Measuring Earth with GPS, Unit 4: Groundwater
Activity 2 Student Exercise: Animation Questions

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In this activity, you will watch an animation that illustrates how GPS can be used to detect the changing amount of groundwater in the ground and drought severity, focusing on California. It describes the relationship between changing amounts of water and vertical ground motion.

Part 1: Animation

Watch the animation titled, *Measuring Drought Water Loss: A GPS Network Offers A New Perspective*. Watch the entire animation first, and then watch it a second time to answer the questions below. Terms you might want to look up if you do not already know them that are used in the animation include: groundwater, aquifer, drought, groundwater withdrawal, subside/subsidence, pore spaces, and recharge.

1. The four methods listed below can measure the water stored on and in Earth's crust. Circle the two methods that can specifically measure the changing amounts of water stored underground.

Satellites measure surface water changes	Effects seen in lakes and reservoirs
Water well levels	Network of GPS instruments

2. Fill in the table on the back of this page comparing GPS motion and its causes in mountains and valleys.

3. People are concerned about permanent compaction of the sediments forming the valley. Circle how the compaction of sediments closer together changes each of the following:

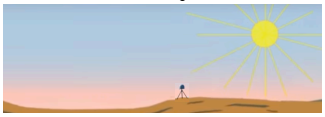
the amount of water the ground can store: increases decreases

the height of the ground: increases decreases

the size of the aquifer (useable water in the ground) in the future: increases decreases

4. Explain why sediments cause the ground height in the valley to react differently to drought compared to the ground height of bedrock in the mountains, including both natural and human-induced effects.

2. Fill in this table comparing GPS motion in mountains and valleys by circling the best answer.

	Mountains 	**Valleys** 
How is water primarily added to the area?	rain snow run off pumped out by people	rain snow run off pumped out by people
How is water primarily removed from the area?	rain snow run off pumped out by people	rain snow run off pumped out by people
What is the *seasonal* trend in ground height?	Summer: rises lowers Winter: rises lowers	Summer: rises lowers Winter: rises lowers
What *causes* this *seasonal* trend in ground height?	Snow and rain: more seasonal water adds weight and causes the surface to lower Pumping: farming pumps water seasonally from the ground which decreases weight and causes the surface to rise	Snow and rain: more seasonal water adds weight and causes the surface to lower Pumping: farming pumps water seasonally from the ground which decreases weight and causes the surface to rise
What is the *long-term* trend of ground height?	Long-term: rises lowers	Long term: rises lowers
How does drought *cause* this *long-term* trend of ground height?	Less water weighs down surface More water pumped out of ground causing compaction	Less water weighs down surface More water pumped out of ground causing compaction
2006–2016 vertical change	2–3 cm 30–35 cm	2–3 cm 30–35 cm
How was 2012–2016 different than the long-term trend and why?	Faster, due to drought Slower, due to drought	Faster, due to drought Slower, due to drought