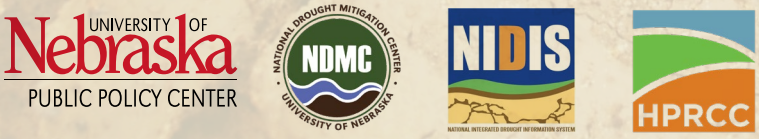
Drought Context



Introduction to Drought and Why Does it Matter

THE BASICS OF DROUGHT

Drought is a complex natural phenomenon that is difficult to define and understand. In its most general sense, drought can be defined as a deficit of expected water availability, resulting in water shortages for some activity or group. Unlike aridity, which describes a climate with permanent dryness, drought is a relative term based on a departure from expected precipitation that can occur in all climates and regions. Thus, differences in expected precipitation and water availability mean that drought conditions in Tucson, Arizona would not be the same for Atlanta, Georgia.

Definitions of drought can also vary by sector depending on the impacts of precipitation deficiencies. Sometimes it is helpful to categorize drought into several component based on its impacts.

TYPES OF DROUGHT:

- **Meteorological drought**: Deficiencies in precipitation based on normal conditions.
- **Agricultural drought**: Low soil moisture that leads to reduced crop production.
- **Hydrological drought**: Decreased surface water or groundwater levels.
- **Socio-economic drought**: Social or economic impacts resulting from meteorological, agricultural, and/or hydrologic drought.
- **Ecological drought**: Lack of water availability in the natural environment that stresses ecosystems.

Photos above courtesy of *Drought Impact Reporter*.

Compared to other natural disasters, the uniqueness of drought challenges traditional risk management approaches in a variety of ways. For example:

1. **Definition**: Drought has no universally accepted definition. As discussed above, drought can be described in terms of where water shortfall is occurring. This presents a challenge for officials because sometimes drought impacts might be happening in some location or sector but not in others.
2. **Timeframe**: The onset and end of drought are difficult to determine, and scientists and policy makers may have different criteria for determining the onset or end of a drought. Drought can also take place over long time periods, such as months to years, leading to long periods of reduced water availability and uncertainty about when a drought will end (NDMC 2018a).
3. **Impacts**: Drought impacts are frequently spread over a large geographical area, and may take weeks, months, or even years to manifest because the effects of reduced water availability do not happen instantaneously (NDMC 2018a), and are often less obvious than other natural hazards that cause structural damage.
4. **Frequency**: Policy makers often view drought as a rare, random phenomena rather than a normal part of climate. This view of drought promotes the notion that droughts are low probability, whereas in reality droughts are certain to occur. When drought is recognized as a normal part of climate, communities will be more likely to prepare for it.

5. **Management:** Responsibilities for managing and protecting water resources across political boundaries may be shared among different levels of government. When drought occurs, confusion can quickly develop between different jurisdictions and agencies responsible for overseeing and managing remaining water supplies if there is no plan for "who is responsible for what" before a drought begins.
6. **Exacerbation due to human activities:** As with other hazards, human development can exacerbate losses during a drought event. Drought is strongly tied to human activity because increasing water demands (irrigation and municipal uses) and changing landscapes (deforestation and expansion of impervious surface) both directly change water availability, resulting in exacerbated impacts during drought events (Van loon et al. 2016).

DROUGHT IMPACTS

The reduction of available water during a drought can lead to both direct and indirect impacts.

- **Direct impacts** occur as an immediate result of reduced water availability. For example, low soil moisture can result in decreased agricultural production, or low stream flow can cause reduced hydropower generation.
- **Indirect impacts** occur as a consequence of a direct impact, or result from a series of interrelated phenomena. These are also known as secondary impacts. For example, a drought may directly result in a reduction of crop yields. Crop losses may then cause job and business losses in agriculturally-based communities,

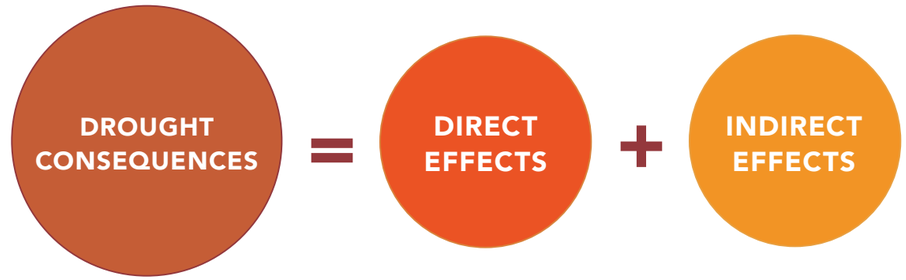


Figure 1: The nature of drought impacts.

leading to further impacts such as stress or depression among community members. Because of drought's spatial and temporal effects, these indirect impacts can ripple through local and regional economies more than other natural disasters.

Because it may be easier to quantify direct losses caused by natural hazards than indirect losses, it can be difficult to identify all of the impacts that take place during a drought. For example, the National Center for Environmental Information's (NCEI) billion dollar disasters list, from 1980 to present, shows that drought is the second costliest natural disaster in the US after tropical cyclones in terms of monetary losses and loss of life (NOAA NCEI 2018b). However, these losses primarily are due to agricultural losses, a direct impact of drought. If all the cumulative direct and indirect impacts were considered, the monetary losses of drought would likely be substantially higher.

An example of the relationship between direct and indirect impacts is shown in the above figure (see Figure 1).

Drought impacts are not always negative. For example, a well-drilling business might receive more business due to increased demands for wells, or natural resources managers may have opportunities to conduct wetland restoration activities during a drought.

DIRECT IMPACTS:

- **Reduction of available water leading to:**
  - Decreased agricultural production.
  - Decreased economic activity.
  - Damaged water supply infrastructure (such as dams, pumps, or piping) due to reduced water flows.

INDIRECT IMPACTS:

- **Water Quality**
  - Reduction in available water negatively impacts the quality of remaining water, causing further reductions in water supply for municipal, hydropower, or environmental uses.
  - High temperatures that often accompany drought negatively impact water quality for aquatic life, further stressing natural ecosystems.
- **Socio-economic Impacts**
  - Reductions in economic output
  - Disruption of daily-life due to lack of available water
- **Heatwaves**
  - Injuries or deaths caused by excessively high temperatures.
- **Power / Electricity Generation Reduction**
- **Environment**
  - Negative impacts on vegetation, fauna, and other natural ecosystems.
- **Wildfires**
  - Increased dry conditions causing greater risks of wildfires.
- **Public Health**
  - Wildfires can reduce air quality, causing respiratory problems for individuals with asthma or pulmonary conditions.
  - Reduced water availability may cause water to "pond," providing more breeding areas for mosquitoes that carry vector borne illnesses such as West Nile Virus.

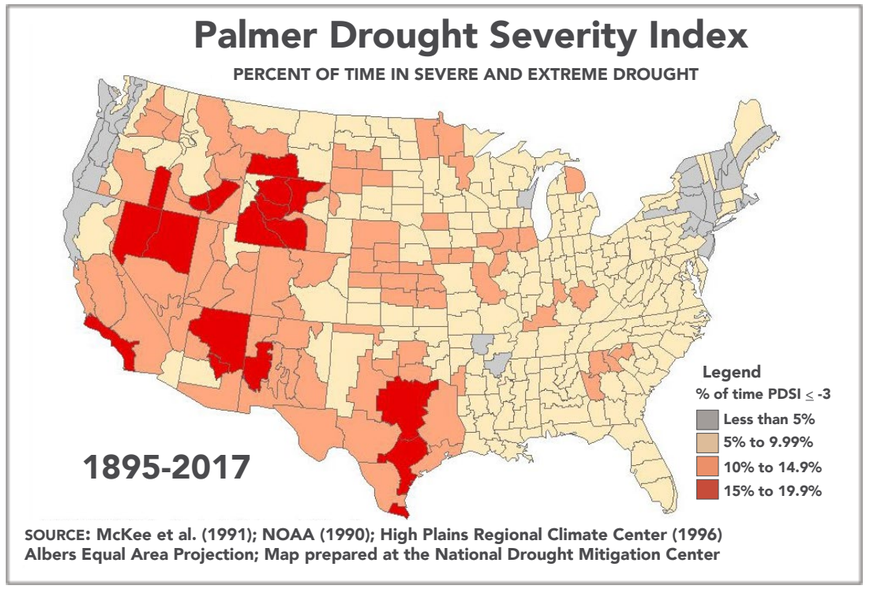
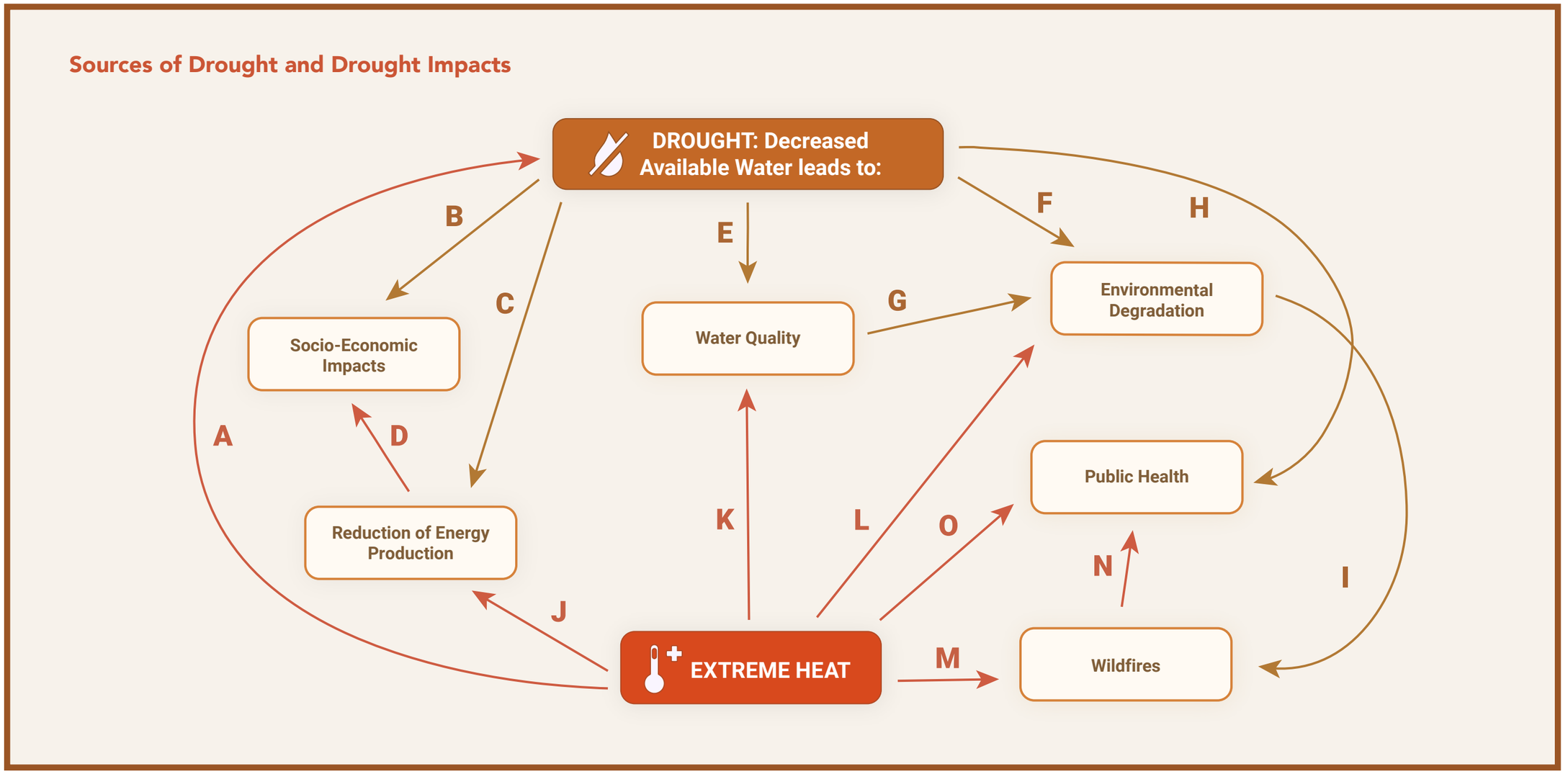


Figure 2: PDSI Percent of time in severe and extreme drought (NDMC).

Historical Drought

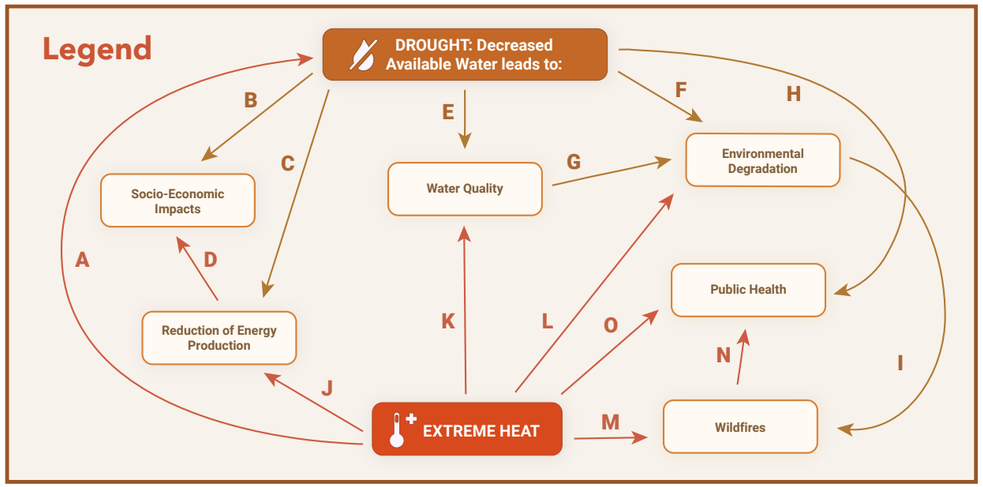
Drought is a natural part of almost every climate. One hundred-plus years of climate and drought information for the United States shows us that drought severity, in terms of magnitude and longevity, is not equally distributed across the United States. Some regions of the country encounter drought more frequently than others (NOAA NCEI 2018a; NOAA NCDC 2018; NDMC 2018a) (Figure 2). This historical data (1895- present) has been used for decision making for current water management, hazard mitigation, and drought planning efforts across the nation (Milly et al. 2008). Drought information on the national, state, or climate division scale can be found at the websites attached to these citations (NOAA NCEI 2018a, 2018b; NDMC 2018a).

Although many planning efforts are based off historical climate and drought information since 1895, the climate is not static and changes over time. Climate histories reconstructed from tree rings, lake sediments, and sand dune composition and occurrence suggest that the United States has experienced longer lasting and more severe droughts than have happened in the contemporary historical (instrumental) record. For example, droughts occurring from A.D. 900 to 1300 in the Midwest, Southern Plains, and West, generally lasted for decades (Bathke et al. 2014). This also holds true for the "water rich" southeastern region of the United States, where proxy data indicates that longer and more severe droughts also lasted from three to five years (Pederson et al. 2012; Seager et al. 2009).



These findings, combined with climate change projections of increased temperatures and higher rates of evaporation, suggest that longer and more severe droughts are a realistic possibility in the future. Social factors such as increased population and land use changes will likely exacerbate the effects of future drought, making it crucial for planners to prepare for extensive periods of decreased precipitation, higher temperatures, and longer droughts.

Figure 3: Sources of Drought and Drought Impacts. Diagram Legend on pages 10–11.



A: Extreme does not cause drought, however, it is usually coupled with drought, in which higher temperatures lead to higher evaporation rates. Furthermore, higher temperatures can lead to higher water consumption rates for cooling purposes. Both of these factors induced by extreme heat can exacerbate drought impacts.

B: Drought can have social and economic impacts because the lack of water can reduce economic output and disrupt people's daily lives.

C: Reduced water supplies may leave energy providers without enough water to produce sufficient energy / electricity to meet demand.

D: Reduction of energy / electricity output can lead to more socio-economic impacts leaving industries, business, and the general public without power during certain times of the day. This can lead to more economic reduction and disruption of daily life

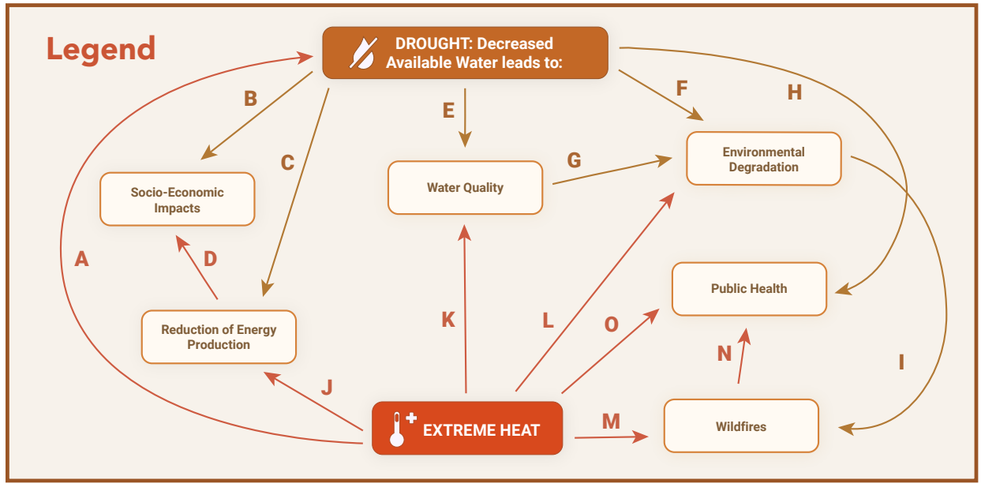
E: The reduction of available water causes the remaining water to be more susceptible to impairment.

F: Drought can also lead to environmental degradation when the environment (both flora and fauna) does not have enough water to sustain various ecosystems.

G: Reduction of water quality can also impact the environment, in which impaired waters may have lethal impacts to both flora and fauna.

H: Decreased water availability can lead to "ponding" where water becomes stagnant. This becomes a perfect breeding ground for mosquitoes, which can lead to an increase in vector borne diseases (such as West Nile Virus), causing public health to decline.

Drought Context - Drought Impact Diagram Legend



I: Environmental degradation, specifically vegetation death can provide fuel for wildfires, increasing the chances for wildfire occurrence.

J: Extreme heat can increase energy needs due to higher usage of Air Condition. Higher needs along with lower water available to create energy can lead to a decrease in energy production.

K: Higher temperatures can cause water temperatures to increase, which a water quality issue. If water temperatures increase too much, it can cause aquatic life to die.

L: Extreme heat can be detrimental to environmental health, in which flora and fauna can not survive due to increased maximum temperatures or exposure to extreme for a long period of time (days to weeks).

M: Extreme heat can lead to increased chances of wildfires due to higher evaporation values, resulting in drier conditions, providing more "fuel" that can be ignited and burned.

N: Wildfire have the potential to cause public health problems. The smoke from wildfires can cause respiratory issues (insert spatial extent), specifically for people with Asthma, COPD, or other respiratory impairments.

O: Extreme heat can have a direct impact on public health as heat exhaustion and heat stroke can become prevalent, specifically to the elderly, the very young, and populations that do not have access to air conditioning.

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