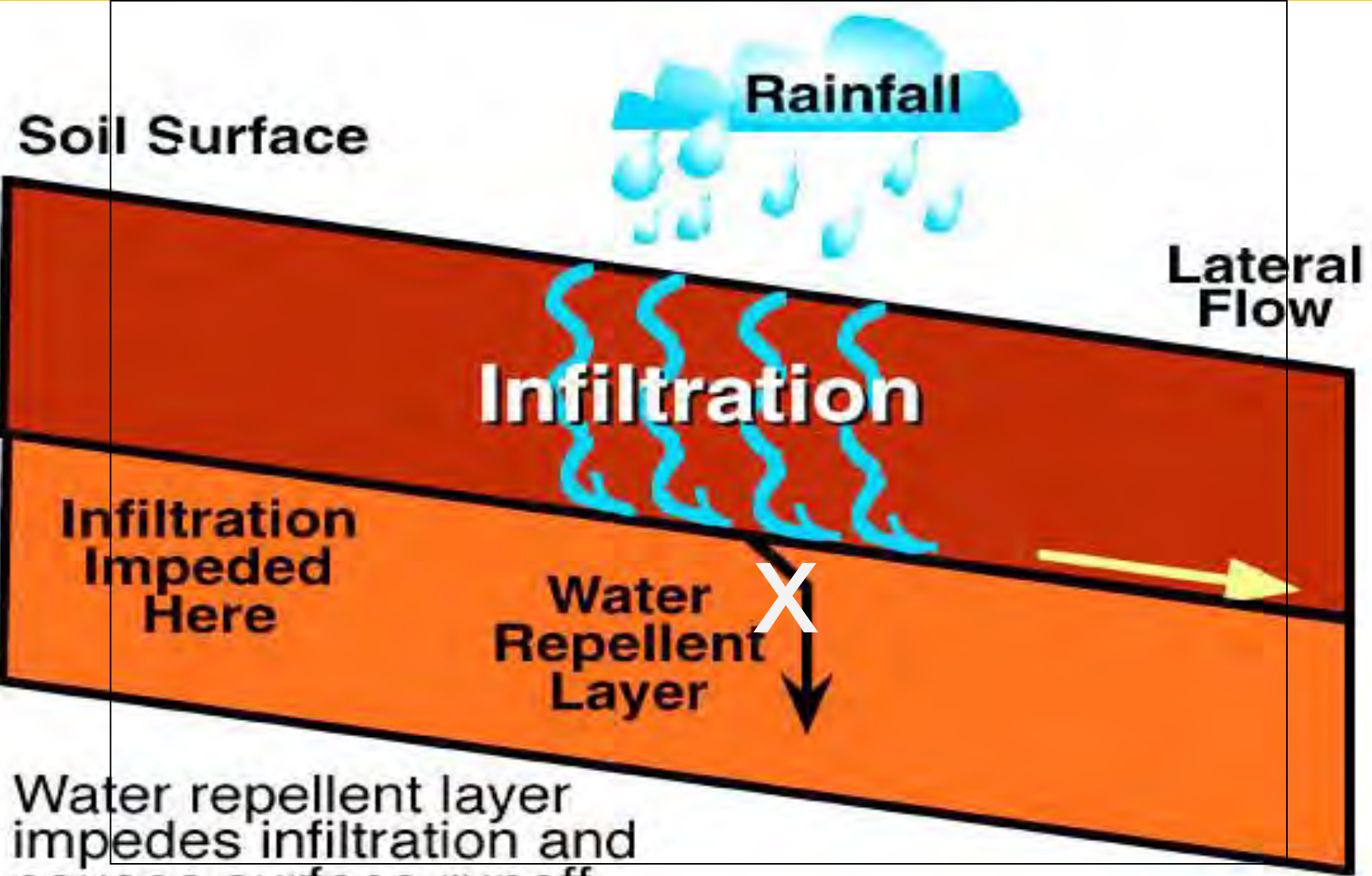
WATER REPELLENCY



WATER REPELLENCY

DRY SOIL 



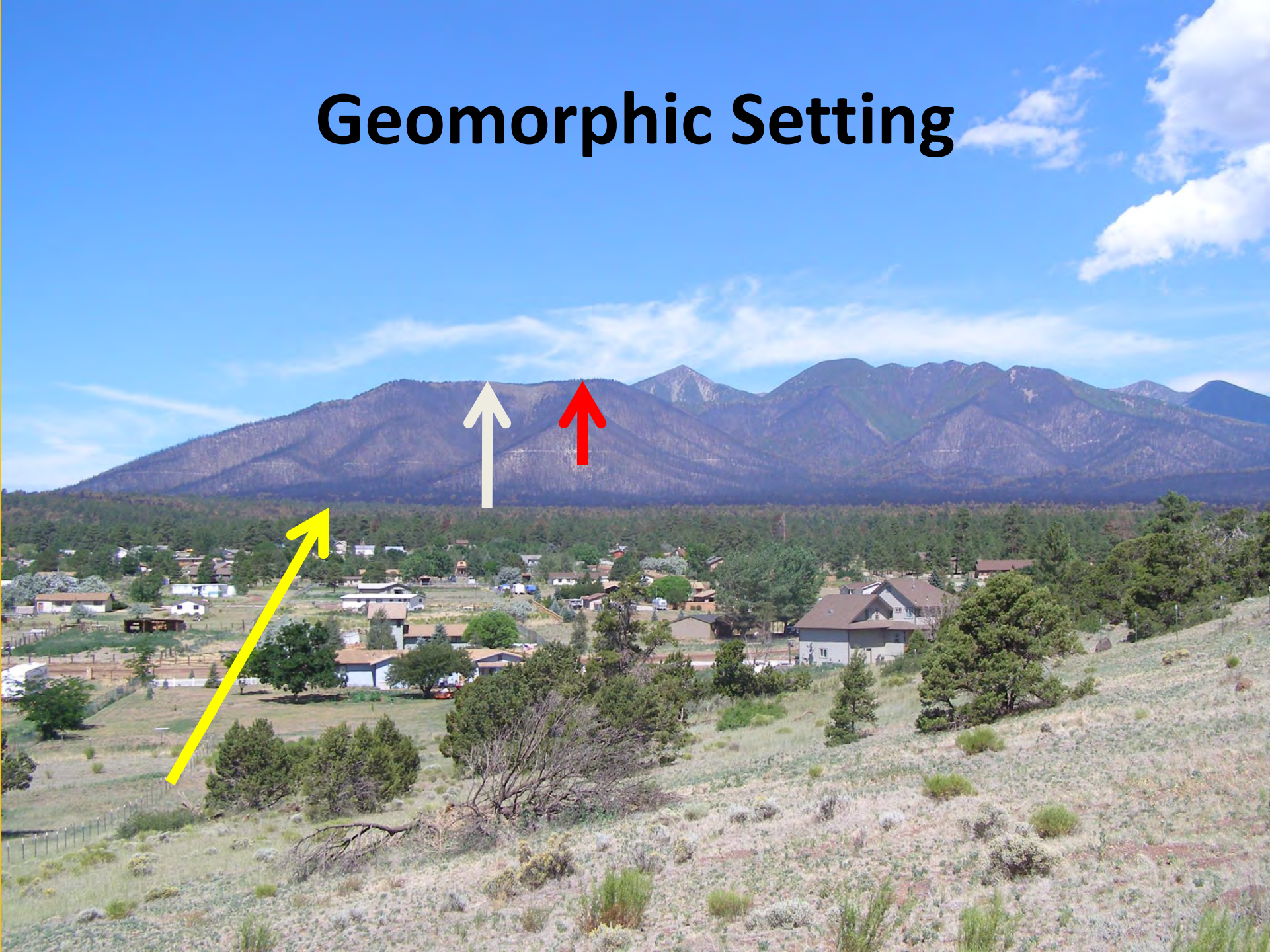


Water repellent layer impedes infiltration and causes surface runoff

An aerial photograph showing a wildfire in progress. In the background, a range of mountains is visible, with a plume of dark smoke rising from a fire on the left side. The middle ground is dominated by a dense forest of green trees. In the foreground, a residential area with several houses and roads is visible. The text "SCHULTZ WILDFIRE COCONINO NATIONAL FOREST ARIZONA" is overlaid in white, bold, sans-serif font within a white rectangular border.

**SCHULTZ WILDFIRE
COCONINO NATIONAL FOREST
ARIZONA**

Geomorphic Setting





ARIZONA HYDRO BOMB

Two Storms Produced Floods & Debris Flows: July 20 and August 16

- **July 20**

- Return Interval 10 - 25 y
- 37 mm/ 1.46" to
43 mm/1.69"

- **August 16**

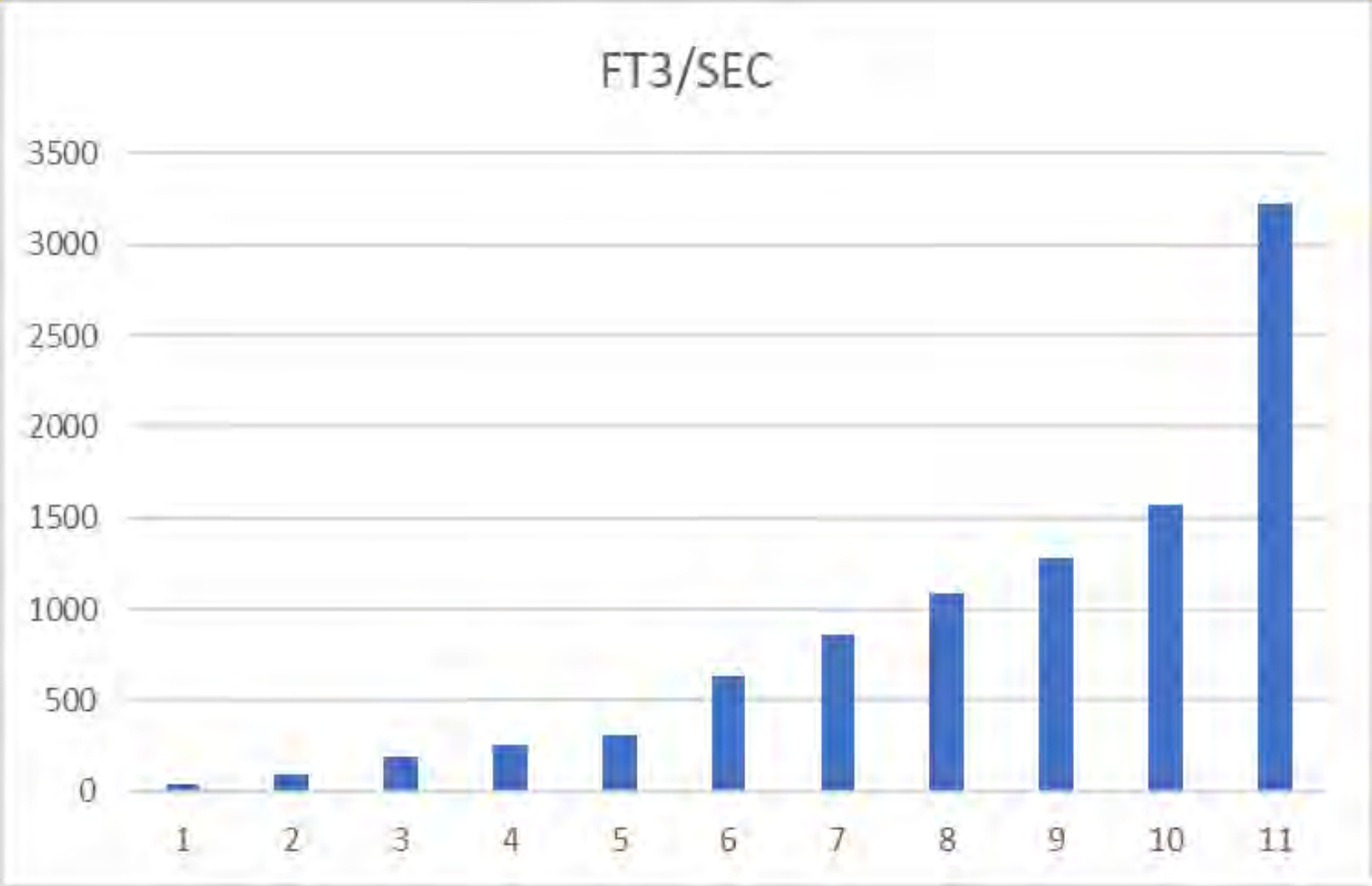
- Return Interval <1 - 5 y
- 9 mm/0.35" to
– 27 mm/1.06"

ONE RAINGAGE – 25 mm (1 in) 15 min

FLOOD SLURRY FLOW



SCHULTZ FIRE 2010 ARIZONA



CHANNEL NUMBER





FLOOD FLOW



SCHULTZ FIRE ARIZONA 2010



WATERSHED FLOODS





**SUNSET
CRATER
SCORIA**

AD 1085

AD 2010

SCHULTZ FIRE FINE SEDIMENT DEPOSITS



A
?

A Horizon Eroded Away
Frequent Wildfires

PORTUGAL



BRINS FIRE ARIZONA





RRILLS

R
I
L
L
S



G
U
L
L
Y
S



Gullies Get Bigger

SCHULTZ FIRE 2010
COCONINO NF
FLAGSTAFF, AZ

Upper Watershed

Slopes 100% +

High Severity Fire

Soil Loss = 1400-1500 Mg ha⁻¹

PREVIOUS ESTIMATES OF MAXIMUM: 300-400 Mg ha⁻¹



SOIL EROSION

RESTORE?

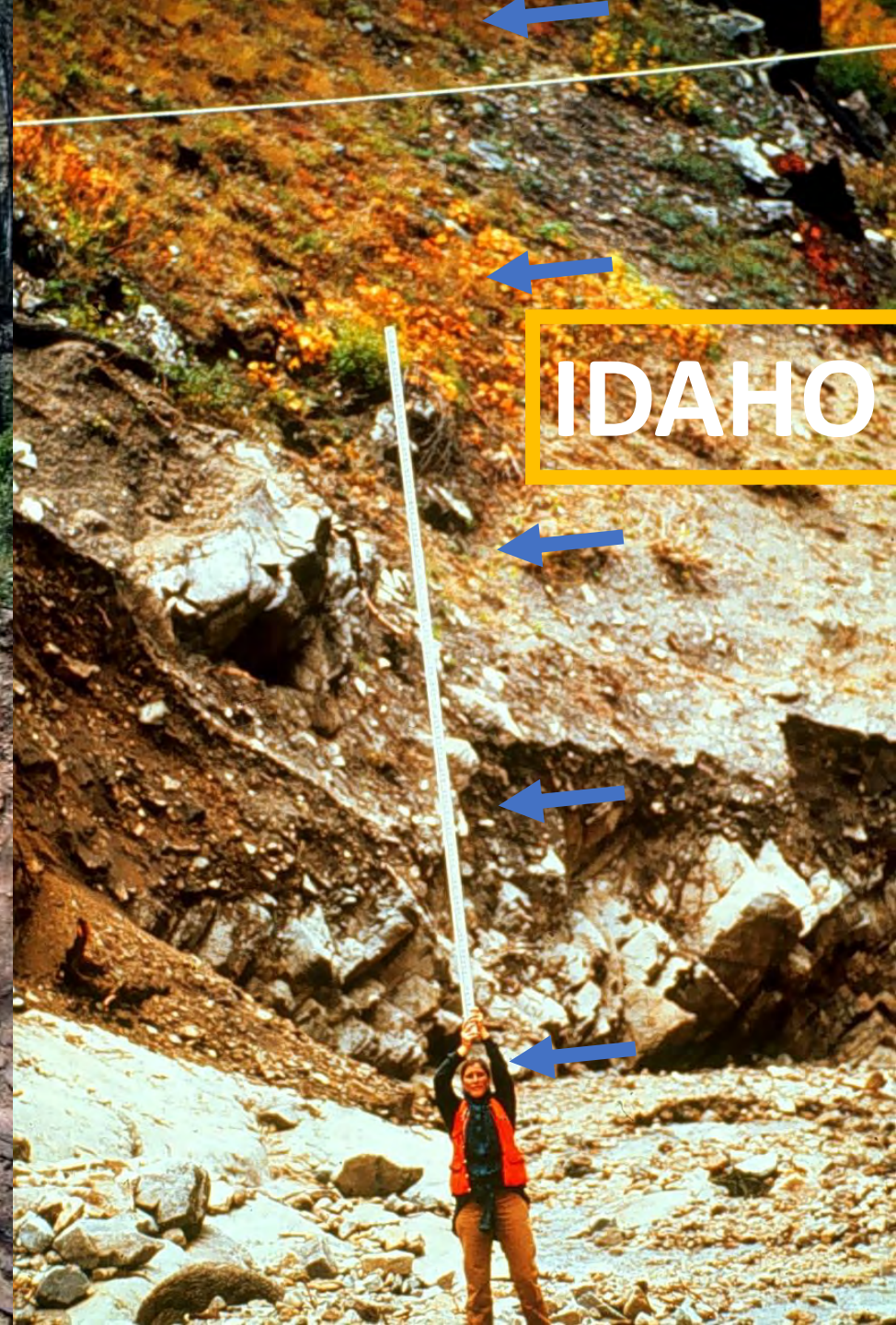
REHABILITATE ??

RESPOND???

ARIZONA



IDAHO



SUMMARY

WHY IS THIS IMPORTANT TO UNDERSTAND

- **SOILS ARE CRITICAL FOR GOOD WATER SUPPLY**
- **SOIL LOSS IN EROSION CAN'T BE REPLACED**
- **NOT ALL REGIONS OF THE USA ARE THE SAME**
- **FLOODING LEADS TO REDUCED WATER QUALITY**
- **RESERVOIRS GET FILLED WITH SEDIMENT**
- **DESERTIFICATION IS INCREASED**
- **FOREST ECOSYSTEM SUSTAINABILITY IS AT RISK**
- **INFRASTRUCTURE IS DAMAGED OR DESTROYED**

SOLUTIONS???

MEGA DROUGHT: NONE

LARGE WILDFIRES: SUPPRESS

POST-FIRE ACTIONS: DO WHAT WE CAN

FUEL BUILDUP:

- **ACTIVE FOREST MANAGEMENT**
- **RESTORATION ACTIVITIES**

MORE INFORMATION

- ***RMRS GTR-42, VOLUME 4***

**FIRE EFFECTS ON SOIL AND
WATER**

- ***FIRE EFFECTS ON
ECOSYSTEMS***

John Wiley & Sons New York

SOME FIRE LINE WISDOM:

*If it looks big & bad
it probably is"*



Paul Combs Blog
Fire Engineering
ArtStudioSeven.com



THE END