Drought, Wildfire, and Groundwater Interpretation of the US and Colorado

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Topic Background and Overview

- Two separate groups, groundwater and drought was one and wildfires the other
  - Through discussion we all believed our topics were related
- Groundwater is a critical component of agriculture in the
  - Castle Rock and South Metro, CO which lack large bodies of water depend on groundwater
  - Both of those areas also suffer from drought/wildfires
- Has caused billions of dollars in damages to the US, specifically the American West in recent decades

Hypothesis and Reasoning

- Hypothesis: The fluctuation and severity of each of these events are intrinsically linked and are following a trend of increasing severity and prevalence.
- Droughts, Wildfires, and Groundwater have recently had increasing importance in Western US
- Initial predictions:
  - Drought Prevalence and groundwater depletion have high correlation
  - Droughts create ideal wildfire conditions
  - Ample groundwater would mean less wildfires
- Analyzing data from USA/CO will prove or disprove hypothesis
- Compare trends between the US and CO to determine any common indicators for the events

Datasets Descriptions

United States Drought Monitor

- Comprehensive/DSCI Drought statistics
- CSV format
- Weekly Measurements taken from 2000 - current
- Easy to extract and analyze. .

Department of Agriculture

- Monitoring Trends in Burn Severity (MTBS) project dataset (CSV).)
- Measurements of every US fire. (beginning in the 1980s)
- Dataset modification in Excel was required
- Large dataset (>1 GB). Data filtering to fit timescale/region was necessary.

USGS National Groundwater Monitoring Network

- Datasets extracted from a map system with differing sites from colorado.
- Good for pinpointing/analyzing specific areas/cities
- Poor at gaging large-scale trends.
- Very difficult to work with in code.

National Centers for Environmental Information

- National Interagency Fire Center (NIFC) Wildfire Dataset.
- Data was easy to extract/analyze. Available data from January 2000 - March 2023.

Description of Data Analyzation Techniques

Python third party libraries

- Numpy - Computational/numerical methods applied to datasets. Datetime conversions.
- Sci-kit learn - Mean-trend evaluation
- Matplotlib - Plotting analyzed data
- Pandas - Dataset reading, grouping, and splitting

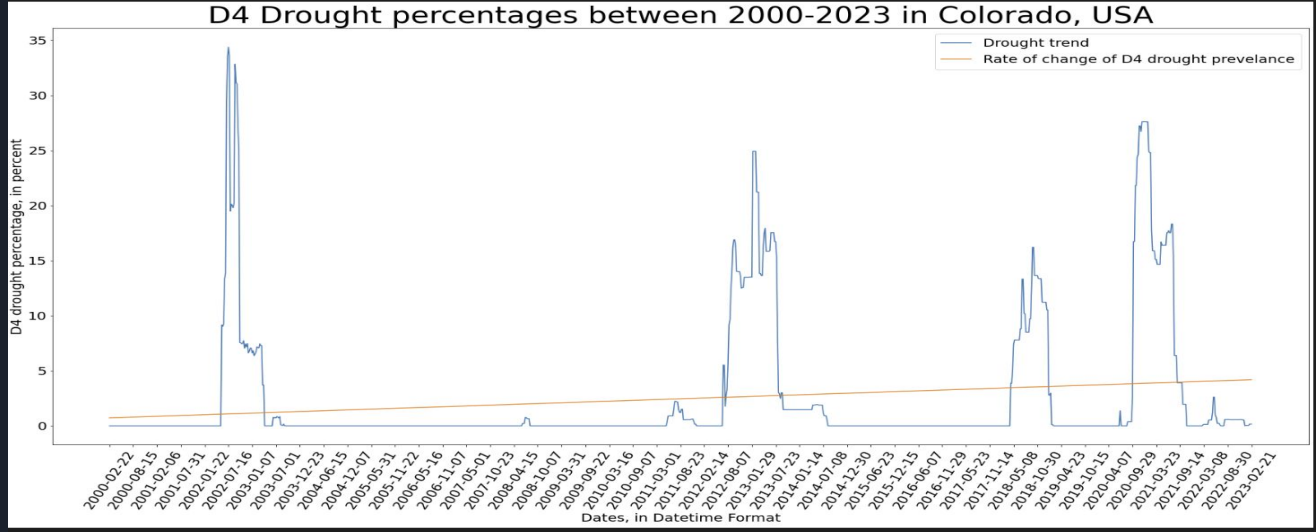
Analyzation Techniques:

- Data assorted from oldest-newest and plotted as a function of time to detect trends.
- Data grouped by month or year to help visualize more apparent trends.

Limitations and Weaknesses to our Approach

- Time comparison, one data set is by month(fire), while drought is done by week, and groundwater was inconsistent throughout.
- Generalizes Entire US which is an inaccurate representation of the US and the rate or intensity of wildfires each state may experience.
- Due to time constraints unable to accurately compare or identify regions with high accuracy.
- Groundwater data covered less time than drought and wildfire

Figure 1, D4 drought in Colorado/USA



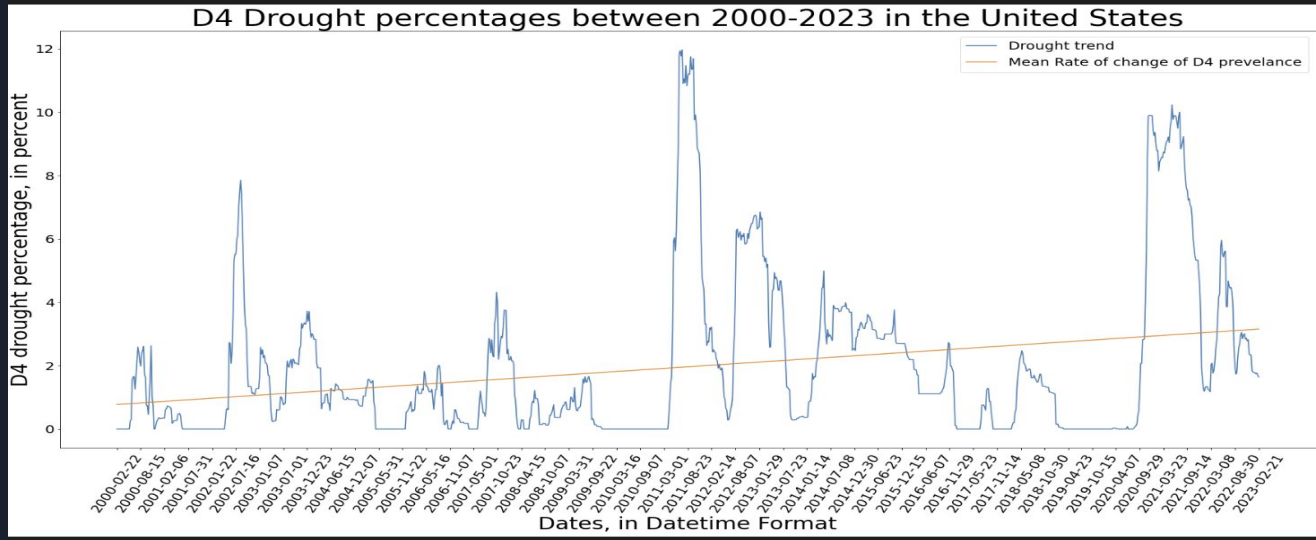


Figure 2, Yearly/Monthly D4 drought averages in USA/Colorado

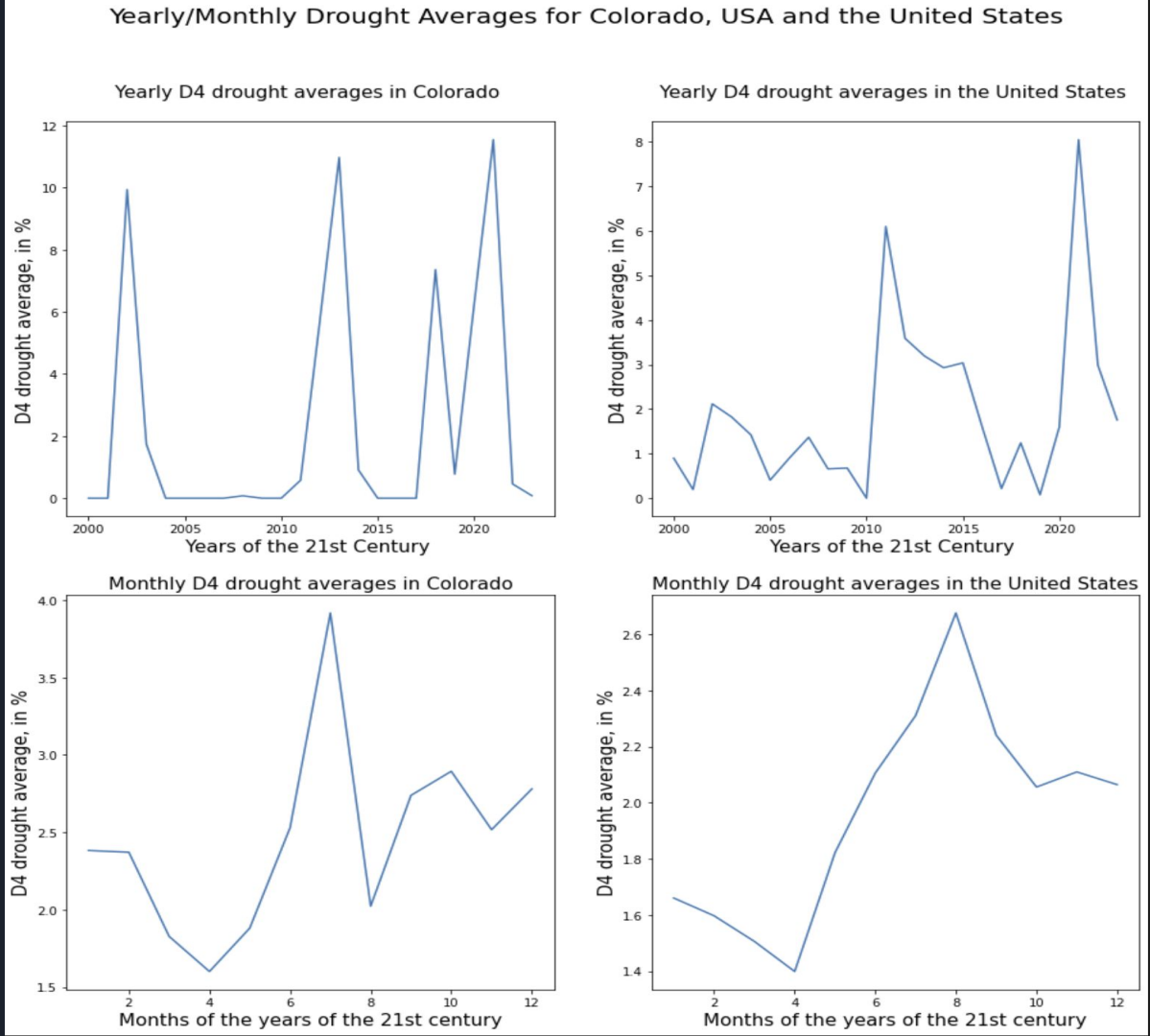


Figure 3, Number of fires, burned Acreage, and Acreage burned per fire in the US.

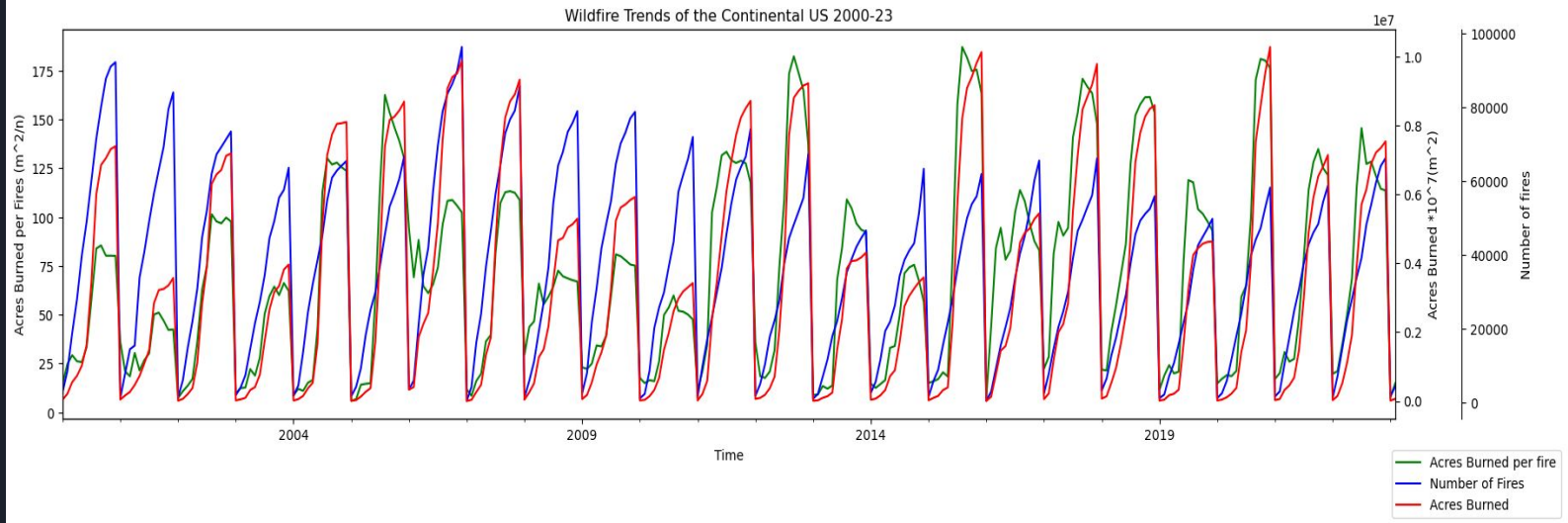
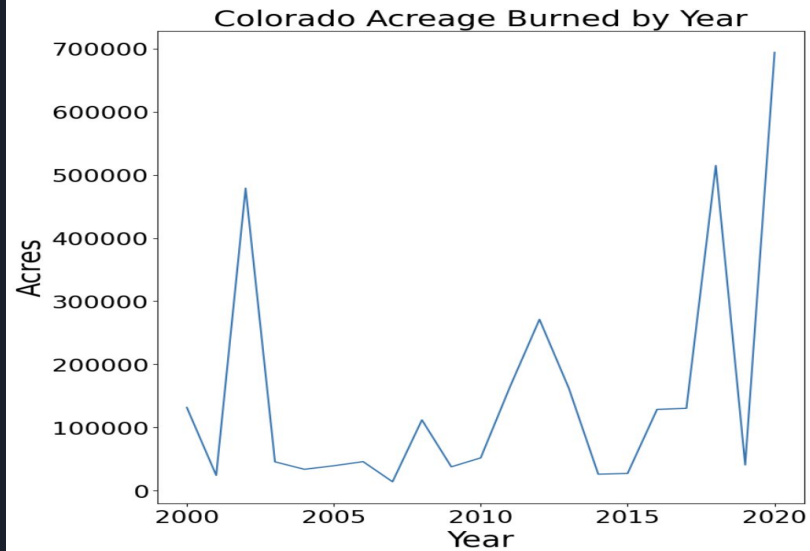
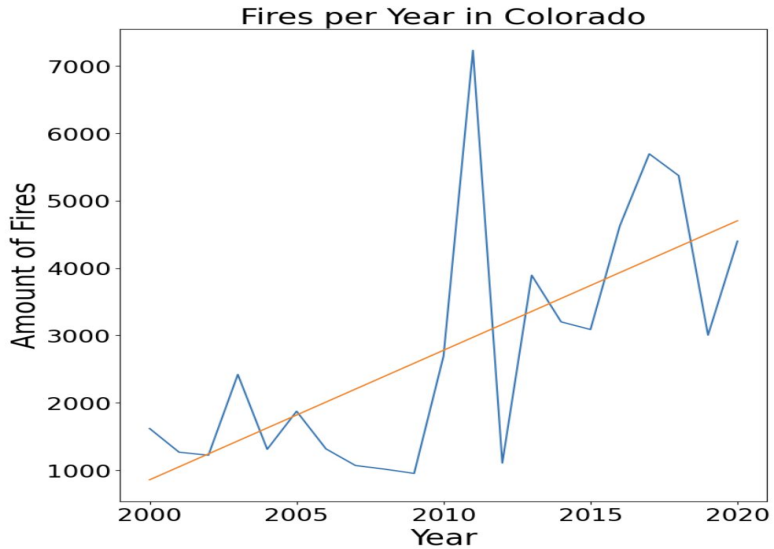


Figure 4, Acreage Burned, and Fires per year in Colorado, USA





‘Peaks’ of Wildfire/Drought in the United States between 2000-2023

Major Peak Years(wildfire)	2007	2008	2012	2016	2018	2021
Major peak years (drought)	2002	2011	2012	2020	2021	

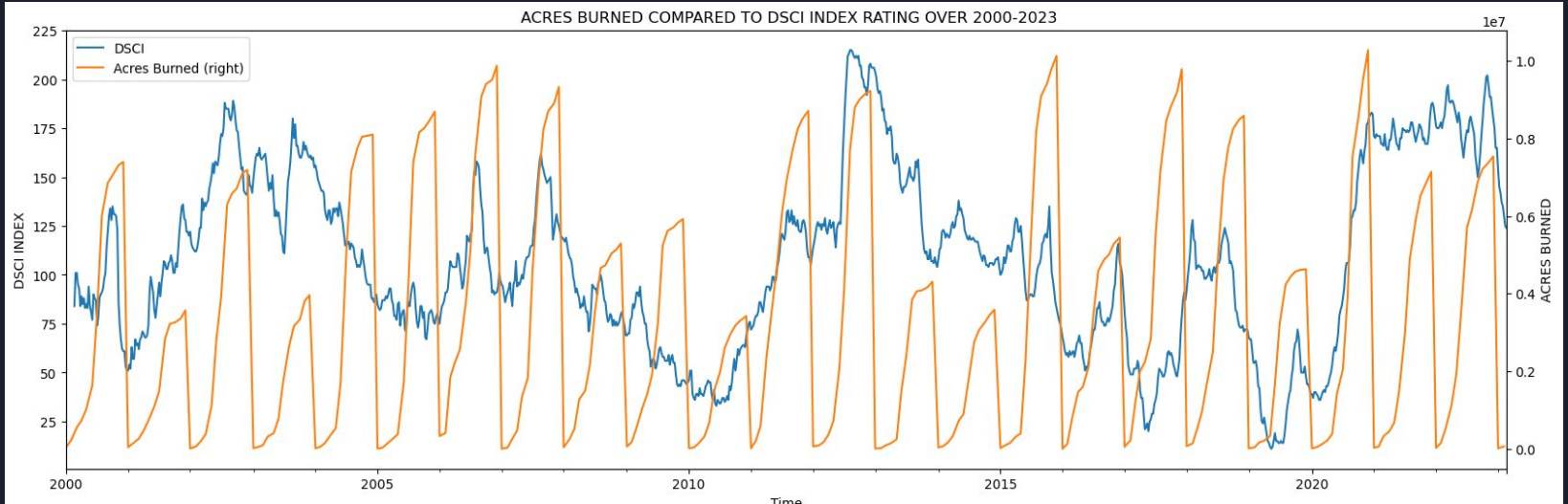


Figure 5, DSCI drought index compared to Acres burned per year in the United States

‘Peaks’ of Wildfire/Drought in Colorado between 2000-2023

Major Peak Years(wildfire)	2002	2012	2018	2020
Major peak years (drought)	2002	2012-2013	2018	2020-2021

Colorado/USA D4 average drought prevalence statistical summary

USA

- 2000s: 1.05%
- 2010s: 2.20%
- 2020-2023: 4.07%

Colorado

- 2000s: 1.21%
- 2010s: 3.39%
- 2020-2023: 5.75%

Analysis of Drought-fire relation/severity in the United States Versus Colorado

United States

- Fire Prevalence Nationwide is affected by more than drought severity
- Variation in climate, fire preparedness, and seasonality can skew fire-drought relations across the U.S.
- Number of fires are decreasing, yet acreage burned per fire is increasing.
- No clear trend in total burned acreage
- D4 drought is on the rise and DSCI drought peaks are lengthening

Colorado

- Peaks of Drought and wildfire match almost exactly
- Smaller scale of land/region lead to more concise matches in trends
- Acreage burned + fire numbers are increasing in Colorado
- D4 drought increases while peaks are becoming more common and severe.
- Colorado has worse drought severity compared to the whole USA.

Groundwater in Colorado Springs, Co

- Data from well locations near Colorado Springs
- Shows no consistent trend for increase or decrease in the past 20 years

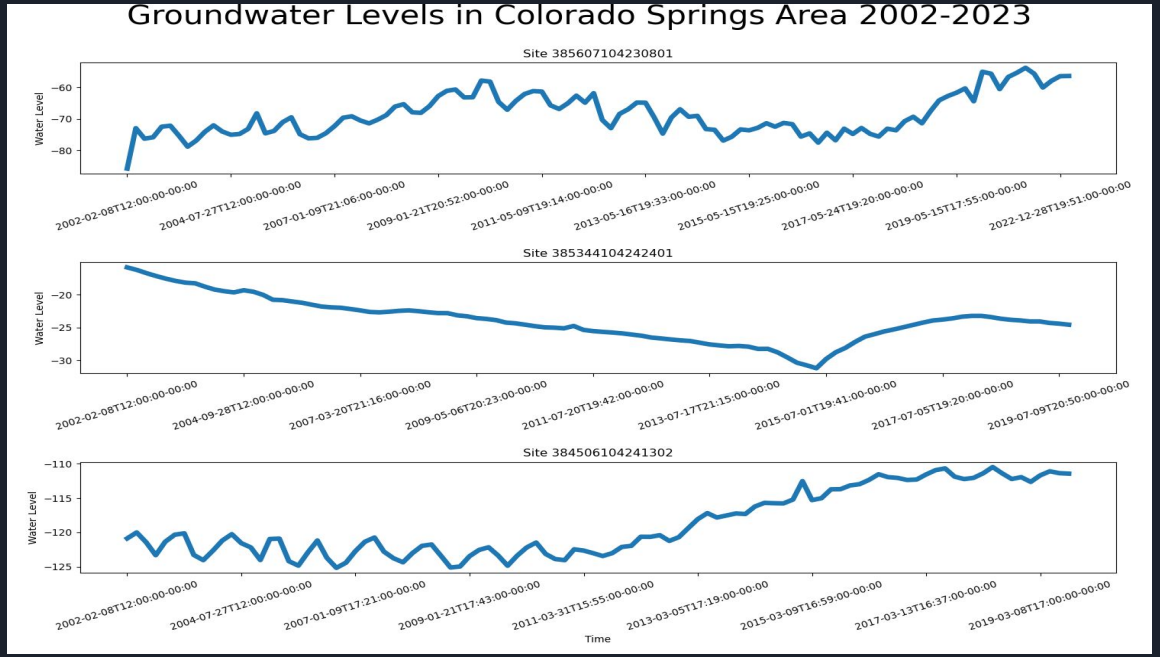


Figure 6: USGS groundwater levels in Colorado Springs at different sites.

Colorado Groundwater Visualization/interpretation

- Compiled average data from locations all around the state of Colorado
- Data show great variation within single years
- The data show a small but consistent decreasing trend from 2002 to 2015.
- There is very little correlation between groundwater level, drought, and wildfire data
- Could fluctuate more based on human impact.

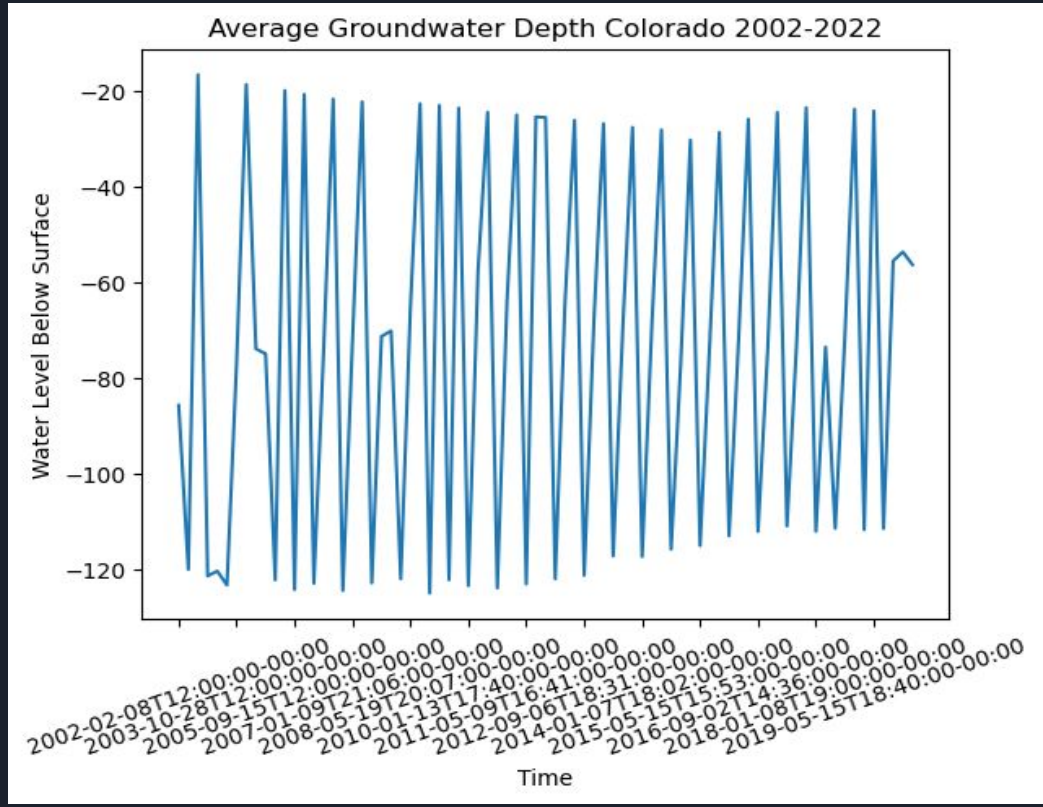
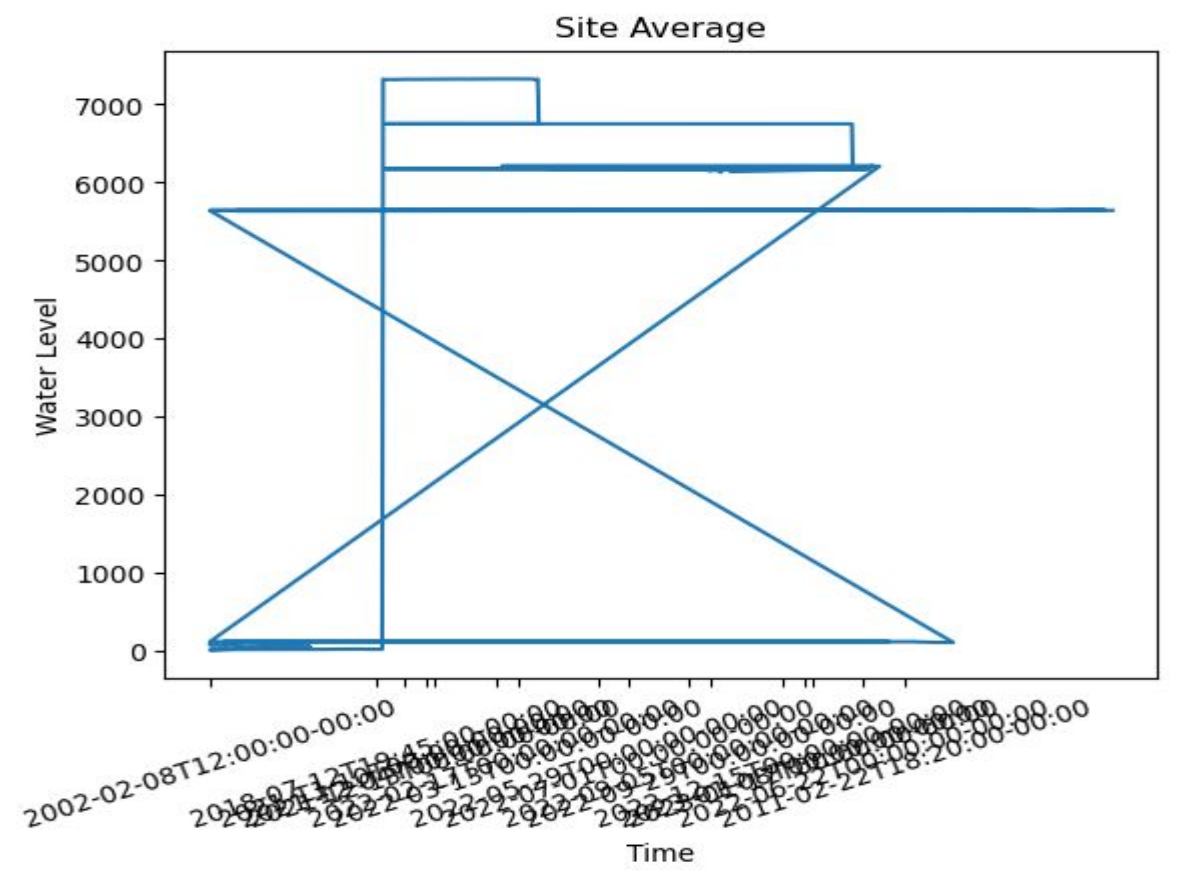


Figure 7: USGS Mean Groundwater Levels of Colorado

Future Research/inquiries

- Human impact on groundwater levels.
- Does groundwater data at a national scale have a clearer relationship to drought and wildfire?
- Prevalence of the same region having repeat wildfires, drought, and low or high groundwater levels
- Can humans reduce the severity of these disasters
- Other regions of the US and world.
- Effect of climate change on these disasters
- How do other water source data such as snowpack depth and reservoir levels change in relation to drought and wildfire data?
- What natural hazards does groundwater impact
- What causes overlapping groundwater sources and what implications do they pose?

Questions?


Site Average
Water Level
7000
6000
5000
4000
3000
2000
1000
0
2002-02-08T12:00:00-00:00
Time

Sources:

1- “Current Map: U.S. Drought Monitor.” Current Map | U.S. Drought Monitor, https://droughtmonitor.unl.edu/CurrentMap.aspx.

2- “Groundwater.” Groundwater | Castle Rock, CO - Official Website, https://crgov.com/1792/Groundwater#:~:text=Castle%20Rock%2C%20and%20most%20South,Denver%2C%20Arapahoe%20and%20Laramie%20aquifers.

3- NCEI.Monitoring.Info@noaa.gov. “U.S. Wildfires.” U.S. Wildfires | National Centers for Environmental Information (NCEI), https://www.ncei.noaa.gov/access/monitoring/wildfires/ytd/0.

4-California Department of Forestry and Fire Protection (CAL FIRE). “GIS Data.” Cal Fire Department of Forestry and Fire Protection, https://frap.fire.ca.gov/mapping/gis-data/.

5- “Monitoring Trends in Burn Severity Burned Area Boundaries (Feature Layer).” Catalog, Publisher U.S. Forest Service, 3 Apr. 2023, https://catalog.data.gov/dataset/monitoring-trends-in-burn-severity-burned-area-boundaries-feature-layer-27201.

6- “National Water Information System.” USGS Groundwater Historical Instantaneous Data for the Nation: Build Time Series, https://waterdata.usgs.gov/nwis/uv/?referred_module=gw.