Climate Change

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There are many other potential impacts, depending on the scale of the projected changes. The complexity of our earth and the many feedback mechanisms, combined with the unknown of future human activities and technological advances, limit the ability to say for certain what we could expect. As we all know, our highly variable, often unpredictable climate means we can still get extremes far from the general trend. Managing those extremes will be the key going forward.

Agriculture and Climate Interaction

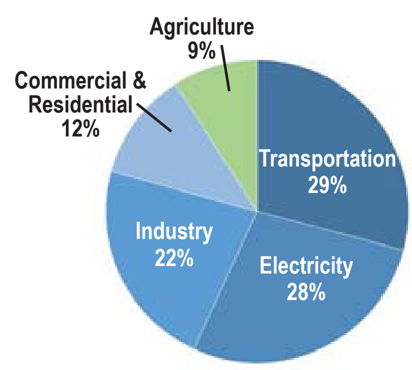
Our climate can influence nearly every aspect of our lives, but when it comes to agriculture, the two are deeply connected. Our climate determines what types of crops we grow, types of cattle breeds to use, seasonal precipitation and temperature patterns, common pests to expect, among other influences. Seasonal variations (i.e. weather) often determine how successful we are in any given year. Managing these deviations and "extremes," is the key to successful agricultural production in a challenging climate.

Climate Impacts On Agriculture: The projected changes mentioned earlier can influence agriculture, but during a 2017 and 2018 "Scenario Planning" project between South Dakota State University Extension and Nebraska Extension, faculty visited with cropping system and beef system stakeholders to determine which climate "scenarios" were most challenging. As you can imagine, this changed by location and individual operation, but there were some common themes. For cropping systems, the biggest challenges were wet and cold springs and falls. When talking with beef stakeholders, wet winters and dry summers were the most challenging.

Many of these challenging scenarios have actually played out over the past year, and the climate projections predict many of these will become more common in the future. It is important to take a look at how your operation "faired" during these conditions and take note of what worked and what didn't in order to develop a plan based on certain scenarios. Scenario planning is used in many industries and it may be what is needed in agriculture moving forward. More information on the Scenario Planning project and impacts/management strategies can be found at *https://weather-ready.unl.edu*.

Agriculture Impacts On Climate: It is easy to see how our climate impacts agriculture, but is not easy to know how agriculture impacts our climate. Many things impact our climate; such as building infrastructure, urbanization, vehicle emissions, energy use and many, many other ways. Agriculture is only a piece of the "pie" when it comes to impacting our climate. Greenhouse gases — such as carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), ozone, water vapor and others — impact our climate by "trapping" heat near the earth's surface. Without these gases, the earth would be about 59°F cooler, however, there is a fine balance to maintain a constant temperature. There are many other human and natural factors that influence our climate, but much of the attention is placed on greenhouse gases.

TOTAL U.S. GREENHOUSE GAS EMISSIONS BY ECONOMIC SECTOR in 2017



In 2010, 24% of global emissions were from the agriculture, forestry and other land-use sector. This 24% includes the emitted greenhouse gases, but does not include the CO_2 that ecosystems remove from the atmosphere by sequestering carbon in biomass, dead organic matter and soils, which offset approximately 20% of emissions from this sector. In 2017, the agriculture sector contributed approximately 9% of all U.S. greenhouse gas emissions (does not include sequestered CO_2). The contribution to this ag sector comes from crop cultivation (49%), livestock (44%) and fuel combustion (7%).

Agriculture has its largest impact when looking at gases other than CO_2. CO_2 emissions are quite low and the overall balance is even smaller when taking into account the carbon dioxide sequestered by plants. CH_4 and N_2O are a different story. Agriculture contributes (as of 2016) 77% of the U.S. N_2O emissions and 35% of U.S. CH_4 emissions. These gases have a stronger "global warming potential" (based on a ratio compared to CO_2) than CO_2 because of the enhanced heat-trapping properties and extended life-span of N_2O (lasts an average of 114 years). Most of the N_2O comes from agricultural soil management and much of the CH_4 comes from enteric fermentation — aka cow burps — and from anaerobic fermentation.

There are many agricultural practices (i.e. no-till farming, irrigation scheduling, etc.) that can reduce economic losses caused by our weather and climate. Many of these losses are often the result of losses of soil or nutrients to the environment. Much attention has been placed on reducing these losses by ag businesses, farmers, universities and many others, with the goal of having an economically, socially and environmentally sustainable agricultural system.

Sources:
- *National Centers for Environmental Information,* www.ncdc.noaa.gov
- *Nebraska's Changing Climate — CropWatch, Dec. 2018,* https://cropwatch.unl.edu/2018/nebraska-changing-climate
- *NOAA Climate.gov,* www.climate.gov
- *U.S. Environmental Protection Agency — Greenhouse Gas Emissions,* www.epa.gov/ghgemissions
- *Yale Program on Climate Change Communication,* http://climatecommunication.yale.edu

Floods and Trees: Helping Trees Recover

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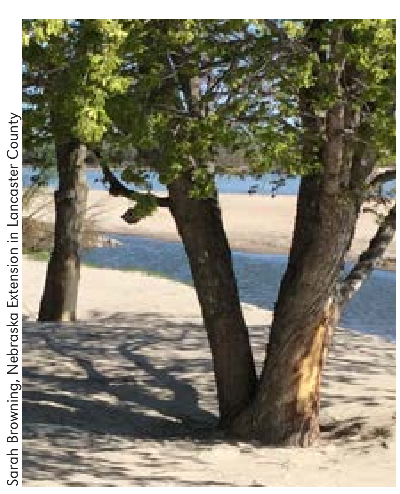
Floods cause damage to trees in two main ways — physical and physiological. The severity of damage is determined by many different factors, including the tree species, beginning health of the tree, time of year the flood occurs, length of flooding event, depth of the water and the amount of soil removed or deposited over the tree's root system. Generally, broadleaved trees tolerate flooding better than conifers, such as pine, spruce and fir.

Fortunately, flooding is less damaging to trees when it occurs during the dormant season — as occurred this year. According to Dr. John Ball, South Dakota State University Extension Forestry Specialist, during winter and early spring before growth begins, most deciduous trees can tolerate several weeks of flooding if they don't receive extensive physical damage.

Physical damage is easily seen, but physiological damage is often invisible and hard to measure. Now the growing season is in full swing and trees have leafed out, it's easier to assess how trees have been affected.

Physical Damage

Strong flood waters, especially when accompanied by large slabs of ice, cause serious physical damage. Branches are broken and bark is gouged from the tree's trunk. Water erodes soil around the roots, causing the tree's root plate to become unstable. Trees can easily be pushed over or pulled from the ground by racing flood waters.



A maple tree with ice damage and sand sedimentation.

Working in large or damaged trees can be extremely dangerous. Contact a certified arborist to have damaged trees assessed and removed. For more information, go to Nebraska Forest Service's "Hiring an Arborist" online at *https://nfs.unl.edu/CommunityForestry/hirearborist.asp*.

To assess trees, look for broken branches hanging in the tree, leaning trees or significant bark damage. If broken branches can be reached safely from the ground, remove them, making a clean cut. Do not apply pruning paint or wound dressing to the cut.

Leaning trees are an imminent fall hazard and should be removed in most cases.

Trees can survive bark damage, depending on the severity. Assess how much of the trunk circumference is affected. If 10% or less of the tree's circumference is affected, a previously healthy tree with little to no root damage has a good chance of recovery. If 50% or more of the tree's circumference is affected, removal of the tree is the safest option as disease and decay are likely to create an unstable tree.

Soil erosion or removal by flood waters may leave tree roots exposed. If the tree is still standing and seems strongly rooted, add soil around the roots to cover them and fill any gaps. But only add soil to the previous grade level, do not add extra soil over the tree's roots. Do not bury the main roots flaring off the trunk. There should be a visible flare at the base of a well-planted tree trunk.

Physiological Damage

How does flooding cause physiological damage to trees? Two main avenues of injury are through oxygen starvation during the flood and soil deposits over the root system afterwards.

Oxygen Starvation. Tree roots are mostly inactive during winter dormancy, with minimal functions or growth, until soil temperatures reach a minimum of approximately 32–40°F. This is good news, because it means tree roots have a much lower need for soil oxygen while dormant and can more easily tolerate the lack of oxygen caused by early spring flood waters such as we experienced this year. In actively growing trees, the available oxygen in roots is used up within 1–3 hours following a flood.

A lack of oxygen causes roots to stop functioning or growing, and eventually results in root death. Heavy, woody roots are more likely to survive a flood than non-woody roots. Root death creates openings for pathogenic fungi to invade the tree. Loss of roots through direct flood damage or disease make the tree prone to drought the following growing season and to windthrow during summer storms.

Flooding also suppresses the growth of mycorrhizal fungi, which need high levels of soil oxygen to grow well. Mycorrhizal fungi are beneficial organisms in the soil that form a relationship with tree roots and greatly expand a tree's root network and nutrient uptake.

Sedimentation. Soil deposits over a tree's root system following flood can range from zero inches to several feet of sand, silt or clay. These new deposits bury the original root system deeper in the soil, creating a long-term oxygen deficit. Some trees may be able to respond by sending out new roots into the upper layers of soil deposits, but other trees will simply decline and die. Even 3 inches of soil deposits can smother the roots of flood-intolerant tree species.

If flood waters have deposited soil beneath trees, remove this material down to the tree's original soil grade in as large an area as possible. This must be done carefully and quickly. Once flood tolerant trees begin active growth in spring, they will grow roots into these new soil deposits. Damaging those new roots while removing the soil deposits is another injury to an already stressed tree.

Tree Tolerance to Intermittent Flooding During the Growing Season

- Tolerant — green ash, bald cypress, cottonwood, sycamore, willow
- Intermediate — arborvitae, river birch, boxelder maple, American elm, hackberry, honeylocust, silver maple, bur oak
- Intolerant — chinkapin oak, eastern red cedar, linden, white birch, buckeye, crabapple, Norway maple, pine, redbud, shagbark hickory, spruce, sugar maple, tulip poplar, walnut

Long-Term Recovery

It is common to see flood-damaged trees die 2–5 years following the event from the long-term effects of physical and/or physiological injury. It's important for homeowners to understand it takes trees several years to fully recover. If the tree is to be saved, it's important to protect it from additional insect or disease damage during this time. Inspect trees periodically throughout the growing season for signs of problems.

After the flood, trees have a reduced root system due to root and mycorrhizal fungi death, so keep them watered during dry summer periods for the next several years as they regrow new roots.

Apply a 2.5- to 3-inch layer of organic mulch in a flat layer around the base of the tree. The most commonly used organic mulches include wood or bark chips — cedar, cypress or hardwood — and shredded hardwood.