Quantifying The Drivers and Impacts of Natural Disturbance Events – The 2013 Colorado Floods

The 2013 Colorado Front Range Flood

- https://youtu.be/IHIckvWhwoo

Why was the Flooding so Destructive?

- Why might this storm have caused so much flooding?
- What other weather patterns could have contributed to pronounced flooding?

The St. Vrain River in Boulder County, CO after (left) and before (right) the 2013 flooding event. Source: Boulder County via KRCC.

Introduction to Disturbance Events

- **Definition:** In ecology, a **disturbance event** is a temporary change in environmental conditions that causes a pronounced change in the ecosystem. Common disturbance events include floods, fires, earthquakes, and tsunamis.

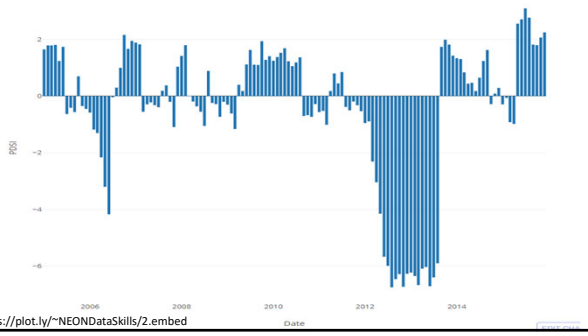
- Ecological communities are often more resilient to some types of disturbance than others.
- Some communities are even dependent on cyclical disturbance events.

Driver: Climatic & Atmospheric Patterns

Drought

- How do we measure drought?

- **Definition:** The **Palmer Drought Severity Index** is a measure of soil moisture content. It is calculated from soil available water content,precipitation and temperature data. The values range from **extreme drought** (values <-4.0) through **near normal** (-.49 to .49) to **extremely moist** (>4.0).



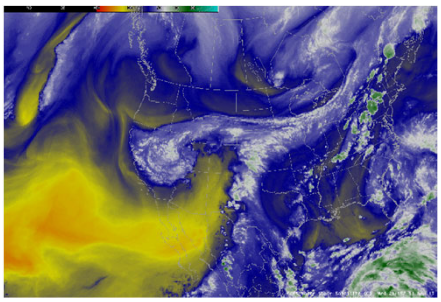
https://plot.ly/~NEONDataSkills/2.embed

Questions

Use the online figure to answer these questions:

- In this dataset, what years are **near normal**, **extreme drought**, and **extreme wet** on the Palmer Drought Severity Index?
- What are the patterns of drought within Colorado that you observe using this Palmer Drought Severity Index?
- What were the drought conditions immediately before the September 2013 floods?

Atmospheric Conditions

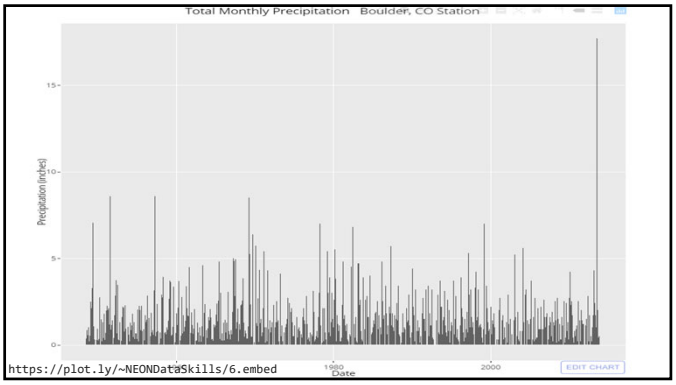


This animated loop shows water vapor systems over the western area of North America on September 12th, 2013 as recorded by the GOES-15 and GOES-13 satellites. Source: Cooperative Institute for Meteorological Satellite Studies (CIMSS), University of Wisconsin – Madison, USA

Driver: Precipitation

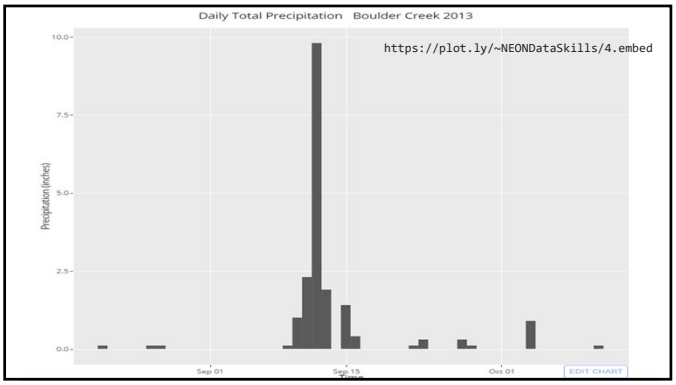
How do we measure precipitation?

- **Definition:** Precipitation is the moisture that falls from clouds including rain, hail and snow.



Notice the general pattern of rainfall across the 65 years.

- How much rain generally falls within one month?
- Is there a strong annual or seasonal pattern? (Remember, with interactive Plotly plots you can zoom in on the data)
- Do any other events over the last 65 years equal the September 2013 event?

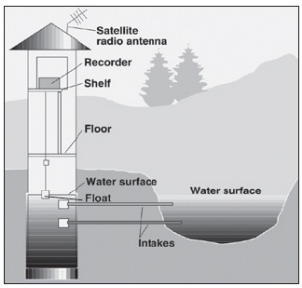


Explore the data and answer the following questions:

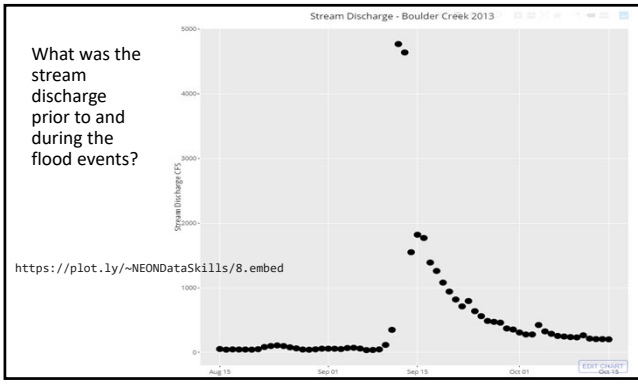
- What dates were the highest precipitation values observed?
- What was the total precipitation on these days?
- In what units is this value?

Driver: Stream Discharge

- **Definition**: Stream discharge is a metric which quantifies the volume of water moving down a stream.
- Measured by streamgages



What was the stream discharge prior to and during the flood events?



Impact: Flood

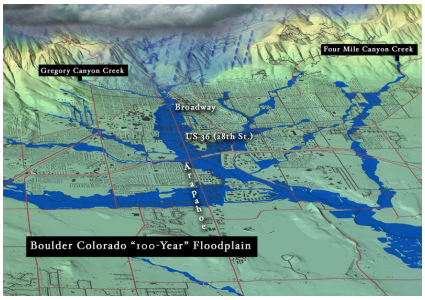
- **Definition:** A **flood** is anytime water inundates normally dry land.

Return Interval

- **Definition:** A **return interval** is the likelihood, a statistical measurement, of how often an event will occur for a given area.

Flood Plains

- **Definition:** A **flood plain** is land adjacent to a waterway, from the channel banks to the base of the enclosing valley walls, that experiences flooding during periods of high discharge.



Impact: Erosion & Sedimentation

How can we evaluate the impact of a flooding event?

1. Economic Impacts

We could look at economic damages to homes, businesses, and other infrastructure.

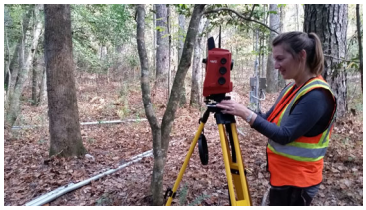
2. Before & After Photos

We could view photos from before and after the disturbance event to see where erosion or sedimentation has occurred.

https://youtu.be/bUcWERTM-OA

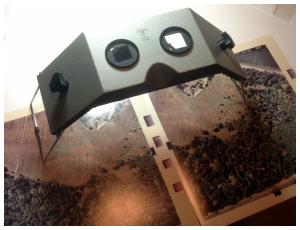
3. Field Surveys

Standard surveys can be done to map the three-dimensional position of points allowing for measurement of distance between points and elevation.



4. Stereoscopic Images

We could view stereoscopic images, two photos taken from slightly different perspectives to give the illusion of 3D, one can view, and even measure, elevation changes from 2D pictures.



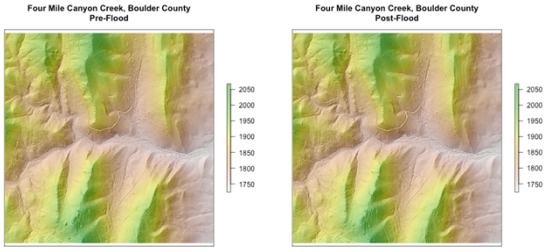
5. LiDA

A new( )AR or lidar).

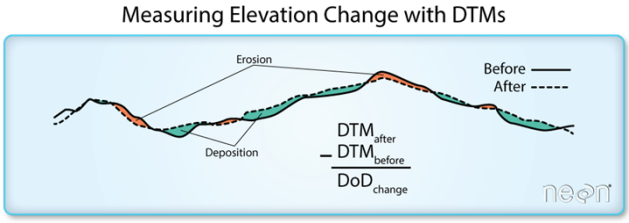
https://

- LiDAR ...surface. The g... rea is a Digita... mmon types:
  - Digital Terrain Models (DTM): The elevation of the ground (terrain).
  - Digital Surface Models (DSM): The elevation of everything on the surface of the earth, including trees, buildings, or other structures.

- **Digital Terrain Models (DTMs)**

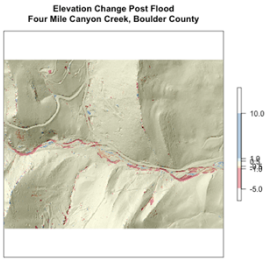


Digital Elevation Model of Difference (DoD)



Four Mile Canyon Creek DoD

- What types of disturbance events or what research question might one want to look at DoDs from Digital Surface Models?



Using Data to Understand Disturbance Events

- What other types of questions could this or similar data be used to answer?
- What types of disturbance events in your local area could you use data to quantify the causes and impact of?