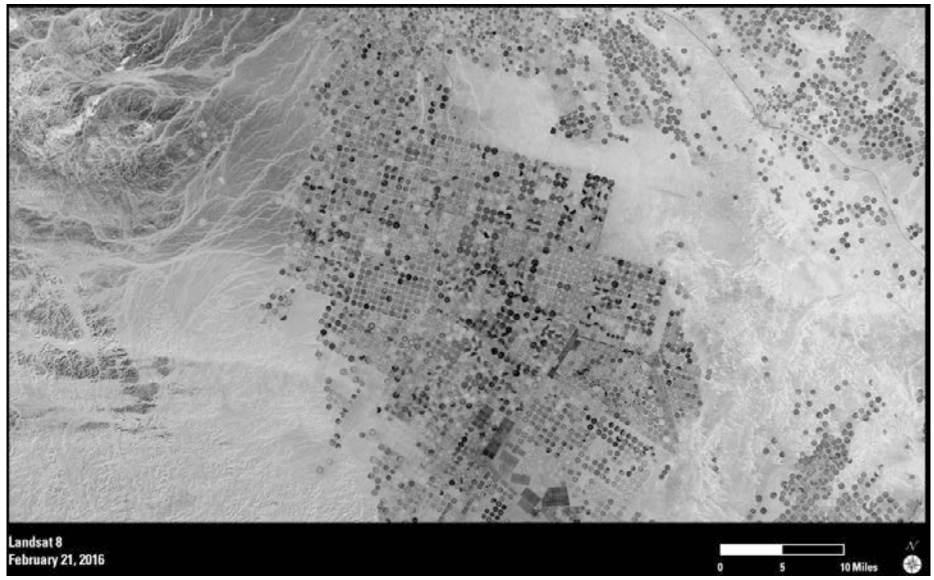
EarthDate

Fossil Water



This 2016 *Landsat 8* image shows vivid green wheat fields that are the product of fossil-water irrigation on the otherwise desolate Saudi Arabian desert.

Credit: USGS/NASA Landsat Program (public domain)

What exactly is fossil water?
And why have we consumed so much of it?

No, it's not a new brand of bottled water, imported from the days of dinosaurs.

Fossil water came from melting ice sheets, ancient lake systems, and a generally wetter climate tens to hundreds of thousands of years ago.

It percolated into porous rocks, which were then buried under deep layers of sediment, where it was sealed off from the surface, and there it stayed.

Until farmers discovered it. And in the second half of the 20th century, they started drilling wells into fossil aquifers and pumping like mad, turning sunny dry places into acres and acres of green farmland.

Crop supplies boomed. Food became cheaper and more plentiful, grown in formerly parched places like California and Kansas and shipped around the world for people like you and me to eat, ingesting fossil water with it.

The trouble is, fossil water is a finite resource, and new studies suggest that many fossil aquifers may become depleted this century, so that we won't be able to rely on them any longer.

This could mean that the crops that depend on them could become less plentiful and more expensive again.

All the while, population will likely increase. The climate will likely warm. Our demand for water will continue to climb.

Which means we'll have to adapt to the lack of fossil water just as we adapted to its discovery. This time with more efficient crops and farming methods—and more efficient use.

Bureau of Economic Geology

Background: Fossil Water

Synopsis: Fossil water is water that was trapped in ancient rocks eons ago, when surface conditions might have been much different than today. After burial, these deep aquifers retained their fresh or saline water for many millennia. Today, deep wells are drilled into some of these reservoirs to extract water for our use on the surface. But how long will the supply last?

- Fluids like water can flow through cracks or spaces between grains that make up a rock.
  - The amount of open space within a rock is called *porosity*, and the amount of connectivity between the spaces in a rock is called *permeability*.
  - Porosity allows water to be stored in a rock, and permeability allows water to move from pore to pore.
  - You may have seen permeable sand soak up water on a beach.
  - Many sedimentary rocks—like sandstones, limestones, and especially chalk—will soak up water. Try weighing them both wet and dry and note the difference.
- The pores of rocks below the soil layer are usually filled with water, like a sponge.
  - In hilly areas where rock layers may be exposed at the surface, water may flow out of the rock to form springs, especially when it rains.
  - Other rock layers, called *aquifers*, get buried deeper and deeper, and their water gets buried with them.
  - Some aquifers are recharged if part of the rock unit is exposed at the surface, allowing rain and surface water to slowly seep into its pores.
  - Some limestone aquifers may recharge very rapidly through karst systems, which are characterized by undulating topography, caves, and springs.
- Rock layers near Earth's surface in past geologic times but now buried deep below the surface—cut off from direct recharge—are called *fossil aquifers*.
  - Layers that contain fresh water are precious and rare—and may become more valuable than fossil fuels in the future because humans can't live without potable water.
  - Fossil groundwater—generally thought to have percolated into aquifers during the Pleistocene and Holocene (about 40,000 to 10,000 years ago)—is often associated with the melting of ice after the Last Glacial Maximum.
  - Fossil water can be dated using stable isotopes of hydrogen and oxygen.
- Fossil freshwater is a finite resource, just like anything else we mine from Earth.
  - We don't know how much ancient water there is, but when we pump water from fossil aquifers we can measure pressure drops that indicate volume decreases.
  - Water from some fossil aquifers requires treatment because contamination occurs from natural radioactivity and minerals that concentrate over the ages as water percolates through the sandstone grains.
  - Brackish and saline aquifers are very common deep in the subsurface but unless desalination occurs, they can't be used for human consumption. Many of these aquifers are used for waste disposal.
  - Fluids such as fossil fuels filling the pores in ancient rock layers is usually associated with salt-water reservoirs.

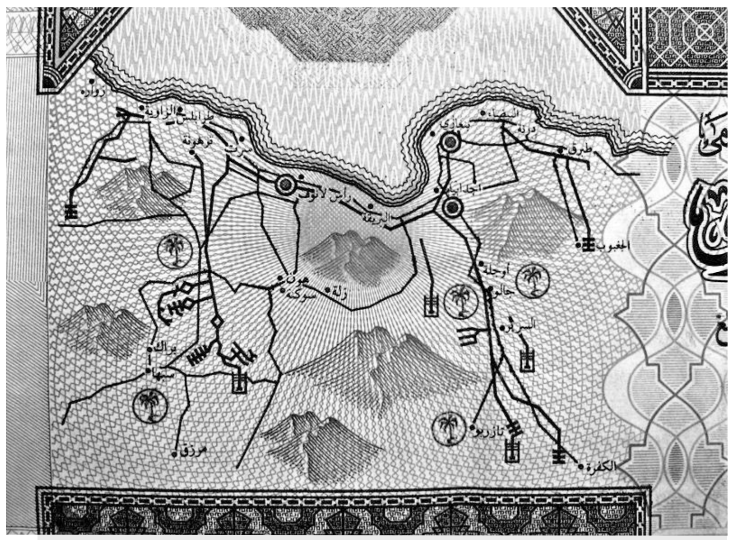
References: Fossil Water

Fossil Water | Wikipedia
Fossil Aquifers | WOCATpedia
As Groundwater Dwindles, a Global Food Shock Looms | National Geographic
EarthView–Saudi Wheat Experiment Relied on Fossil Water | USGS
Parched: Global Water Wars | National Geographic

Contributors: Dr. Bridget Scanlon (UT Austin Bureau of Economic Geology), Juli Hennings, Harry Lynch

Background: Fossil Water

- People of many regions rely upon ancient freshwater that was stored deep in the earth during wet periods in the geologic past. And not just for drinking water—global food staples like rice and wheat are very thirsty crops that depend on fossil aquifers in Africa, Europe, North America, and Asia.
    - In North Africa, water trapped up to 75,000 years ago when the climate in the region was humid was covered by the sands of the Sahara as climate shifted.
        - The availability of fossil water in the Nubian Aquifer System enabled Libya to develop a huge water-pipeline infrastructure system, called the *Great Manmade River*, to deliver water from the desert to population centers such as Tripoli, Sirte, and Benghazi.
            - With increased water and agriculture available, these cities have grown and require even more water than before.
    - In Saudi Arabia, governmental experiments at becoming food self-sufficient by growing wheat in the desert relied on deep aquifers of the Arabian Peninsula.
        - These experiments were abandoned, however, because water pressure in the aquifers indicated they could not support the extraction intensity required to farm in the desert.
        - The country now depends on food imports from global markets to feed its citizens and is buying up fertile lands in other countries for farming.
    - In the southern part of the High Plains, the Ogallala Aquifer beneath Kansas, Oklahoma, New Mexico, and Texas contains water that was stored in alluvial deposits after the Last Glacial Maximum.
        - Modeling projections show that intensive pumping for farming is causing depletion that may limit deposit productivity to just 30–50 more years.
- As water rights become more important, cross-border management of fossil aquifers will become critical. Scientists use satellite-based technologies to estimate and track changes in groundwater volumes.
    - Some methods look for changes in irrigation and crop patterns (European Space Agency [ESA] Aquifer project).
    - Some look for millimeter-scale surface subsidence indicating water withdrawal (ESA Aquifer project InSAR).
    - Some use changes in Earth's gravitational field to look at changing masses of water below Earth's surface (NASA's GRACE project).
    - Many global regional studies document over-extraction of groundwater.



Map of the Great Manmade River water project in Libya as seen on the 20-dinar currency.

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