Examining Snowfall Patterns in the Blue River Basin

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Introduction

- Climate Change has been happening for a long time, but we are just beginning to enter the period during which we will feel the effects
- Most climate analysis is done over large geographic regions
- In order to better plan for the expected impacts of the changing climate, more analysis needs to be done on how macro trends affect critical subsections of the region
- To illustrate this we will take a case study of snowfall levels at the Blue River Basin

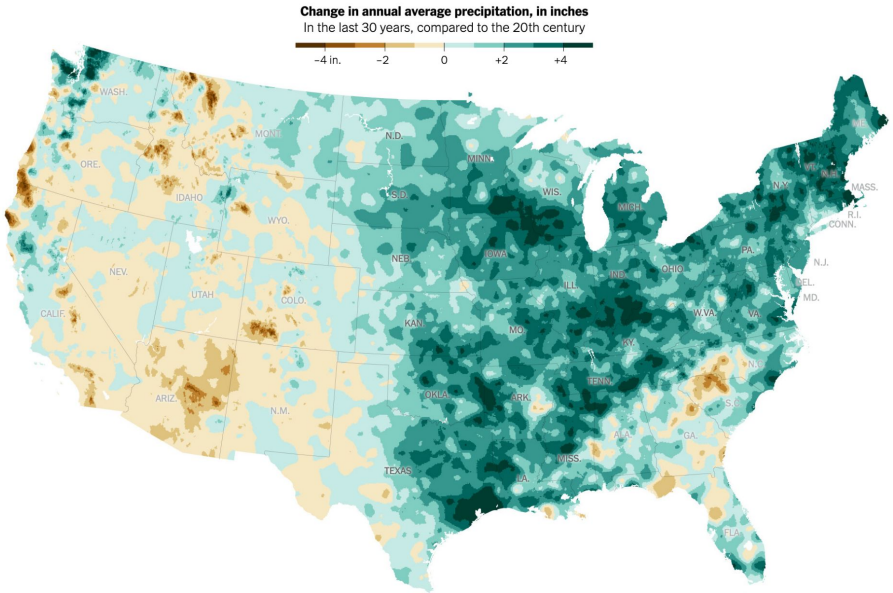
The Colorado River Basin

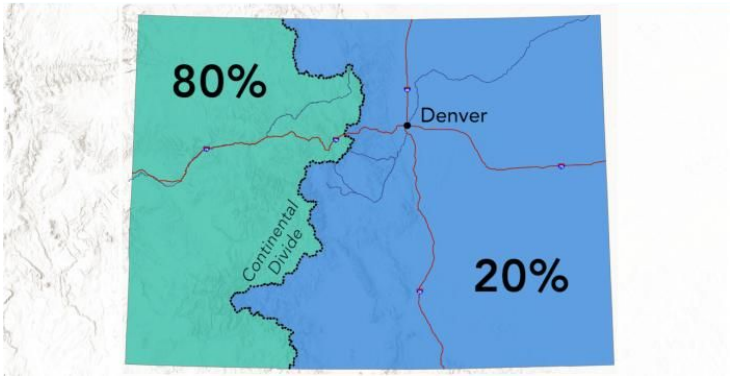
- Provides water for much of the American Southwest
- Faces over extraction and rarely reaches the Gulf of California
- Streamflow levels have decreased 19% from the 1978-2000

Colorado River Basin map | U.S. Geological Survey. (2016, November 3). https://www.usgs.gov/media/images/colorado-river-basin-map

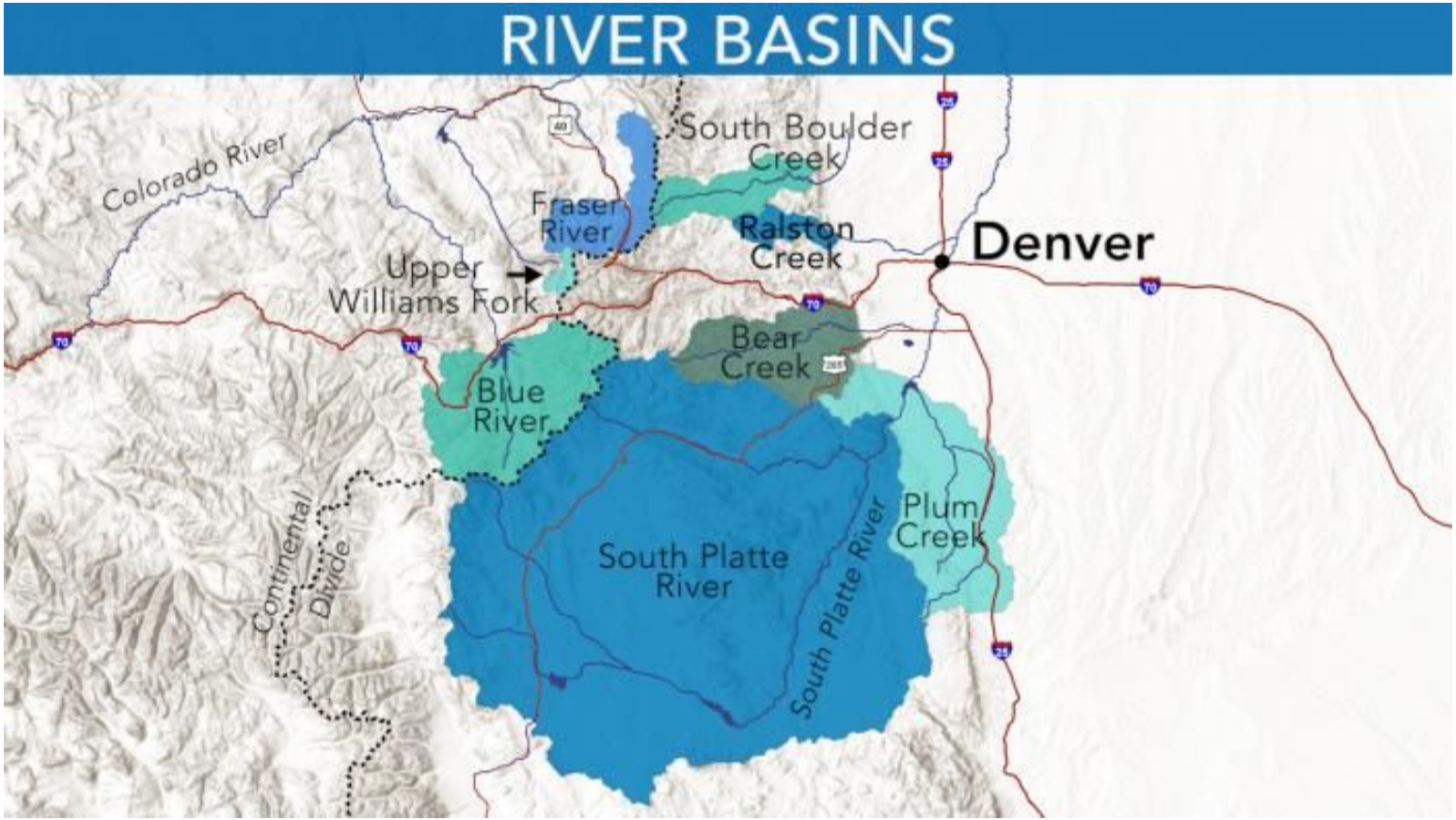
Declining Precipitation

- The “wettest” areas are seeing the largest declines in precipitation
- Increases in precipitation are in seasons and areas with the least precipitation





Bhatia, A., & Popovich, N. (2021, August 24). *These maps tell the story of two Americas: One parched, one soaked*. The New York Times. https://www.nytimes.com/interactive/2021/08/24/climate/warmer-wetter-world.html



Adams, J. (2021, June 29). Where does your water come from?. Denver Water. https://www.denverwater.org/tap/where-does-your-water-come?size=n_21_n

Data Sources

- Colorado State University's Colorado Climate Center compiles records from weather stations going back to 1800s
- Records come from 7 stations located in and around the Blue River Basin
- Concerned only with snowfall
  - Conversion between solid and liquid precipitation totals is contentious
  - Rainfall does not meaningfully contribute to streamflow
  - Virtually all the streamflow is produced from snowmelt
  - Simple shifts in precipitation form from solid to liquid would have similar impacts as decreases in snowfall

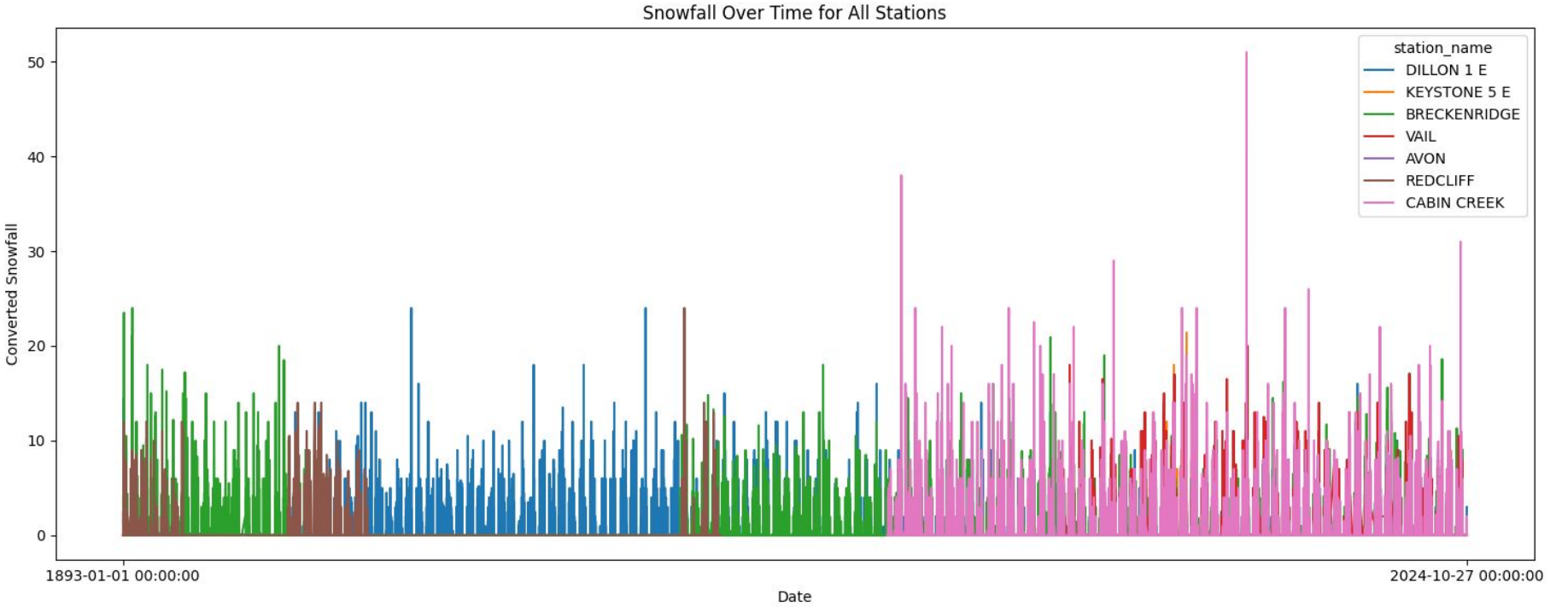
Data Aggregation

- Due to the changing distribution of stations we have to use a simple average of the records from active stations
- More sophisticated aggregation methods exist, but require more accurate hydrological data or constant areas of measure
- Due to the intermittent nature of snowfall and variability of daily data totals will be aggregated at the monthly level

Missing Data

Snow Event	Count
No Snowfall	87367
Measurable Snowfall	19684
Missing	43342
Trace	6670
Total	157063

- Missing and Trace values need to be dealt with
- Trace values will be imputed
- Missing values will be dropped


Snowfall Over Time for All Stations
station_name
DILLON 1 E
KEYSTONE 5 E
BRECKENRIDGE
VAIL
AVON
REDCLIFF
CABIN CREEK
Converted Snowfall
0
10
20
30
40
50
1893-01-01 00:00:00
2024-10-27 00:00:00
Date

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Original

Station	count	mean
AVON	43	1.96
BRECKENRIDGE	6935	2.36
CABIN CREEK	2860	2.78
DILLON 1 E	6421	2.21
KEYSTONE 5 E	235	3.52
REDCLIFF	850	2.63
VAIL	2340	2.76

Imputed

Station	count	mean
AVON	60	1.42
BRECKENRIDGE	8877	1.85
CABIN CREEK	3876	2.07
DILLON 1 E	9400	1.53
KEYSTONE 5 E	332	2.54
REDCLIFF	1118	2.01
VAIL	2691	2.40

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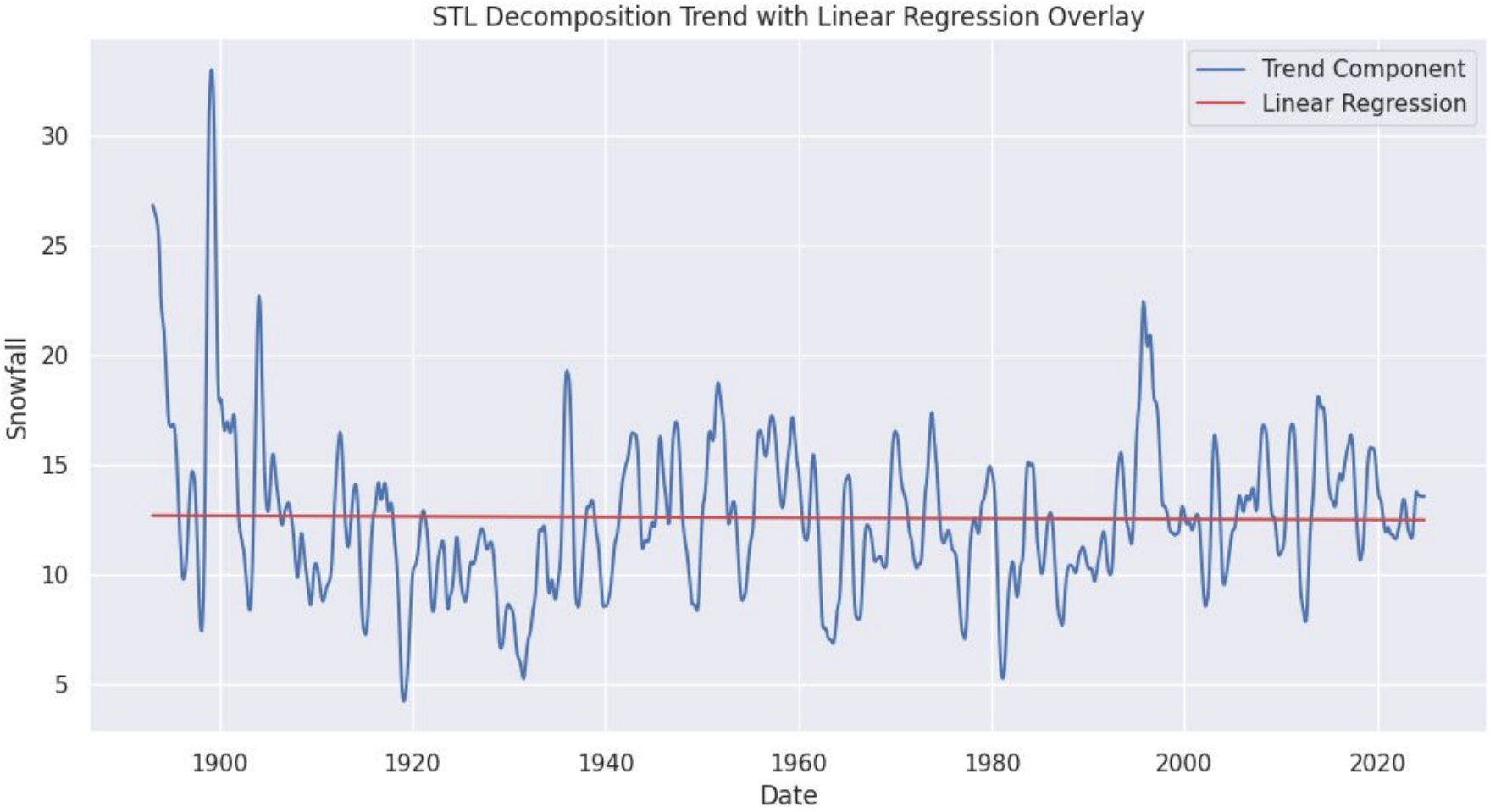
STL Decomposition

- Separates the seasonal component of the data
- Residuals are white noise
- Indicates a flat trend over the time period


STL Decomposition Trend with Linear Regression Overlay
Trend Component
Linear Regression
Snowfall
30
25
20
15
10
5
1900
1920
1940
1960
1980
2000
2020
Date

Conclusion

- The Blue River Basin is not following the trend of decreased precipitation present in the wider region
- Understanding of local conditions is critical when attempting to prepare for and mitigate the effects of Climate Change
- Making policy decisions based on the trend of the larger region would result in a misallocation of resources