Desert Water

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Joshua Tree National Park

Suggested Grade Level: Junior and Senior High School (7^{th}-12^{th})

Time Required: Two-three class periods

Materials and Technology Needed: Internet access, 4 glass beakers or jars, sand, gravel, water, water siphon or similar device, 2 coffee filters

Files Needed: surface water of Joshua Tree National Park, groundwater of Joshua Tree National Park, student worksheet

Safety Considerations: n/a

Background:
There is a saying in the desert about water; “Water is more precious than gold.” In the desert, water is the center of life. Everything waits for the water. Although many envision it as a wasteland where nothing grows, the desert is very much alive. With just a small amount of water, the desert seems to come to life with plants that looked dead, blooming with lush green leaves and flowers. In a wildflower bloom year precipitated by high fall and winter rains, visitation to Joshua Tree National Park hits its highest (JTNP, visitation stats). The desert comes alive.

The park is located in the transition zone of two deserts: the high Mojave Desert of Joshua trees and rock formations, and the low Colorado Desert, a subsection of the Sonoran Desert.

The Mojave Desert receives on average approximately 4 inches of rain a year. While many consider a place that receives less than 10 inches of rain a year a desert that is only part of the definition. A better definition would be a place where evaporation exceeds precipitation (Desert USA, and other sources). The Colorado Desert, a subsection of the Sonoron Desert, receives less than 4 inches per year. In both places evapotranspiration is very high. The water is evaporated from surface and ground water, plants, animals, anything that is alife (JTNP).

The Southwestern Deserts of the United States have a huge amount of groundwater. Most of this is due to the geology of the region. The deserts are considered rain shadow deserts and as such have various mountains that receive rain. This rain is moved down the mountains into aquifers beneath the deserts (USGS, USBR). The Mojave and Colorado deserts sit on some of the most active fault zones in the world. They are sliced by various faults that create sub-basins that are interconnected (USBR, USGS). Use of one sub-basin affects the others.

Water in Joshua Tree National Park
Water in Joshua Tree National Park comes from many sources fed by underground aquifers. There are 200 surface water sources. (Water quality report, JTNP) that include springs, oases, ephemeral streams or washes. On top of this, there are several man-made lakes created by various dams and tanks like Barker Dam and several water guzzlers. The park has several aquifers that are recharged from run-off from the monsoon season, fall and winter rains, and snow melt of the nearby mountains ranges (USGS). These basins reach outside of the park and are used by the local communities surrounding the water. These water sources help to maintain the health of the desert

habitat within Joshua Tree National Park. Many of the plants and animals are well-adapted to survival in an arid land. See Joshua Tree National Park website for additional wildlife adaptations.

Use of groundwater

The aquifers in and around Joshua Tree National Park are used by the various communities surrounding the park like Twentynine Palms, Joshua Tree, Yucca Valley to the north and Palm Springs, Desert Hot Springs, and Indio to the south. The communities to the north of the park draw much less water per year than the communities to the south. Joshua Basin Water District, which serves the community of Joshua Tree, uses 65,000 gallons per capita per year (USBR). This is compared to the Victor Valley Water District which uses 100,000 gallons (USBR). All of the communities use recharge from either the California Water Project to the north or the Colorado River Aqueduct to the south to recharge the basin.

Recharge means most of the communities have overdrawn on their current water. Simply said, overdraft refers to using more water from ground than is naturally recharged back into the system. In order to be able to continually withdraw from the aquifers, they must be artificially recharged (USGS, JBWD, TPWD, MSWD, CVWD). The aquifers are connected sub-basins and are mainly separated by fault lines (USGS).

Often when a draw-down happens in one area, there is a small draw-down in a closely related sub-basin. The basins are considered to be connected and what affects one, affects nearby basins (USGS and USBR).

Water quality

The quality of water in this area has high total dissolved solids, high levels of fluoride, and at times high levels of nitrate. Some of the water within the Mission Springs Water District cannot be used due to high total dissolved solids (MSWD and). Other water districts in the area have similar problems.

Overdraft and drawdown

Many of the areas around Joshua Tree National Park withdraw more water from the aquifer than is replenished naturally from runoff every year. The precipitation in the desert is very variable. Precipitation data from the park shows that rainfall in the last few years is below normal and the park is in a drought (JTNP). Much of the rainfall runoff comes from the park and other mountains surrounding the area (USGS). This rainfall runoff is what naturally recharges the aquifers. Unfortunately, it is not enough for areas like Yucca Valley and the greater Coachella Valley. (USGS)

Because demand exceeds the groundwater available, many areas buy water to recharge or supply to their customers. Several areas get water from the California State Water Project and the Colorado River Aqueduct to recharge. With the increase in population in desert regions, the demand for water was increased. Several water districts are looking at ways to reduce water usage and alternative water sources (gray water) to use for outside the home area like on golf courses. (CVWD). Many water districts are building recharge ponds and capture areas to be better able to capture the water during the rainy seasons.

Some of the areas, especially south of the park, are facing land subsistence. Land subsistence is when the water is removed from the ground and not replaced. The land then compresses down, literally sinking. Currently, several customers of the Coachella Valley Water District are suing the water district and the builders. This comes from a

USGS report on the land subsistence in the PGA West area. (USGS and *the Desert Sun*). Many communities have to buy water to recharge the aquifer they rely on. Some places that have not done this, like Borrego Springs, have dried up their aquifer. (*The San Diego Union Tribune*).

The town of Yucca Valley has had problems with overdraft, drawdown, and recharge. In order to recharge the aquifer, the town brought water from the California State Water Project to pump in water to the aquifer. They were successful, but a new problem arose. The added water raised the aquifer up higher and leakage from the septic tanks leaked nitrates into the water supply. The town currently is in the process of trying to build a waste treatment plant. (Hi-Desert Water District). Recharging in the rural areas can be scary. Many rural areas like Yucca Valley, rely on septic tanks which can leak nitrates into the groundwater system.

The overdraft of groundwater in the desert has far-reaching consequences. In the Amargosa River watershed, the pumping of groundwater has put the area into serious over draft. New requests for water based on housing increases in Pahrump Valley will draw down the groundwater level. The city of Las Vegas has also requested to pump for this region. The cost of the overdraft will be to the native wildlife communities. As riparian areas dry up, which is happening, unique areas in Death Valley National Park will disappear (California Fish and Game). The same could be projected in Joshua Tree National Park as populations increase in the area surrounding the park.

Essential Question: What issues surround desert ground water and how do human activities affect ground water?

Objectives and Learning Outcomes:

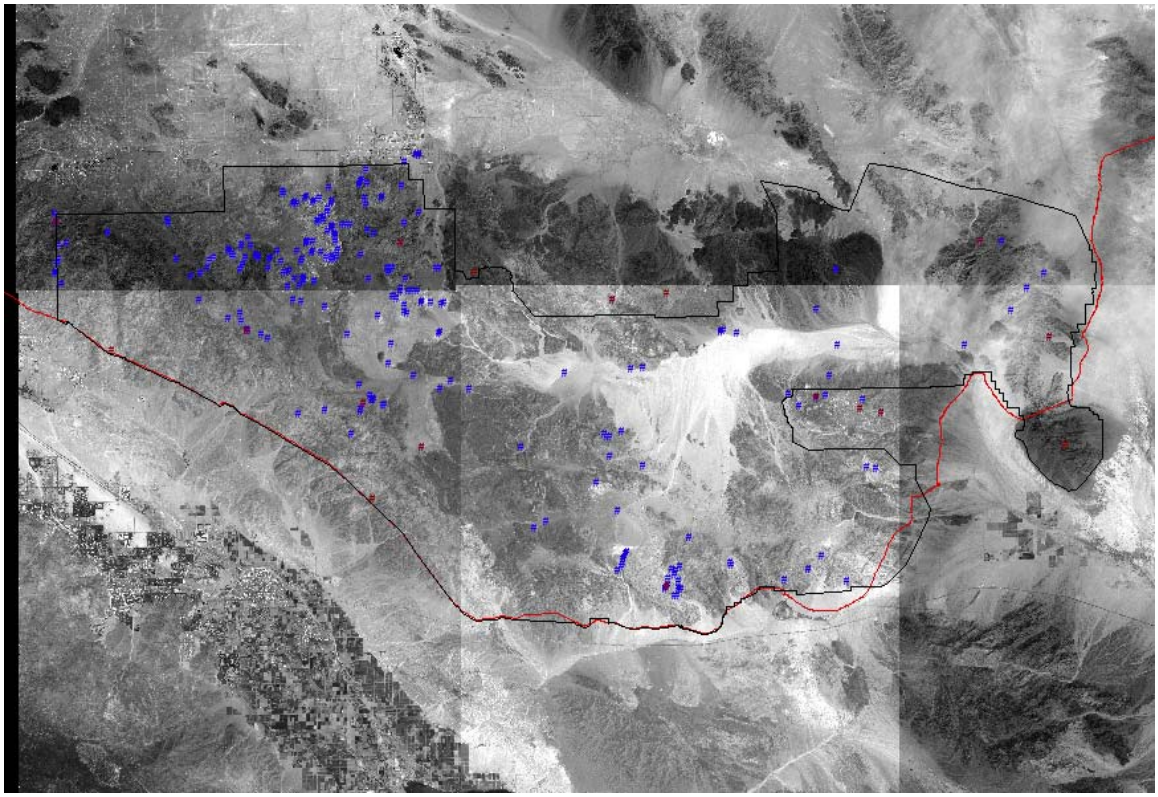
Students will be able to understand the concepts of drawdown and overdraft in desert groundwater and be able to understand how recharge can decrease this. Students will be able to speculate how this will affect the water sources, plant and animal life of Joshua Tree National Park.

Purpose: To help students understand that there are vast aquifers under the desert, but they are limited and can be affected by things humans do.

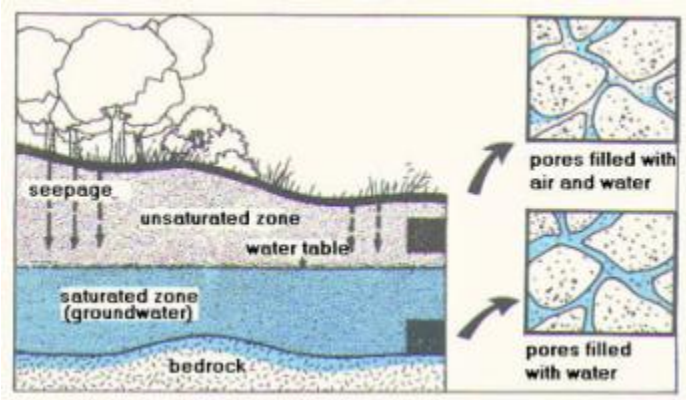
Procedure:

Start-up Questions:
Where do animals get their water in the desert?
Where do plants get their water in the desert?
Where do people get their water in the desert?

Show map of the surface water available in and around the park. Where is the water located? Lead students to the idea of ground water.



What is groundwater and what does it look like?



If desired, there are more graphics at http://www.mgtinfo.org/planningeduc0019.asp describing how groundwater works. There is also a short music video at http://dnr.metrokc.gov/wlr/wq/groundwater-animation.htm that has great graphics that shows water getting into the ground.

Show groundwater map of Joshua Tree National Park and area.

See attached PDF file. The light-colored areas are the groundwater and aquifers in and around the park. Joshua Tree National Park is most of the land located between the blue line (road) on the south and the red line (road) to the north.

Where is the groundwater located?
Who is going to use the groundwater?
How does it get to the surface for people to use?
The park is a political boundary drawn by people. Does the groundwater location fit into these political boundaries? Who can use the water?

Math activity of water uses.
Have students look at the chart below and figure out the difference between use and natural recharge of the water.

Basin or Subbasin	Amount of water withdrawn from the aquifer in acre feet/year	Amount of water recharged naturally to the aquifer in acre feet/year	Difference/ positive or negative
29 Palms Valley	1500	300	
Warren Valley	2201	330	
Copper Mountain	1100	1300	
Mission Creek	12099	6000	
Desert Hot Springs	unknown	2900	
Joshua Tree	1595	975	
San Gorgonio	9000	2100	
Indio	465,800	31000	

*based on the California's Groundwater Bulletin 118.

Is the difference positive or negative? What do these numbers tell us about the water underground?

One of the biggest problems as population increases in the desert is that more and more water is being withdrawn from the aquifers. Not all of it is being returned naturally. In order to break even, water that is withdrawn from the aquifer has to be returned. This return is called recharge.

What will happen if all of the water taken from the aquifer is not returned?

When more water is withdrawn than is being replaced it is called overdraft. What affects could this have on the plants and animals in the area?

Experiment of overdraft and land subsidence

You can do this as a demonstration with student assistance or have the students work in lab groups.

Set up 2 jars to serve as groundwater examples
1 jar has sand in it, layered with a piece of coffee filter paper, and then more sand
1 jar has gravel in it, layered with a piece of coffee filter paper, and then sand
Add water until saturated below the coffee filter paper

Explain that this is what groundwater looks like. Where is the groundwater in relation to the sand or gravel?

Add a siphon to one side of each jar to represent a well that is pumping out the groundwater. Have another jar to hold the water being pumped out.

Have students measure the height of the sand in each jar and record. Begin pumping water out. Record the levels. Continue pumping out the water. At various intervals, stop and record levels of the sand.

What happens as more and more water is withdrawn?

How does this translate to real-life situations and the drawdown on the aquifers?
What is land subsidence? Explain that when water is continually withdrawn from an aquifers with inadequate recharge to the aquifer, the land compresses and loses elevation due to the lost of water. In other words, the land sinks. Share examples of this.

If communities continue to overdraft on the aquifer, they can find that they will have to dig deeper wells or have their water source dry up. Share the example of Borrego Springs.

Based on this what are the choices to overdraft for communities?
What could communities do?
What would most people do? How do different places in the desert handle overdraft?

Artificial recharging is generally used as a way to increase the amount of natural recharge from precipitation in an area through greater increase of capture of water. Artificial recharging involved collecting more water from somewhere else and putting it into the aquifer. The sources can be better capture of water from runoff or by buying water from somewhere else.

Some communities buy water from the California State Water Project using aqueducts and pipelines to bring water from outside the desert or an area to their water supply. This water is then recharged (put back) into the ground. Others use retaining ponds to recharge the water back in the aquifer. USGS has found through recent studies, that locating retaining ponds near or in wash areas helps to increase the recharge to an area.

All of the above take place outside the park. Show groundwater map again.
Are the various groundwater sources connected or separate from each other?
Where is most of the groundwater located?
Will this affect water sources inside Joshua Tree National Park?
How does what happens outside the park affect inside the park?

What are possible solutions that would protect the water sources of the communities surrounding the park and of Joshua Tree National Park? What might be some of the consequences of water in the desert? What does this say about water sources in arid areas?

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