

“EVERY WET YEAR  
IS A MIRACLE”



Drought, Climate, and Water Use in Colorado

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Little Thompson Water District Water Forum

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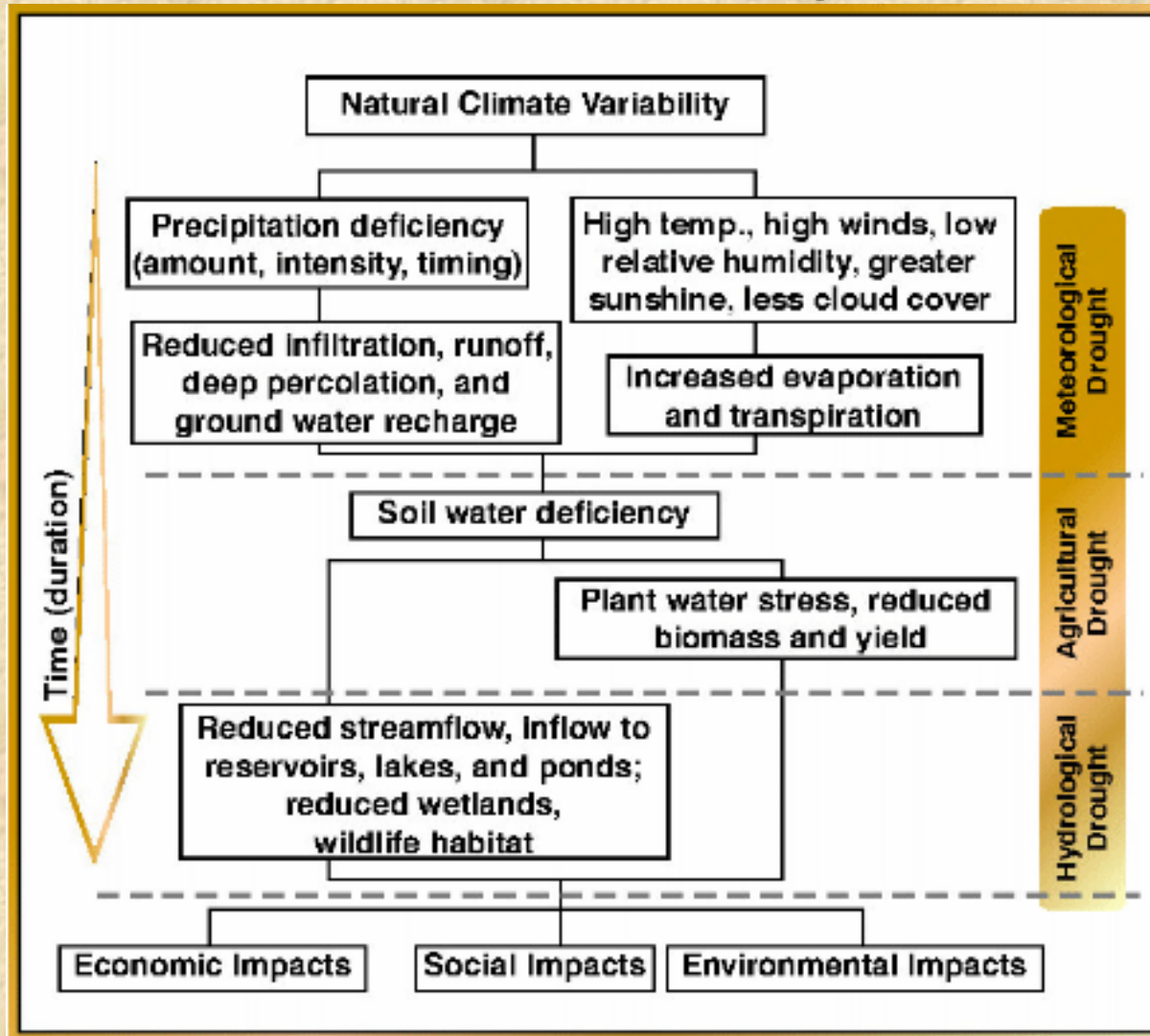
# Presentation Outline

- how we define drought
- Colorado's climate and variations
- Colorado's water uses
- drought response/mitigation in Colorado
- lessons from history
- how you can help

# What is Drought?

- very hard to define
- unique among natural hazards
- “lovely sunny weather”

# What is Drought?



Source: National Drought Mitigation Center  
web site: <http://enso.unl.edu/ndmc/>

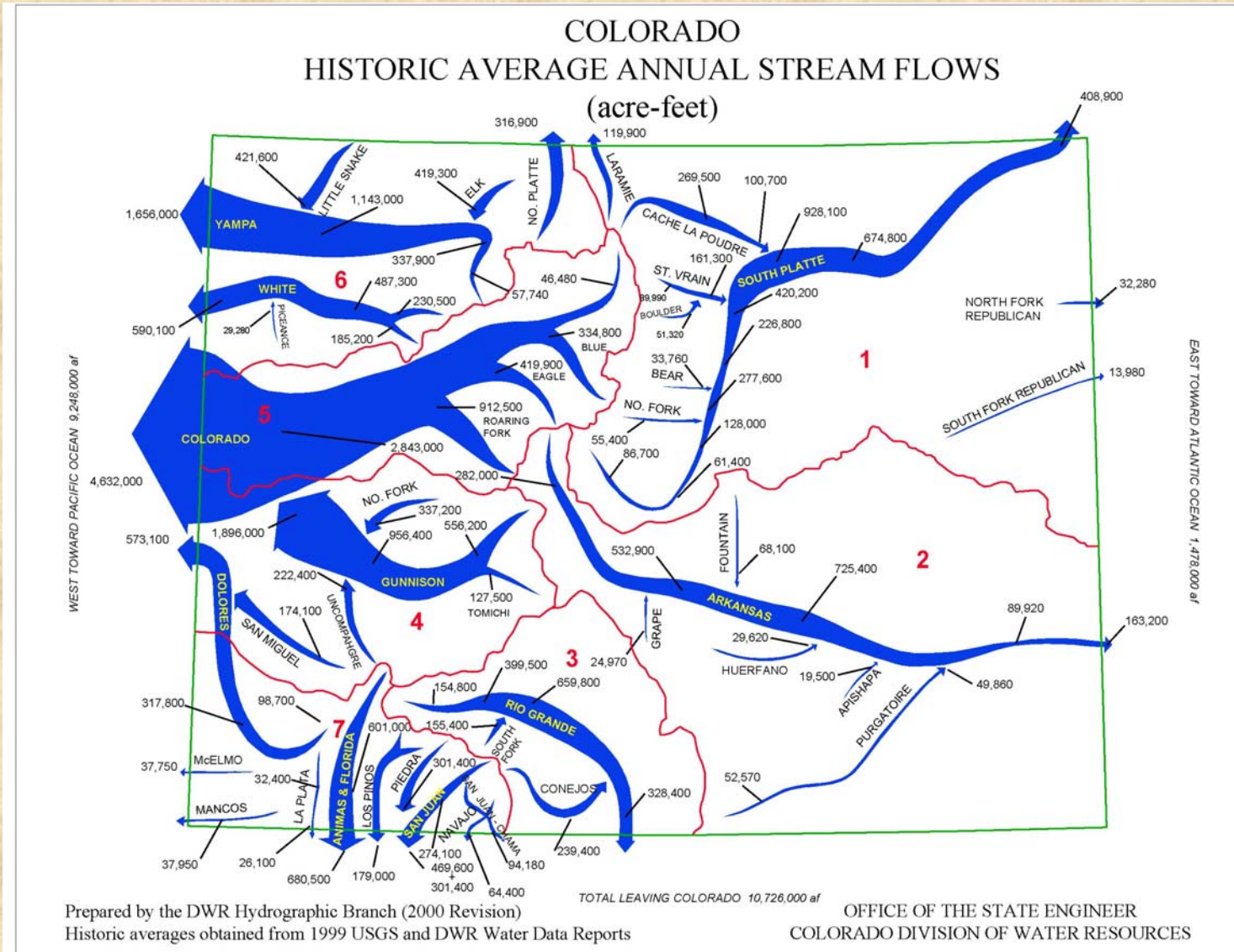
# What is Drought?

- duration, magnitude, areal extent
- “relative” to what is “normal”
- impacts on nature and society

# What is Drought?

- demand for water exceeds supplies
  - what are your demands?
  - what are your supplies?
- understanding -- and thus preparing for and responding to -- drought requires an appreciation of how Colorado receives its water supply and how, when, and where water is used

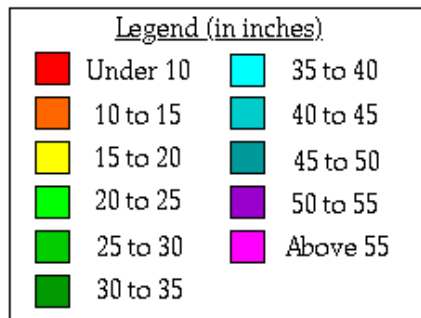
# How Colorado Gets Its Water



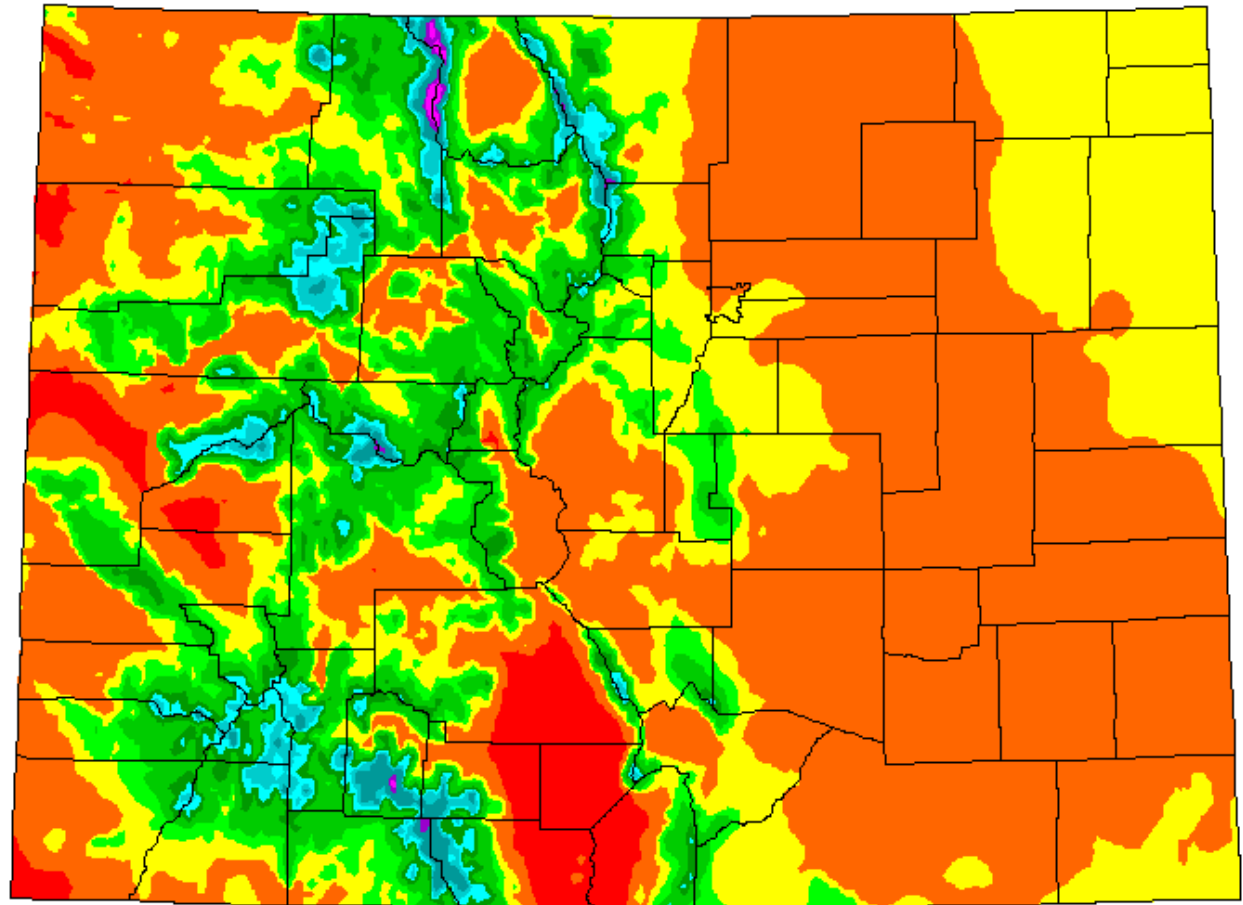
# How Colorado Gets Its Water

## Average Annual Precipitation

### Colorado



Period: 1961-1990



This map is a plot of 1961-1990 annual average precipitation contours from NOAA Cooperative stations and (where appropriate) USDA-NRCS SNOTEL stations. Christopher Daly used the PRISM model to generate the gridded estimates from which this map was derived; the modeled grid was approximately 4x4 km latitude/longitude, and was resampled to 2x2 km using a Gaussian filter. Mapping was performed by Jenny Weisburg. Funding was provided by USDA-NRCS National Water and Climate Center.

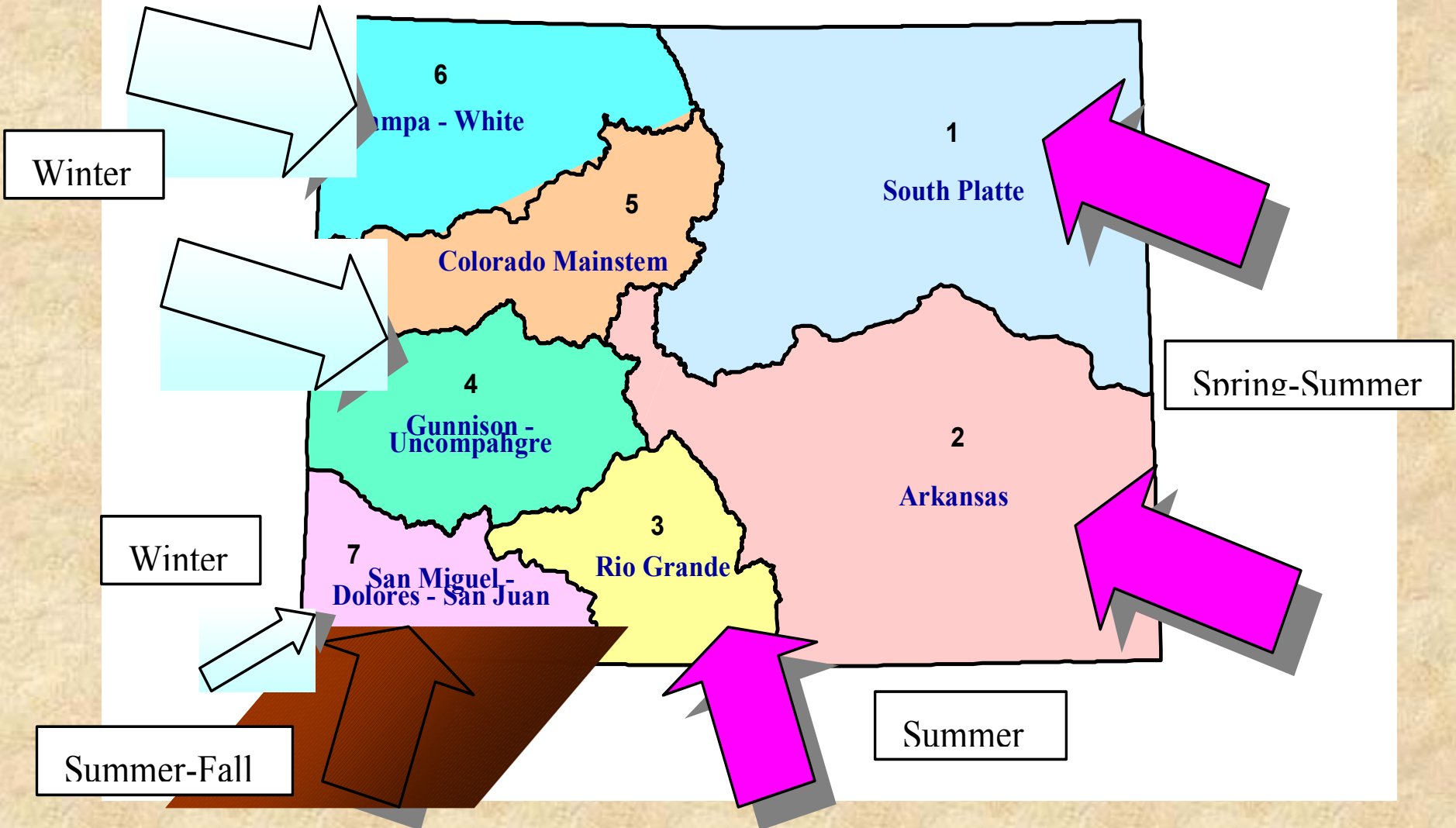
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# Precipitation: Colorado's Water Source

- **Two essential ingredients:**
  - **water vapor in the air**
  - **upward vertical motion**
    - **cools the air**
    - **water vapor condenses**

# How Colorado Gets Its Water

Figure: Sources of Atmospheric Moisture in Colorado



# Precipitation: Colorado's Water Source

- 80% of the days on which precipitation occurs contribute only 20% of the usable water supply.
- 20% of the days on which precipitation occurs contribute 80% of the usable water supply usually in a few heavy downpours.
- Thus, the presence or lack of a few large storms can make the difference between a “wet” year and a “dry” year.

# How Colorado Gets Its Water

## Five Forms of Usable Water

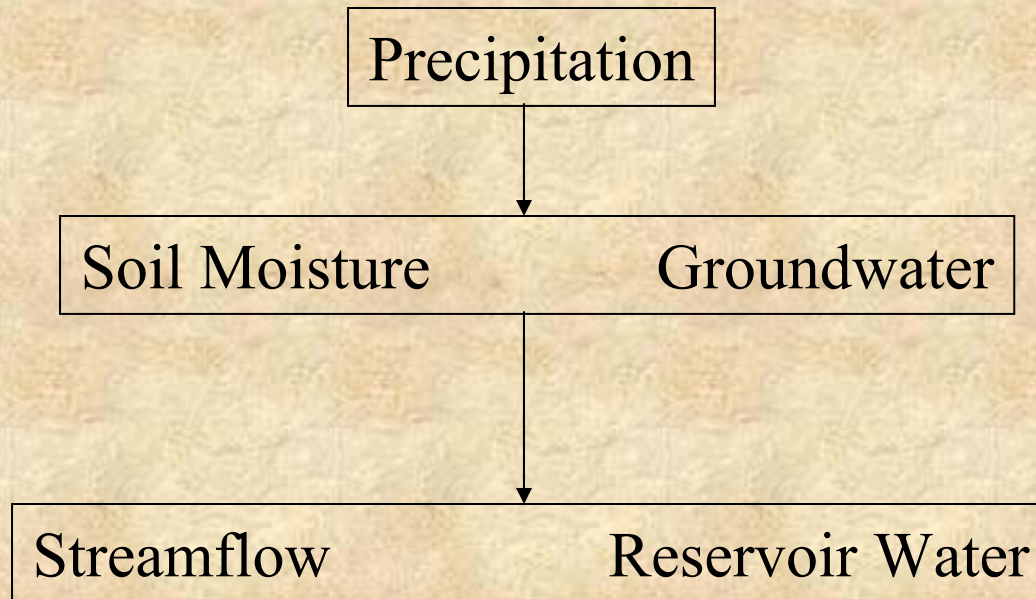
- Streamflow (ST)
- Reservoir Water (RW)
- Groundwater (GW)
- Soil Moisture (SM)
- Snowpack (SN)

# How Colorado Gets Its Water

## Two Pathways

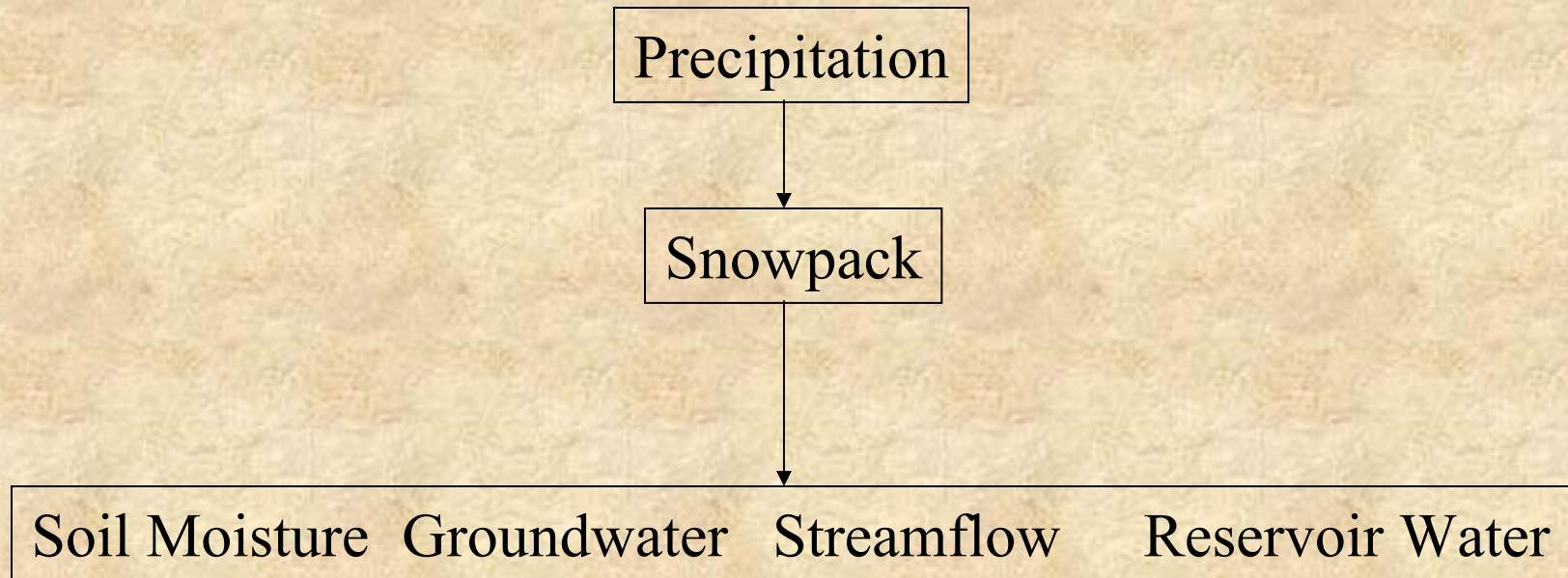
### Pathway One

(esp. lower elevations and higher elevations in the summer)

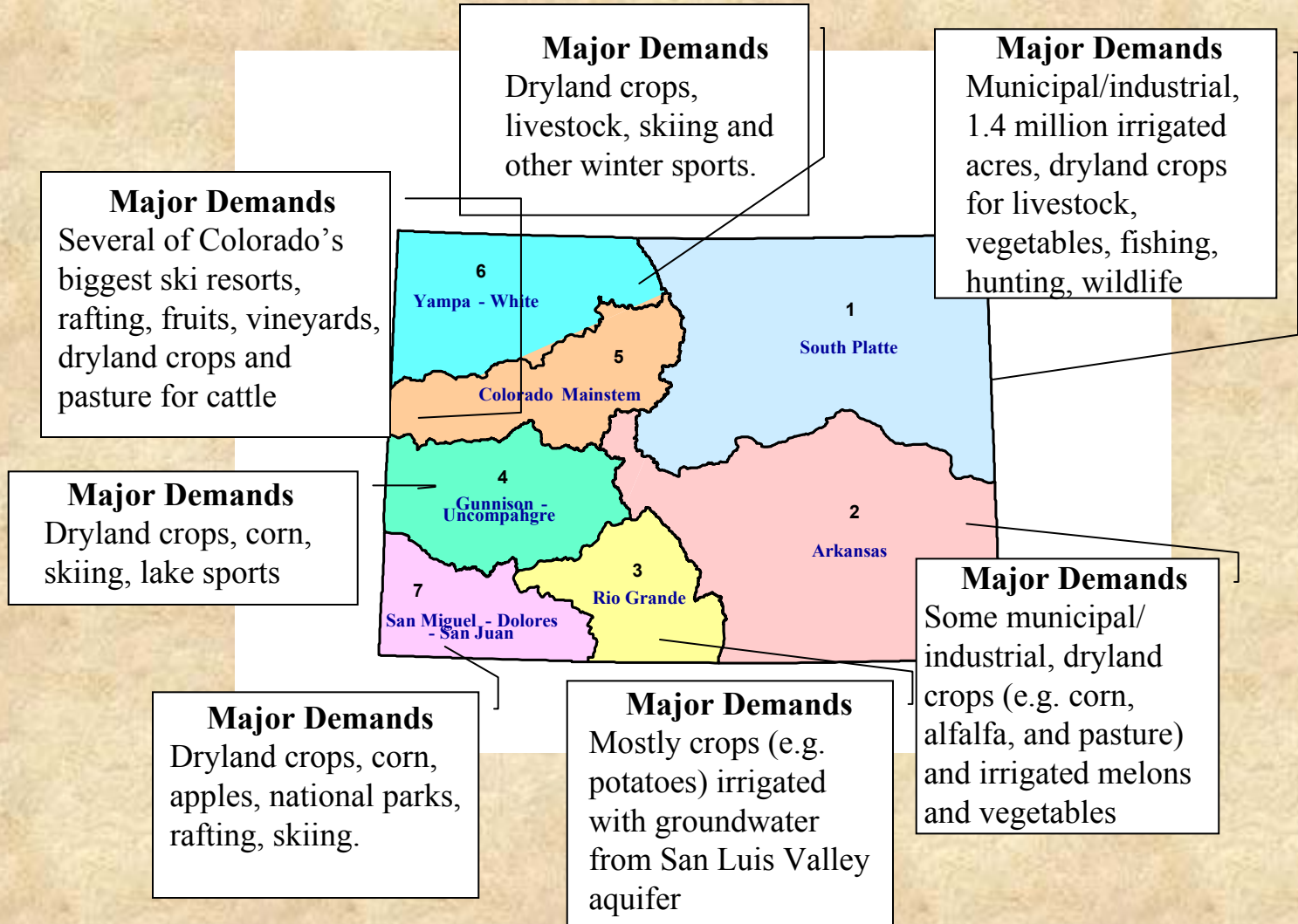


# How Colorado Gets Its Water: Two Pathways

Pathway Two  
(esp. higher elevations in the winter)



# Colorado's Water Demands: How and When We Use Water



# Colorado's Water Demands: How and When We Use Water

## REMEMBER:

- Each water use has a time, location, form, and quantity of water needed
- Lack of water in different places, times, and forms will have different impacts on different sectors of the economy
- Impacts on one economic sector can have more widespread impacts indirectly

# Drought Impact and Response: Examples from 1976-1977 Drought

## Drought characteristics

- Short, severe drought, with below-average precipitation occurring mainly in the mountain areas during the early winter

## Drought impact

- Direct impacts to the ski industry
- Indirect impacts to the economy of the whole state

# Colorado's Water Demands: How and When We Use Water

## REMEMBER:

- Drought mitigation and response measures can change how we are impacted by lack of precipitation:
  - reservoirs
  - snow making
  - drought resistant plants
  - and much more

# Drought Impact and Response: Examples from 1976-1977 Drought

## Drought response

- Snow making -- now presents new water demands in October and November
- Colorado Drought Response Plan (developed after second short severe drought in 1980-1981) “to provide an effective and systematic means” to respond to drought
- Followed by 20 wet years

# Colorado Drought Response Plan

- Water Availability Task Force (determines whether “trigger levels” have been reached -- notifies Gov.)
- Impact Task Forces
  - Municipal Water
  - Wildlife
  - Wildfire Protection
  - Energy Loss
  - Agricultural Industry
  - Health
  - Tourism
  - Aggregate Economic Impact
- Review and Reporting Task Force

# Current Drought Responses

- municipal conservation, including fee structures
- storage, including conjunctive use
- water law: administrative flexibility
- basinwide assessments of supplies and demands
- water education

# Drought in Colorado

## Historic Analysis of Wet and Dry Periods

- Study began by Colorado Climate Center in late 1970s/early 1980s of all records in CO
- New drought indices developed for CO, including the Standardized Precipitation Index (SPI)

SPI Values	
2.0+	extremely wet
1.5-1.99	very wet
1.0 to 1.49	moderately wet
-.99 to .99	near normal
<b>-1.0 to -1.49</b>	<b>moderately dry</b>
<b>-1.5 to -1.99</b>	<b>severely dry</b>
<b>-2 and less</b>	<b>extremely dry</b>

# Drought in Colorado

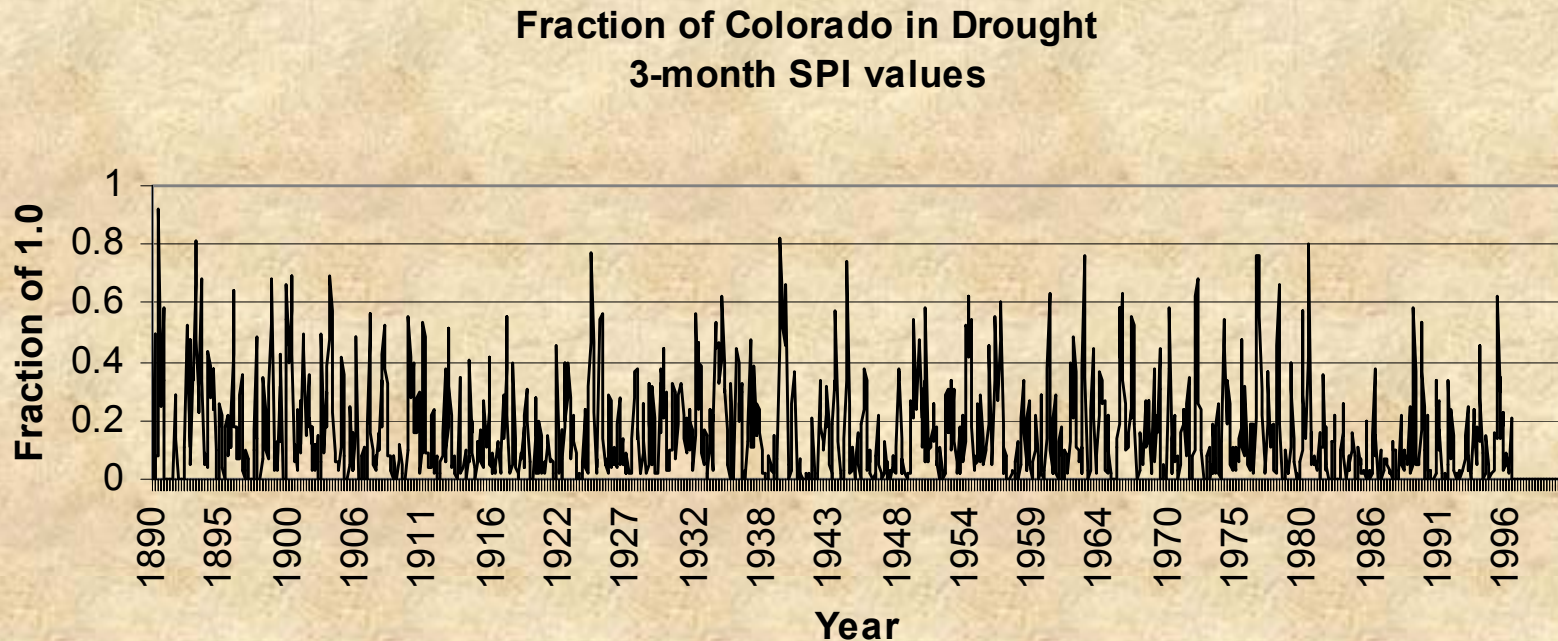
## Historic Analysis of Wet and Dry Periods

Fraction of Colorado Dry for 24 Months			
Dates	Dry	Wet	Duration
1893-1905	X		12 years
1905-1931		X	26 years
1931-1941	X		10 years
1941-1951		X	10 years
1951-1957	X		6 years
1957-1959		X	2 years
1963-1965	X		2 years
1965-1975		X	10 years
1975-1978	X		3 years
1979-1999		X	20 years
1999-present	X		???

# Drought in Colorado

## Historic Analysis of Wet and Dry Periods

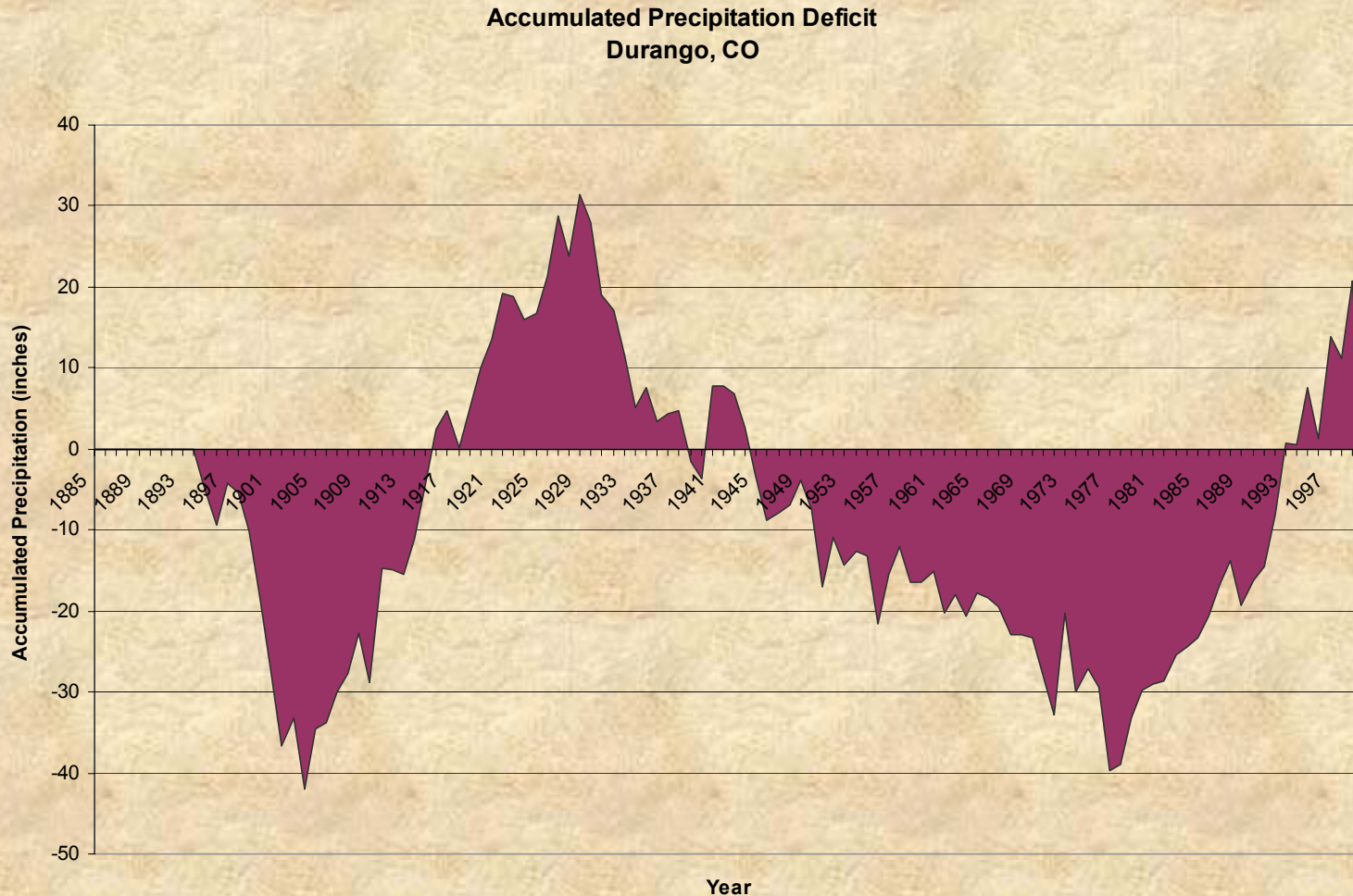
- Drought occurs frequently in Colorado
  - single season (3 month) droughts occur EVERY YEAR in some part of the state
  - every region of the state has had below average precipitation (SPI of -1 or less) some a 3-month period 90 out of 100 years



# Drought in Colorado

## Historic Analysis of Wet and Dry Periods

- Accumulated deficits magnify impacts

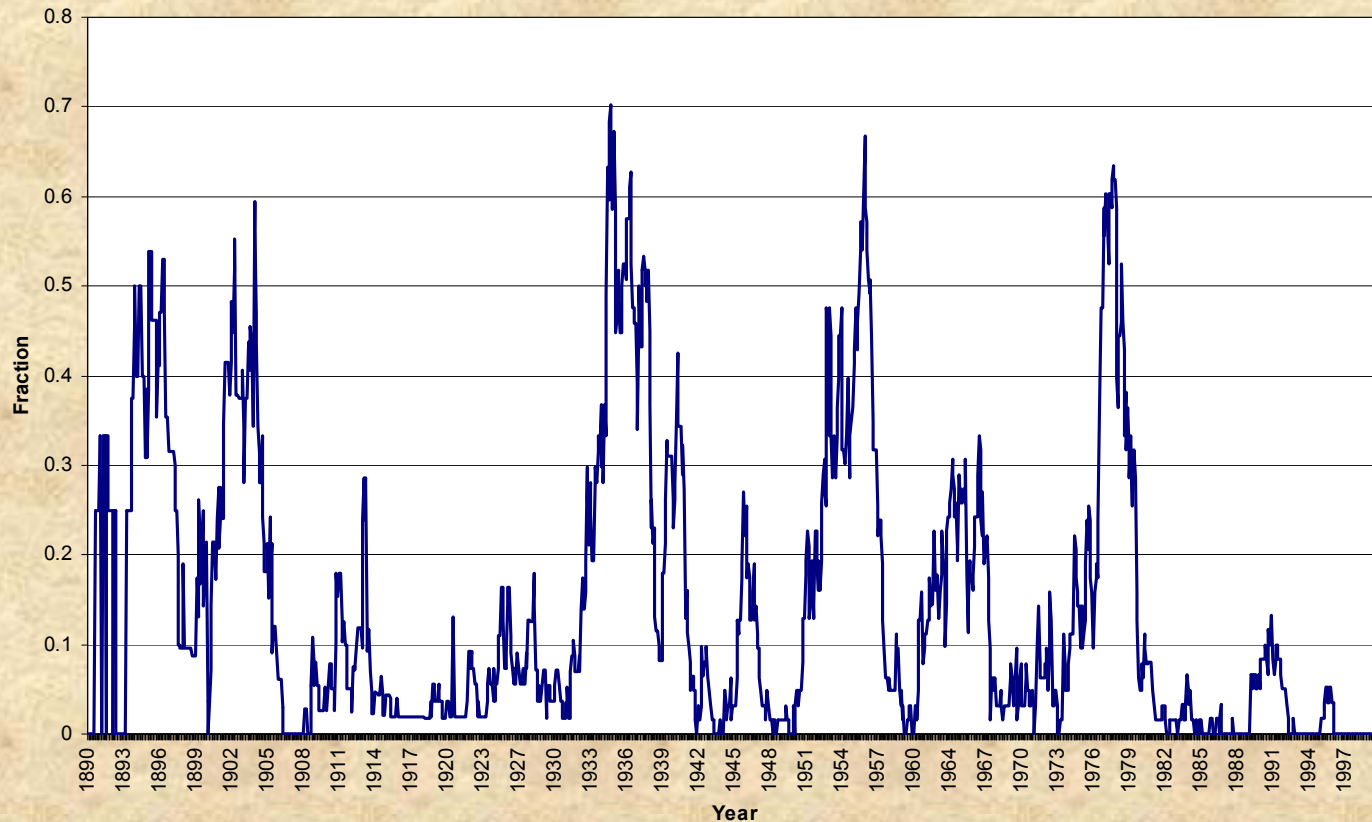


# Drought in Colorado

## Historic Analysis of Wet and Dry Periods

- Droughts have occurred in the past century that have lasted more than 4 years, and as long as 10 years (1930s)

Fraction of Colorado in Drought Based on 48-month SPI





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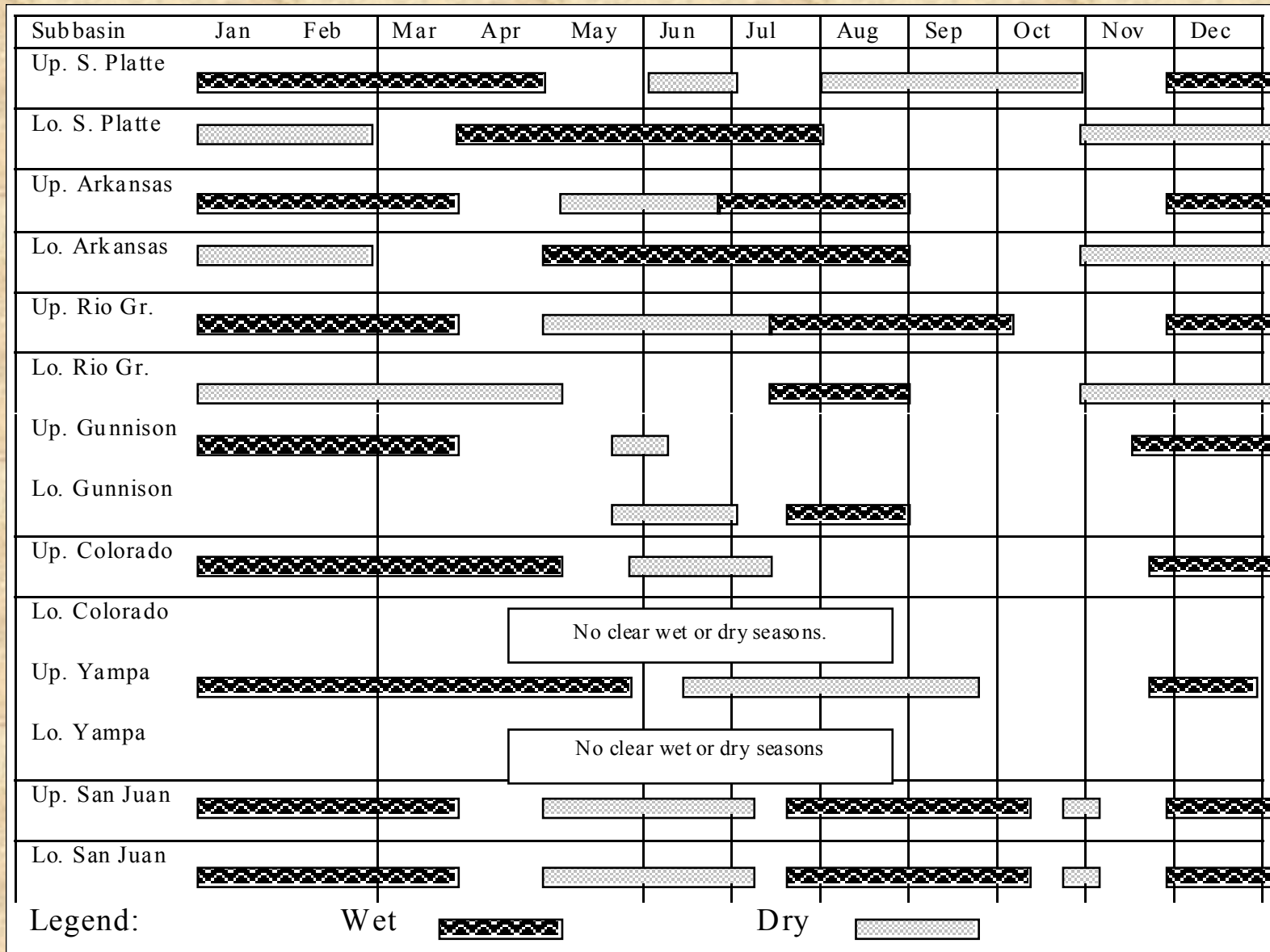
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<http://climate.atmos.colostate.edu/>

# How Colorado Gets Its Water



# Colorado's Water Demands: How and When We Use Water

- Agriculture
  - dryland (inc. pasture for livestock)
  - irrigated
- Municipal and Industrial (M&I)
- Hydropower

# Colorado's Water Demands: How and When We Use Water

- Recreation
  - ski resorts
  - summer recreation
  - white-water rafting
- Forests
- Other environmental/habitat uses