Actuarial Weather Extreme Series

Droughts Around the World in Early 2024

Author:
Michael Reis, FSA, CERA, JD
Fortitude Re

NOAA Global Drought Narrative

The National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information (NCEI) provides a Global Drought Narrative monthly that explains where droughts are most prevalent internationally.[1] As of the time of this writing, the most recent Global Drought Overview comes from April 2024. Analysis for this report focuses on areas mentioned in the March and April report. In this report, the NOAA identifies many areas of the world that are experiencing extreme drought. Some examples are below:

- Spain, especially the Catalonia region
- Mediterranean areas of Europe
- Southwest Asia
- Micronesia
- Vietnam
- India
- Morocco
- 28% of Africa
- Southeast Africa, especially Malawi, Zambia, and Zimbabwe
- Tasmania, Australia
- Mexico

[1] NOAA National Centers for Environmental Information, Global Drought Narrative for April 2024, published online May 2024, retrieved on June 9, 2024 from https://www.ncei.noaa.gov/access/monitoring/monthly-report/global-drought/202404.

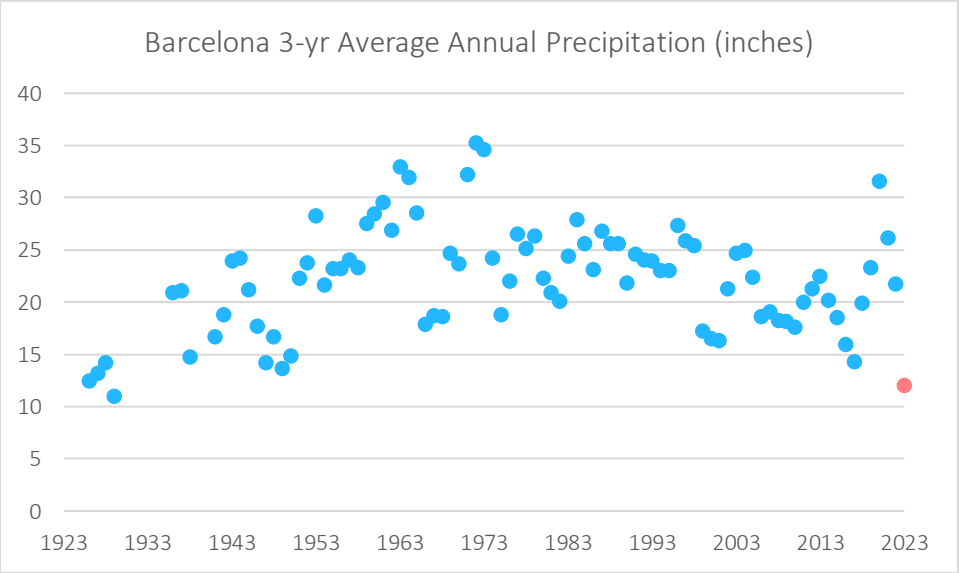
Data Analysis on Select Regions

While many of these drought-plagued areas lack long-term reliable data on precipitation accumulation, some of these areas have data that is complete enough to see a general trend and how extreme the current droughts are.

By using the data from NCEI's GHCN daily data pulled on June 9th, we can see the drought experience that certain weather stations have experienced through 2023.[2] Since much of the drought report speaks to droughts that are several months or years in the making, the data through yearend 2023 is sufficient to see the effect. Many of these areas did not have sufficient data to do analysis through 1Q 2024. Figures below show a three-year average of annual precipitation to capture the water shortages that accumulate after multiple years of drought.

The state of Catalonia in Spain declared a state of emergency for their drought. Barcelona's airport has a robust history of data going back to the 1920s. The current three-year drought is worse than any time since the 1920s.

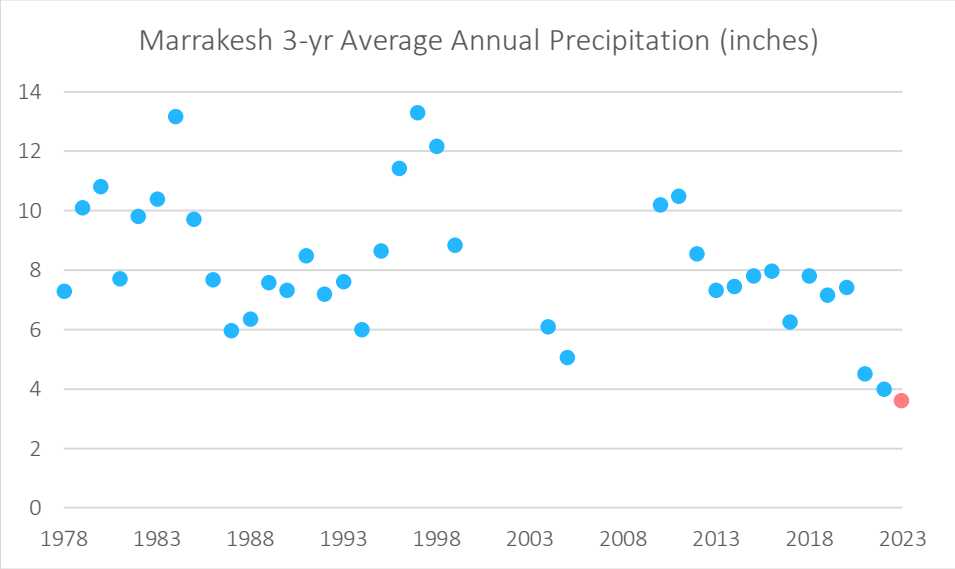
Figure 1: Barcelona Aeropuerto, Spain



While Catalonia experiences a state of emergency for their drought, the Mediterranean area has many other areas with a drought. This extends to northwest Africa and the Kingdom of Morocco, where their second-largest reservoir is almost empty. Marrakesh is the large city closest to this reservoir that has data readily available. Figure 2 below shows the data from the Menara weather station in Marrakesh, showing how devastating the last few years have been to this region.

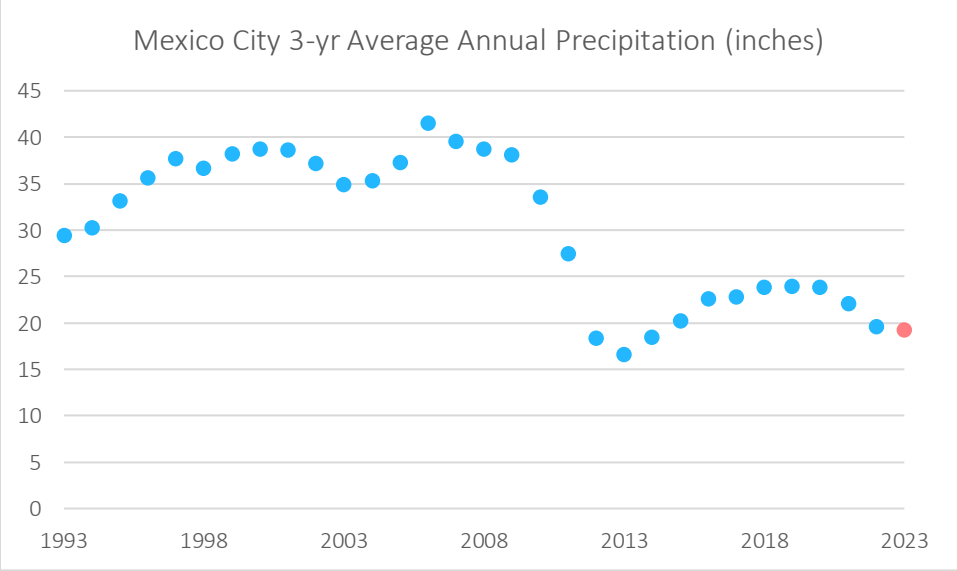
[2] https://www.ncei.noaa.gov/pub/data/ghcn/daily/?C=S;O=D

Figure 2: Menara, Morocco



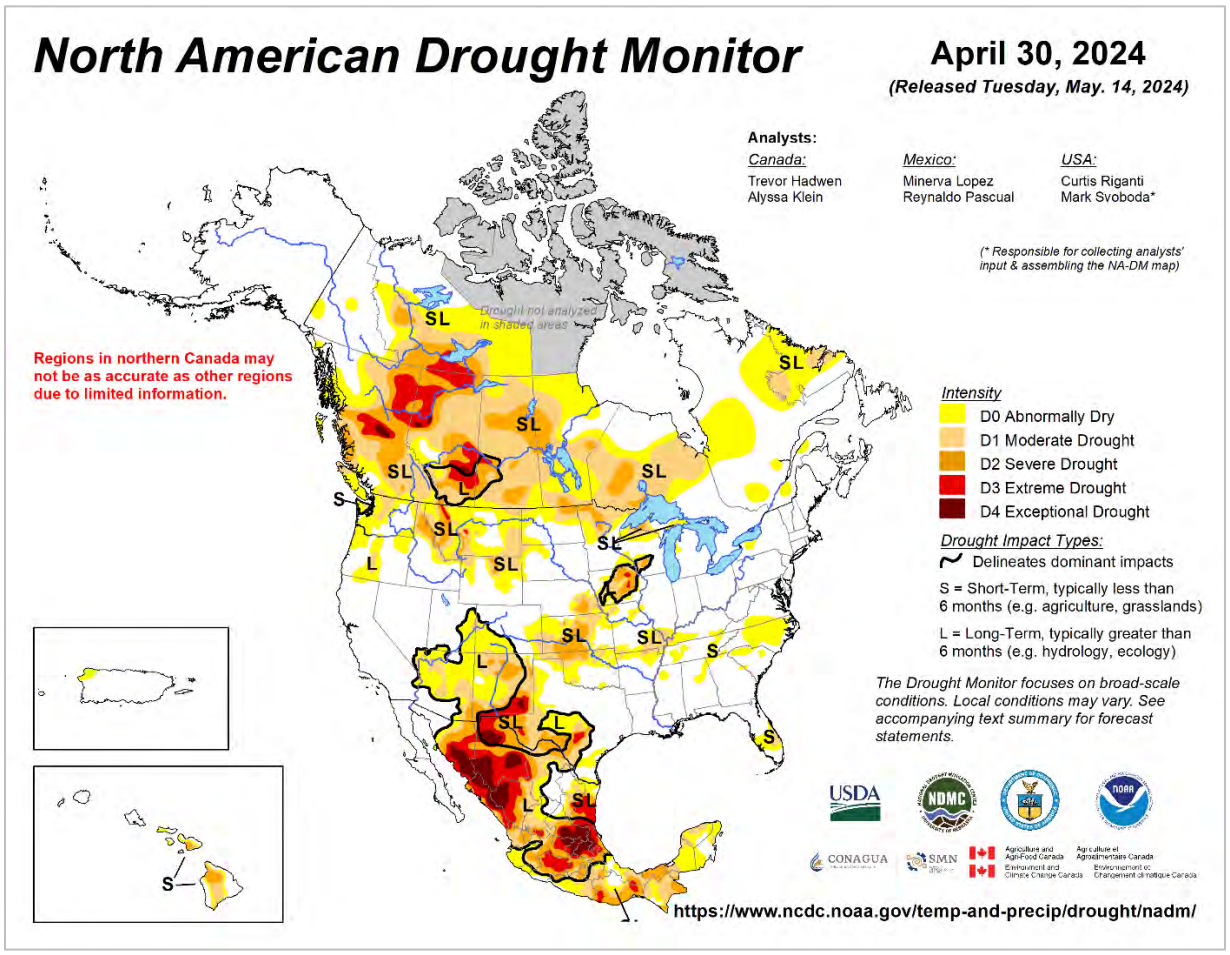
Sometimes when a region is used to a relatively high level of rainfall, a sustained lowering of precipitation can cause drought-like conditions and a shortage of water resources. Looking at the precipitation from this weather station in the suburbs of Mexico City, we can see that although the most recent drop off has not been as extreme as other areas, but since 2010, there has been significant less rainfall from the period 20 years prior.

Figure 3: Toluca (Obs), Mexico



In addition, we can use the drought monitor tool produced jointly by the University of Nebraska-Lincoln, U.S. Department of Agriculture (USDA), and NOAA to track how severe this drought in Mexico is in comparison to areas of Canada and the United States at a single point in time (30 April 2024).[3]

Figure 4: Canada, US, Mexico Drought Map as of April 30, 2024



The U.S. Drought Monitor is jointly produced by the National Drought Mitigation Center at the University of Nebraska-Lincoln, the United States Department of Agriculture, and the National Oceanic and Atmospheric Administration. Map courtesy of NDMC.

This map shows that the Mexico City region falls under "D4 Exceptional Drought", a state only experienced widely in Mexico as of the end of April, but not prevalent in the U.S. or Canada. This means that the widespread drought in Mexico City is even more severe than the most severe drought in the U.S. or Canada as of the end of April.

[3] https://droughtmonitor.unl.edu/ ; https://droughtmonitor.unl.edu/nadmdata/operational/png/202404/202404_nadm-en.png

The NOAA report also mentioned drought conditions in northern Chile and northern Argentina. This area is mainly desert with Chile having the most reported data. **Error! Reference source not found.** shows the rainfall in the city of Antofagasta, Chile. Since this is such a dry area naturally, rainfall amounts can vary drastically when there is only one or two rainfall events. For comparison, **Error! Reference source not found.** shows Puerto Montt, an area of Chile that traditionally gets a lot more rainfall. This graph shows a severe drop off compared to the last few decades.

Figure 5: Antofagasta, Chile

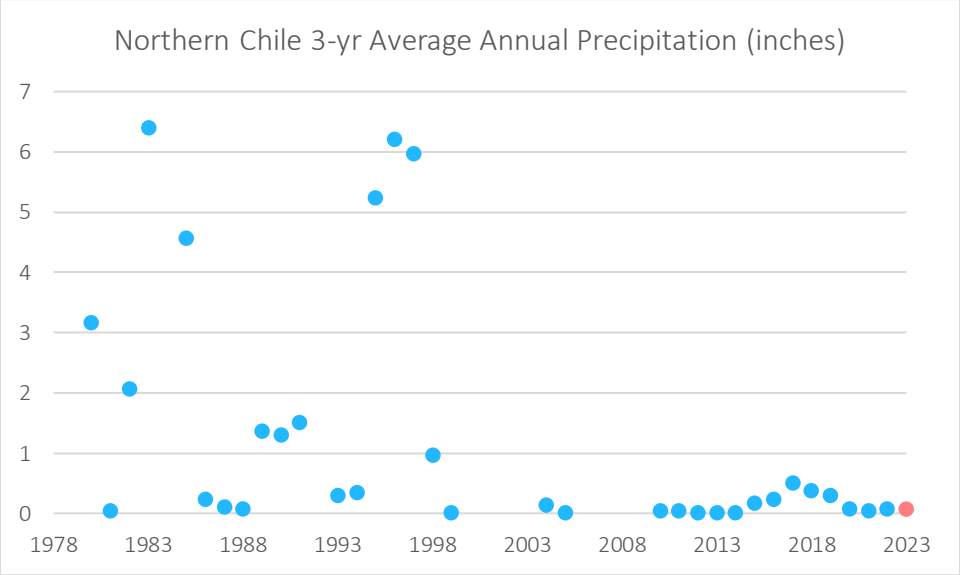
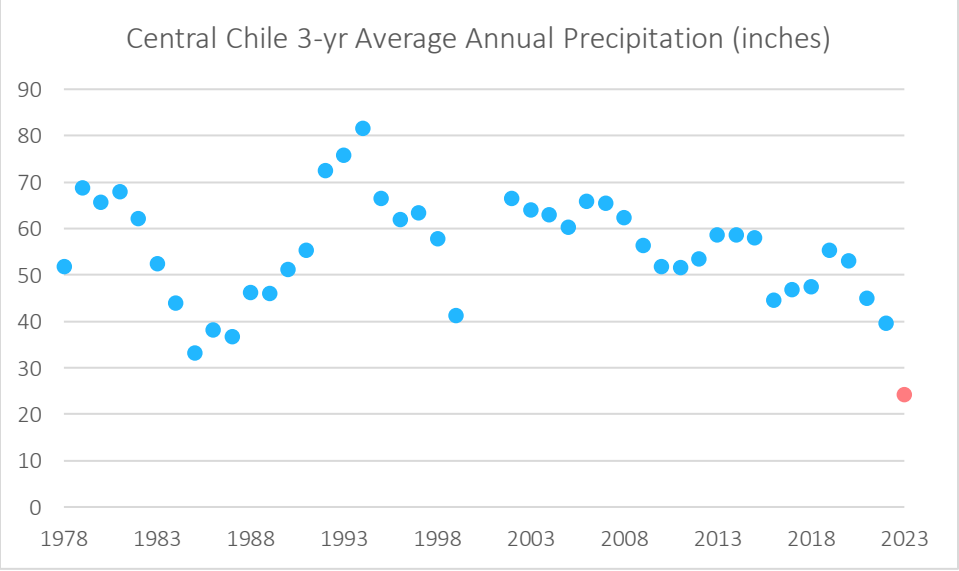


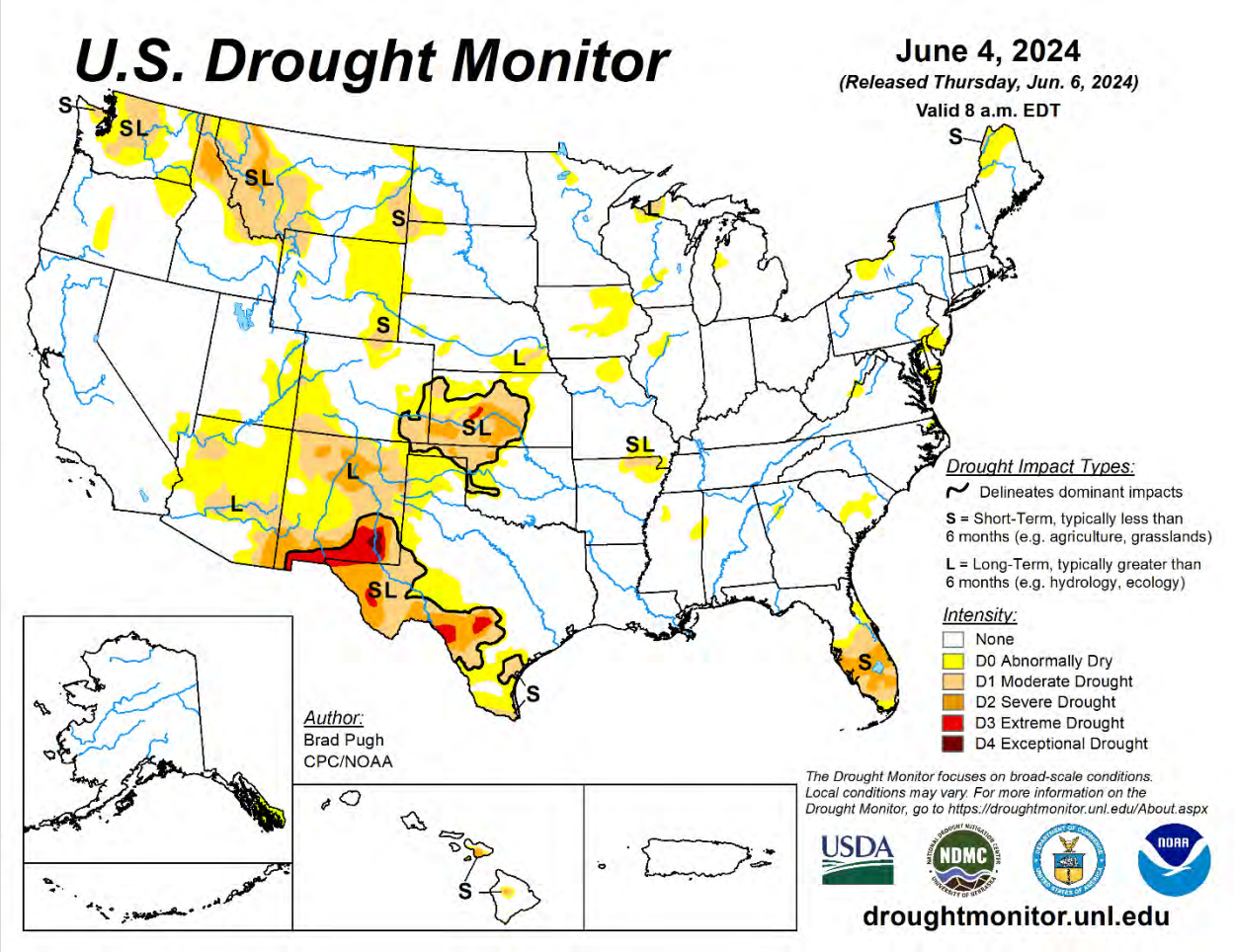
Figure 6: Puerto Montt, Chile



Affected Areas in the US

Certain parts of the United States have also experienced drought conditions in recent months. By looking at the U.S. Drought Monitor mentioned earlier, we can see which areas are experiencing a drought currently (US data is updated more frequently than the Canada / U.S. / Mexico map).[4] The map below was released on June 6th and is valid for June 4th.

Figure 7: U.S. Drought Monitor for June 4th, 2024



The U.S. Drought Monitor is jointly produced by the National Drought Mitigation Center at the University of Nebraska-Lincoln, the United States Department of Agriculture, and the National Oceanic and Atmospheric Administration. Map courtesy of NDMC.

[4] https://droughtmonitor.unl.edu/ ; https://droughtmonitor.unl.edu/data/png/20240604/20240604_usdm.png

The red areas are the places experiencing the strongest drought, with "S" referring to short-term effects (less than 6 months) and "L" referring to long-term effects (greater than 6 months). Outside of the desert Southwest, we see a strong drought in the Kansas region. There is a lag in the reported data, so it is difficult to see the drought from rainfall amounts reported through April. Indeed, at the end of April, Kansas had a much milder drought than what they are currently experiencing as of June 4th.[5]

Economic Impact

As noted in the March and April NOAA reports[6,7], drought can drastically affect the prices of various commodities. There is concern that long-term climate change could have effects on soft commodities.[8] The drought in Vietnam caused a 3.5 month high in the price of arabica coffee and robusta coffee posted a record high price.[9] Because of a humid heatwave and intensifying drought in Ghana, cocoa hit a new record high price which will be felt worldwide in the price of chocolate since most chocolate is made from cocoa grown in West Africa.[10] Thailand, the world's second-largest sugar exporter after Brazil, dropped production for the 2023-24 crop year, possibly pressuring the global market.[11] Global wine production was at a historic low in 2023.[12] The crop yield in Morocco will suffer a 20% loss as a result of the drought.[13] Mexico's continued drought has caused lakes and rivers to dry up, exacerbated by the demand by commercial farms to water their water-dependent export crops, such as avocados.[14]

Droughts obviously also have local impacts in the costs of water when groundwater supplies are depleted as has been seen in the complete depletion of the 150 million cubic meter Cogoti reservoir in Chile.[15] Zimbabwe has recorded that 2.7 million people will go hungry this year due to drought and 9,000 cattle deaths have already been reported to USAid.[16] In Zambia, drought affects their electricity production as 87% of their electricity comes from hydropower.[17] This has knock-on effects to any other industry that requires electricity. Canada relies on the melting snowpack as a water resource in the spring and summer, but in British Columbia, snowpack is 63% of normal, leading to fears that drought may be on the horizon.[18] Panama is planning for a "dry canal" as a result of drought conditions which may affect the 6% of global maritime trade that goes through the Panama Canal.[19]

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[5] https://www.weather.gov/ict/drought
[6] NOAA National Centers for Environmental Information, Global Drought Narrative for March 2024, published online April 2024, retrieved on June 9, 2024 from https://www.ncei.noaa.gov/access/monitoring/monthly-report/global-drought/202403.
[7] NOAA National Centers for Environmental Information, Global Drought Narrative for April 2024, published online May 2024, retrieved on June 9, 2024 from https://www.ncei.noaa.gov/access/monitoring/monthly-report/global-drought/202404.
[8] See footnote 7.
[9] See footnote 6.
[10] See footnote 6.
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The drought can increase the probability of wildfires, as we have seen in the western U.S. in recent years. Dryness has caused some of the wildfires in the Amazon rainforest region, especially Venezuela.[20] Even a rainwater catchment basin caught fire in Mexico City due to dried-up vegetation.[21]

Conclusion

There are many droughts occurring across the globe right now, with some of the most severe being noted here. In addition to a drop off in the precipitation for these areas, irregular timing and increased demand for water can cause drought conditions, even if it does not show up in graphs such as the ones displayed here.

The droughts currently happening will potentially have worldwide consequences such as increasing prices, increased demand for water resources, decreased economic production, and potentially migration in the most extreme circumstances.

[20] See footnote 6.
[21] See footnote 6.

Appendix: Data Extraction

Data for the graphs have been provided on the SOA website where this report is published. Below details how the graphs using GHCN data was created.

1. Data was pulled from the website, namely, the 3GB+ file ghcnd_all.tar.gz from https://www1.ncdc.noaa.gov/pub/data/ghcn/daily/ .

2. The ghcnd-stations.txt file was also pulled.

3. The ghcn-weather-data-analysis.xlsm tool (published with this report) was used to automatically convert the data into a usable format by pointing to the folders containing the data.

4. Tab "4 Select Geographic Region" was used to find the nearest weather stations to the coordinates corresponding to key areas mentioned in the NOAA report.

5. Once a station with a fair amount of data available (typically 75%+ complete data for the time period desired), the code corresponding to that station was input into "3 Fetch Data for One Station" and run to get all daily data for that particular station.

6. This data was pasted into an additional workbook where I totaled the monthly precipitation observations and created a table below the copied data. This data was the basis for graphs that eventually were used in this report.