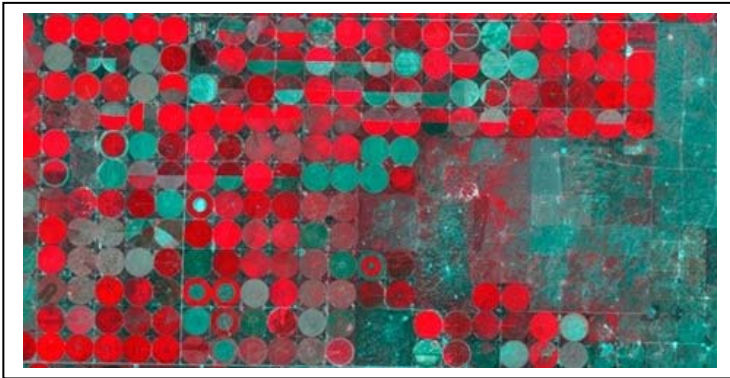


The top image obtained by Landsat in 1972 shows arid farm land near Garden City, Kansas. The dimensions of the area are 2 miles wide (East-West) by 1 mile tall (North-south). The bottom image was taken of the same area in 2011.

Center-pivot 'sprinklers' use water pumped from the sub-surface Ogallala aquifer to irrigate circular crop areas 800 meters in diameter.



Because the Ogallala aquifer recharges from new rainwater slowly, some of the water used to irrigate these fields is actually water that's been trapped underground since the last Ice Age. Even with the rise of water-conserving center-pivot irrigation and other efforts to conserve, this aquifer is slowly going dry.

Problem 1 – Farmers measure crop areas in acres. If the radius of one crop circle is 400 meters, and $1 \text{ acre} = 4047 \text{ meters}^2$, what is the area of a single irrigation circle in the Landsat images? (Use $\pi = 3.14$).

Problem 2 – How much additional acreage was irrigated in 2011 compared to 1972?

Problem 3 – Typical water application from center-pivot systems is about 8 gallons/minute per acre for corn, and suppose the irrigation is conducted for 12-hours each day for a normal 120-day growing season. How many extra gallons of water are being drawn out of the Ogallala Aquifer to irrigate the increased acreage of corn in this region of Kansas between 1972 and 2011?

Problem 1 – Farmers measure crop areas in acres. If the radius of one crop circle is 400 meters, and 1 acre = 4047 meters², what is the area of a single irrigation circle in the Landsat images? (Use $\pi = 3.14$).

Answer: $3.14 (400)^2 = 502,560 \text{ m}^2$. Then $502,560 \text{ m}^2 \times (1 \text{ acre}/4047 \text{ m}^2) = \mathbf{124 \text{ acres}}$.

Problem 2 – How much additional acreage was irrigated in 2011 compared to 1972?

Answer: Count the number of circles in each image and take the difference to get the increased number of irrigated areas. In 1972 there were 30 in 2011 there were about 189 full circles. Students may obtain slightly different numbers depending on how they count. In this example, the difference is $189 - 30 = 159$. The total acreage added is now $159 \text{ areas} \times (124 \text{ acres}/1 \text{ area}) = \mathbf{19,716 \text{ acres}}$ added to the irrigation load of this region.

Problem 3 – Typical water application from center-pivot systems is about 8 gallons/minute per acre for corn, and suppose the irrigation is conducted for 12-hours each day for a normal 120-day growing season. How many extra gallons of water are being drawn out of the Ogallala Aquifer to irrigate the increased acreage of corn in this region of Kansas?

Answer: $8 \text{ gallons/min} \times (60 \text{ minutes}/1 \text{ hour}) \times (10 \text{ hours}/1 \text{ day}) \times 120 \text{ days} \times 19,716 \text{ acres} = \mathbf{11 \text{ billion gallons}}$ of water each growing season.