PlantingScience – Agronomy Feeds the World

Key Concept: Geography and Water

Key Concept #3: Geography and Water

How do these aspects affect growth of the same crops?

Overview

Goal: To understand how geography and water quantity and quality impact food and fiber production.

Objectives:
1) To understand what an ecoregion is and how crops are impacted by weather, climate, and geography among various ecoregions.
2) To understand how water stress impacts crop production.
3) To conduct an experiment using scientific inquiry based on a water quality or quantity research question.
4) Think like a scientist: Use statistical tools to compare and graphs to summarize results. Reason about your results, and those of other groups in your classroom, to draw conclusions related to the goal of understanding how geography and water availability and quality impact food production, and the impact on mankind.

Related Concepts and Threads:
1) Ecoregion and water availability.
2) Water quantity and quality and crop production.
3) Water requirements of plants.
4) Explaining why plants are grown in some ecoregions and not others.
5) Explaining the impact of drought or flood on crops.

Key Skills:
1) Understand the concept of ecoregions and crop production differences based on climate.
2) Understand plant water requirements.
3) Understand impact of water quantity and quality on crop production.
4) Ability to conduct open scientific inquiry and draw conclusions.
5) Ability to translate guided and open inquiries into a prototype proposal or management plan.

'Juicy' Questions:
1) Ethical/political implications of the capacity of food production in low capacity ecoregions.
2) What use of water is more important: agriculture, municipal, industrial? How does land use planning help determine which need is most important?
3) How do periodic droughts (Texas in 2013, California in 2015-16) impact crop production? Prices in the grocery store?

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Questions for agronomists or farmers:

- What happens if there is a drought? Farm insurance or no profit
- Fracking – Does this affect local farms?
- Hydroponics- how does water use compare, the type of crops

Background & Resources:
A biome is a VERY large ecological area with unique *genera* of plants and animals that are adapted to the environment within that biome. Abiotic factors, such as climate, slope, geology, soils, and vegetation, contribute to the flora and fauna specific to each of the biome types. Learn more about biomes here:

https://www.oxfam.org.au/get-involved/how-schools-can-get-involved/classroom-resources/food-4-thought-2/food-4-thought-geography/worksheet-2-which-biomes-are-able-to-produce-food/

Ecoregions are smaller and more precisely defined regions within biomes. Not only does the flora and fauna define the ecoregion, but the environmental conditions, such as temperature and precipitation, and their patterns, are useful to determine ecoregions. Learn more about ecoregions with peer-review journal article reading:

http://bioscience.oxfordjournals.org/content/51/11/933.full (potential outside reading) (2 figures in this article to use)

An ecoregion is defined as a large unit of land that has a similar native flora and fauna *species* and environment. The environment is a combination of factors, such as temperature and precipitation (rain, snow, and hail fall). Distance from equator and geography impact temperature and temperature impacts the boundary of each ecoregion. Precipitation varies worldwide and also determines the boundaries of each ecoregion. In North America there is more precipitation in the east and it is reduced as you travel west. The geology and precipitation will determine soil type because soil forms from weathering of rocks (the parent material for soils), and rain and snow are big factors in how quickly parent material degrades into soil.

The type of crop grown within an ecoregion is grown there because it is adapted to the specific environment, meaning water available, temperature, and soil type. North America has several biomes including, temperate forest, temperate coniferous forest, temperate grasslands, tropical and subtropical coniferous forest, and deserts. Within the biomes of North America, there are many ecoregions (http://www.fs.fed.us/rm/ecoregions/products/map-ecoregions-north-america/). This website makes comparisons of what crops are grown in different ecoregions and how much water is needed for those crops to be produced: http://environment.nationalgeographic.com/environment/freshwater/global-water-footprint/

Water is most limiting nutrient to crop production. When plants are not adapted or weather patterns change, irrigation is required. Irrigation doubles yield and increases number of crop cycles annually, but is expensive and water use between municipal, agriculture and industrial uses must be balanced. If water is limiting to plant production, due to ecoregion or lack of irrigation, crop row spacing must be wider, which reduces the crop yield per acre. In the United States, we grow enough food to feed our population and much of the world because inputs, like irrigation and fertilizer, are readily available. In other areas of the world, drought or poor environment may cause hunger due to lack of water. Can you identify which biomes and ecoregions might be most susceptible for low crop production?

See the ASA text book for information on Balancing Water for Human Needs –comparison graph

Connection of terrestrial and aquatic biomes

Water is the most essential nutrient to life. We need water to live, both to drink and to produce food and feed. Additional demands on water to keep landscapes green, pools for summer fun, sanitary toilets, and showers add to the consumption required by humans. Quantity is not the only important aspect of water, quality is just as important. Some areas have brackish (salty) well water which reduces irrigation potential for crop production; these areas grow food 'dryland' which is risky for farmers. Fertilizer is necessary for crop production; this is highlighted in the Soil Fertility Student Guide. Farmers use soil tests to ensure they do not over apply fertilizer because over application increases the nutrient load of run off into aquatic ecosystems. Precision agriculture technology uses GPS to pinpoint where nutrients and herbicides are applied, drastically reducing the application rates and the environmental load. Residue management of crops is important to stabilize soil and increase water infiltration of rain and irrigation, and enhance water storage of the soil. Farmers are intimately aware of the importance of water conservation and they must understand the science behind how Agronomy Feeds the World in order to conserve the natural resources that they work with to produce food.

How agriculture scientists & farmers are decreasing water use

Plants that are adapted to an ecoregion based on plant tolerance to heat, cold, water requirement, and soil fertility, tend to the primary crop in the ecoregion where they are grown. That's why corn grows well in Iowa and cotton grows well in the southern USA. Within a given plant species, like corn, plants that are the most efficient at using water to produce food, feed, and fiber can be selected and bred via traditional methods or using genetically modified organism (GMO) technology. Varieties or cultivars of particular species are the result of plant breeding. While society is skeptical of GMO technology, it is an important tool in the toolbox for agronomist to continue to feed the world. When DNA is edited, some proteins (including enzymes, which are proteins) are changed while the rest of the plant remains the same. Plants bred for greater water use efficiency are typically more heat tolerant, which also expands the ecoregions where they are adapted to grow.

Production methods of even the most heat tolerant varieties or cultivars is where agronomy comes into play. The type of irrigation, such as drip irrigation or deficit irrigation, will determine the amount of water applied to a field. Agronomists work to reduce water application by testing new irrigation technology. Green water and water from fracking are newer areas of interests that may play a pivotal role in increasing water conservation.

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<u>Logistics</u>

<u>Quantity of water</u>

Soda bottle greenhouse and give plants different amount of water/number of plants in given area.
Measures:
Plant height
Color (greenness)
Herbage mass (oven/microwave)
Leaf number, leaf area
Yield (radish weight/length and width)

Water holding capacity of different soils. Simulate an ecoregion (dig soil from yard/school/scientist mentor send).
Activity 3: http://edis.ifas.ufl.edu/pdffiles/4h/4H36000.pdf Potential guided activity; sand/potting soil most similar to comparison to 'natural' ecoregion differences
Measures:
Water output volume
Turbidity – at 1, 5 and 10 mins clarity of 300 ml (in 100 ml 'zones')
As an open experiment
Plant height
Color (greenness)
Herbage mass (oven/microwave)
Leaf number, leaf area
Yield (radish weight/length and width)

Thought experiment: http://www.sciencedirect.com/science/article/pii/S2211912414000583

<u>Quality of water</u>

Grades 6-8:
http://www.agclassroom.org/NH/matrix/lessonplan.cfm?lpid=227&grade=6,7,8,9,10,11,12&content=SCIENCE

Grades 9-12:
http://www.agclassroom.org/NH/matrix/lessonplan.cfm?lpid=235&grade=6,7,8,9,10,11,12&content=SCIENCE

Soda bottle on side to drain water from spout:
Group or Open-Different soil layers (pebbles, peat, soil, sand) or different plants (radishes, grass, mulch, rocks, nothing) and color of water that comes out
Measures:
Water output volume

Turbidity – at 1, 5 and 10 mins clarity of 300 ml (in 100 ml 'zones')
As an open experiment
Plant height
Color (greenness)
Herbage mass (oven/microwave)
Leaf number, leaf area
Yield (radish weight/length and width)

Pollute water with too much nutrient, salt, etc… and water plants.
Measures:
Water output volume
Turbidity – at 1, 5 and 10 mins clarity of 300 ml (in 100 ml 'zones')
Plant height
Color (greenness)
Herbage mass (oven/microwave)
Leaf number, leaf area
Yield (radish weight/length and width)

Statistics:

Suggest toolkits

http://www.mathportal.org/calculators/statistics-calculator/