EARTH SCIENCE JOURNAL for KIDS

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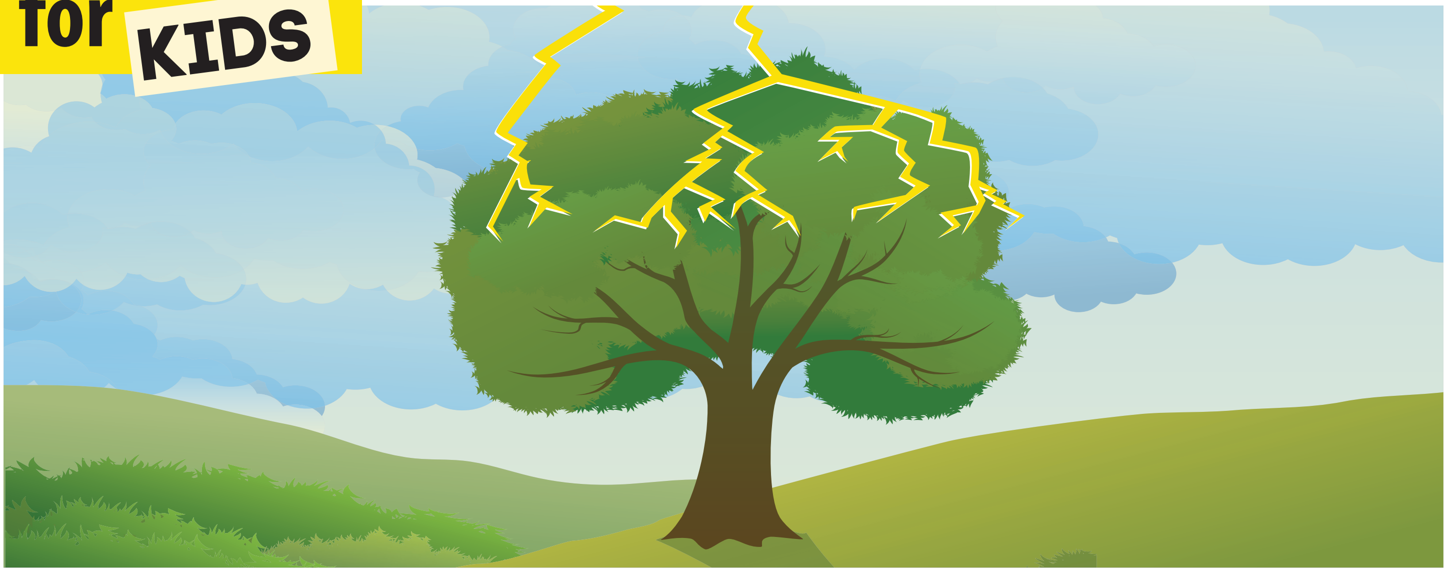
What do trees know about rain?



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Abstract

Did you know that Australia was the driest inhabited experiencing quiet a lot of rain? In fact, in some places it rained more than at any time in the past 200 hundred years! But how do we know how much it rained in the early 1800s? At that time the Brits had barely just started colonizing the continent! They definitely didn't bother setting up rain gauges!

The answers come from the trees! By taking a core from old native trees and carefully studying the annual tree rings, scientists can work out how much it rained in 1802! What's more important, though, is that in some parts of Australia the last two decades turn out to be unusually wet compared to the previous two centuries. In the one hundred and ninety years from 1800 to 1990 there were only two years when it rained more than 20 inches. By contrast, in four out of the past 20 years alone, it rained that much (and more). What is causing this?

Introduction

Australia is not tiny and consequently local climate varies from one place to the next. In this study, the scientists collected data from the northwestern region. It's an arid area away from the sea. The typical local climate consists of prolonged drought periods interrupted by a couple of very wet years. When variability is the norm, though, how can we tell if a few wet years back to back are an exception or part of a natural cycle?

The only way to answer this question is to compare recent rainfall data to long-term trends. But we only have instrumental rainfall data (i.e. collected with rain gauges) for the last 100 years. This is not enough. Instead of relying on direct measurements, scientists use a work-around. We know that trees add a tree ring to their stems every year. The width of this ring, however, varies from year to year depending on how much water was available for tree growth. If it rains a lot in a year, the tree grows relatively fast and

ends up with a fat tree ring. If there isn't much precipitation in a given year, the tree doesn't from much and adds only a skinny annual tree ring. Scientists often use indirect information such as the width of tree rings to infer data about annual rainfall. We call such data sources a "proxy".

Methods

Sample collection & chronology

The perfect trees for this study turned out to be cypress pines (*Callitris columellaris*) – common and native to Australia. These pines have shallow roots and no access to groundwater so their growth completely depends on rainfall.

Fortunately, scientists don't have to cut them down in order to "see" the annual tree rings. Instead, they use a corer – a metal drill with a diameter of a straw. They sink it through the tree bark of a standing living tree all the way to its center and extract a sample of the tree tissue, which shows all the tree rings. For this study, they used 40 such cores from 27 different trees. No trees were killed for this study.

The next step is to develop a chronology – a time sequence of all the years for which we want to calculate rainfall data. The oldest trees in the sample were more than 200 years old, so scientists could start the chronology at the beginning of the 19th century. From the width of all the tree rings, we infer how much more it rained in, say, 1824 relative to 1823. But how do we know how many inches of rain this equates to?

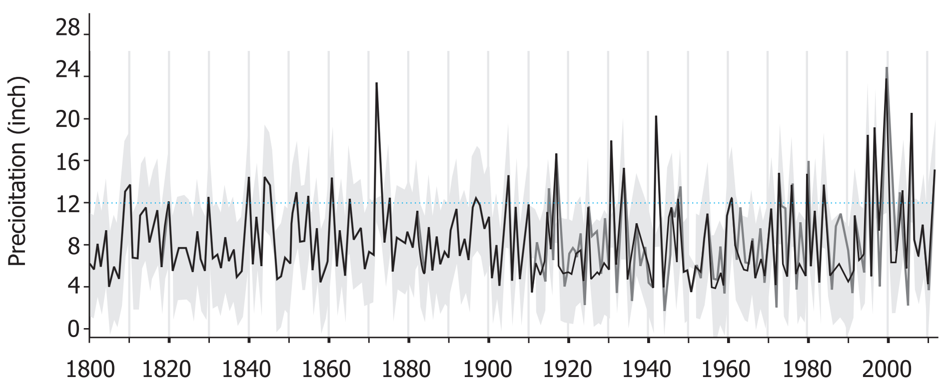
Precipitation data & reconstruction

We do have some rainfall data from rain gauges we've set out since 1910. (You can download the data yourself from Climate Explorer: http://climexp.knmi.nl/) We can take these precipitation data and overlay them with the tree ring widths since 1910.
If the rain gauge measurement for, say, 1940 was 10 inches and the tree ring for that year was ¼ of an inch fat, than we can infer that 1/8 of an inch tree ring in 1880 means there were 5 inches of rain that year (even if no rain gauge was available at that time). Using this principle, scientists are able to reconstruct precipitation data since 1802.

Results

The last two decades (1995-2012) have been unusually wet. The average wet season precipitation was 12.2 inches compared to an average of 9 inches for the previous two centuries. In fact, five of the ten wettest years in the past century occurred in the last two decades (1995, 1997, 1999, 2000 and 2006).

The tree ring data demonstrated a long-term rainfall pattern of droughts lasting 10-30 years followed by 5-10 wet years. Twenty consecutive wet years is indeed an unprecedented event.



Rainfall over northwest Australia in the past two centuries. The black line indicates precipitation reconstructed from tree rings. The gray line after 1910 indicates precipitation measured directly with a rain gauge.

Discussion

Scientists have been trying to figure out why it has been raining so much lately. They looked for causes such as air pollution coming from Asia (pollution particles can seed rain clouds), El Niño Southern Oscillation and the Antarctic Ozone Hole. None of these events could fully explain the rainfall pattern.

The best explanation for the abnormally high rains is a recent anomaly in sea level pressure and wind patterns in the Southern Ocean – one example of climate change. As we continue to burn fossil fuels and increase the concentration of greenhouse gases in the atmosphere, this anomaly will most likely continue. As a result, the scientists expect that the rainfall in northwest Australia will also continue to increase.

Conclusion

Climate change causes weather extremes such as floods, droughts and wildfires. People have always had to face such events and adapt to them. The problems begin when he change is too sudden for us to adapt.

Farmers, for example, completely depend on predictable weather. How otherwise would they know when to sow, water and harvest their crops? Extreme weather makes activities such as timber cutting, mining and building difficult or even impossible. Insurance companies have to charge homeowners higher house insurance to make up for the higher risk of fire or flood. Droughts and floods threaten our water supply and the cleanliness of the available water. Climate change potentially touches all people's lives, not just those of Aussies in Western Australia.

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TEACHER'S GUIDE

Grade level: 9-10
Key terms: rainfall, Australia, tree rings, proxy data, climate change

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Glossary of Key Terms

- **Precipitation** - rainfall. Scientists usually measure it in millimeters (or sometimes inches) per year.
  E.g. The average annual precipitation in Northwest Australia is 200 mm.
- **Proxy data source** - indirect source of data which scientists use when direct measurements are not available.
  E.g. Annual tree rings are a proxy for precipitation data.
- **Data reconstruction** - inferring data from proxy data sources for a time period for which direct measurements are unavailable.
  E.g. Scientists reconstructed the precipitation data for the 19th century based on tree rings and 20th century rain gauge measurements.
- **Tree ring chronology** - a time sequence of events based on annual tree rings.
  E.g. Based on the tree ring chronology, scientists can see a big drought 45 years ago followed by a forest fire 43 years ago.
- **Core** - a long narrow sample of tree tissue extracted from a living tree with a metal straw-like drill.
  E.g. Scientists collected two cores from each tree.