CLIMATE CHANGE IMPACTS ON IOWA 2010

January 1, 2011

Report to the Governor and the Iowa General Assembly

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Iowa Climate Change Impacts Committee

(July 2009 – December 2010)

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Introduction

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Today, perhaps without their realization, Iowans are factoring climate change into their lives and activities. Current farming practices and flood mitigation efforts, for example, are reflecting warmer winters, longer growing seasons, warmer nights, higher dew-point temperatures, increased humidity, greater annual stream flows, and more frequent severe precipitation events (Fig. 1) than were prevalent during the past 50 years. Some of the effects of these changes (such as longer growing season) may be positive, while others (particularly the tendency for greater precipitation events that lead to flooding) are negative. Climate change embodies all of these results and many more in a complex manner.

The Iowa legislature has been proactive in seeking advice about climate change and its impacts on our state. In 2007, Governor Culver and the Iowa General Assembly enacted Senate File 485 and House File 2571 to create the Iowa Climate Change Advisory Council (ICCAC). ICCAC members reported an emissions inventory and a forecast for Iowa's greenhouse gases (GHGs), policy options for reducing Iowa's GHG, and two scenarios charting GHG reductions of 50% and 90% by 2050 from a baseline of 2005.

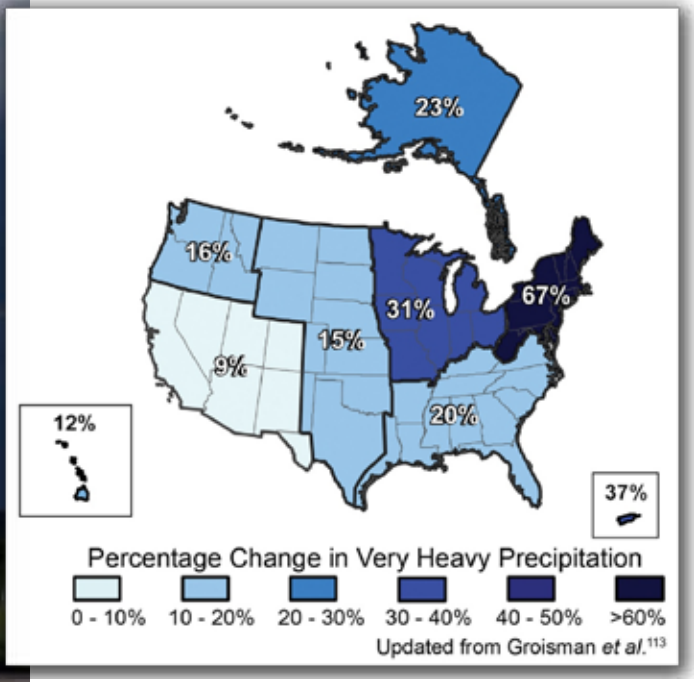

Figure 1. ***Increase in very heavy precipitation in the US. Climate change has very real regional implications for Iowa and the Midwest.*** *Shown here is the increase in very heavy precipitation in different regions of the US from 1958 to 2007. Very heavy precipitation is defined as the heaviest 1% of all events. (Karl et al. 2009)*

Following issuance of the final report in December 2008, the General Assembly enacted a new bill in 2009 (Sec. 27, Section 473.7, Code 2009 amended) that set in motion a review of climate change impacts and policies in Iowa. This report is the result of that 2009 bill. It continues the dialogue between Iowa's stakeholders, scientific community, and the state legislature that was begun with these earlier reports.

Climate Change Impacts on Iowa 2010 attempts to highlight the latest literature in order to define the specific effects of climate change on our economy, health, and natural and agricultural systems. Professor Eugene Takle, director of ISU's Climate Science Program, has compiled data from primary information sources, including his own extensive research, to present an exceptional picture of Iowa's current climate trends. But there is little Iowa-specific research on the precise impacts of these changes. However, regional and continental trends pertaining to climate impacts can be and have been aptly applied in this report. Further research in all climate-related subjects, which is much needed, will continue to refine our understanding of climate change and its effects on Iowa and Iowans.

This Executive Summary includes the main elements of a larger report by the same title. References for material in this summary as well as for the longer report are included in that longer report, as are considerably more information and graphics.

Iowa produces among the highest GHG emissions per capita, but Iowa also has the capacity to benefit economically by reducing those emissions through increasing energy efficiency and renewable energy sources. Thus, we can improve our economy, our health, and the environment simultaneously by *mitigating* GHG emissions. Wisdom dictates that we simultaneously build climate resilience into our state's policies and activities – that is, that we attempt to reduce current and future climate impacts on Iowa and Iowans by *adapting* to climate extremes. Iowa's Regents' institutions and broader scientific community stand ready to work together with the state's legislature, business community, and others toward this end.

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Climate Changes in Iowa

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Professor, Department of Geological and Atmospheric Sciences
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Iowa's changing climate is already affecting the state's economy and the welfare of its people. Current state climate changes are linked, in very complex and sometimes yet unknown ways, to global climate change. Some changes, such as the increased frequency of precipitation extremes that lead to flooding, have seriously affected the state in a negative way. Others, such as more favorable summer growing conditions, have benefitted the state's economy. *Floods*, *water-logged soils*, and *droughts* have the highest impact on Iowa's economy.

Iowa has experienced significant changes in precipitation, including:

- a long-term upward trend in precipitation (see Fig. 2),
- an increase in extreme heavy precipitation in summer in the last 40 years
- an increase in extreme heavy precipitation in summer in the last 40 years, consistent with regional changes (see Fig. 1), and a shift in seasonal distribution: more precipitation now comes in the first half of the year, and less in the second half, and
- a larger precipitation increase in eastern Iowa than in western Iowa.

All of these trends are projected to continue well into the future.

Iowa has experienced a long-term upward trend in temperature (see Fig. 3). Again, details are most significant:

- Long-term winter temperatures have increased six times more than summer temperatures.
- Nighttime temperatures have increased more than daytime temperatures since 1970.
- Since 1970, daily minimum temperatures have increased in summer and winter; daily maximum temperatures have risen in winter, but declined substantially in summer.

Iowa (and the central US) has been experiencing fewer extreme high summer temperatures in the last 40 years, which seems counter to global and continental trends. This is likely due to increased summer precipitation and moist soils, which suppress surface heating and daytime summer maximum temperatures. If severe drought were to return, the current slow and steady rise in annual mean temperature could abruptly produce extreme summer heat, comparable to that of 1983 and 1988.

Temperature changes are manifest in multiple ways:

- Iowa has gained an average of 8-9 more frost-free days than 100 years ago (see Fig. 4). This is providing a longer growing season, earlier seasonal snowmelt, and longer ice-free period on lakes and streams.
- The number of heating-degree days has declined significantly since 1893 (see Fig. 5), decreasing winter space-heating requirements.
- Trends in annual growing degree days are variable across the state; some locations show increases, other decreases.

Global and regional climate models, which in past decades correctly predicted current trends for Iowa, now predict that Iowa's annual average temperatures will continue to increase. In the near future, rates of increase will be more like those of the last 30 years than those of the last 136 years. However, year-to-year variation around the averages of the last 10 years will be high. Decadal averages are unlikely to return to those recorded before 1970.

Iowa's humidity has risen substantially especially in summertime, which now has 13% more atmospheric moisture than 35 years ago as indicated by a 3.5°F rise in dew-point temperature. Greater atmospheric moisture provides more water to fuel convective thunderstorms that provide abundant summer precipitation.

In recent years, Iowa's streamflow levels have risen in part because of changes in precipitation. Rainfall in excess of 1.25 inches/day initiates runoff and increases streamflow. The recent increase in extreme precipitation and projections of global and regional climate models point to continued enhanced streamflow and the potential for more frequent and greater flooding in coming years.

Summertime seems to be the new seasonal flood norm in Iowa. For a given amount of rainfall, summertime precipitation can create more flooding than springtime precipitation because of seasonal changes in alignment of storm tracks. Also, Iowa's recent rise in the number of large summertime rainfall events (those exceeding 1.25 inches) increases the probability of summertime floods. Higher winter and spring temperatures seem to be melting snow earlier and more slowly, reducing springtime flooding.

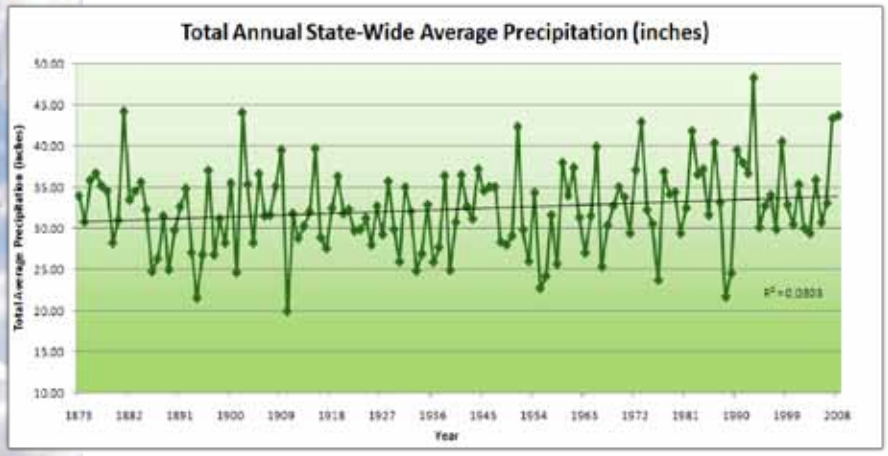

Figure 2. **Iowa annual state-wide precipitation in inches from 1873-2008.** *Note that the state has had an 8% increase in annual average precipitation over this 136-year period. Eastern Iowa has had a higher upward trend than this statewide average. (Iowa Climatology Bureau 2010.)*

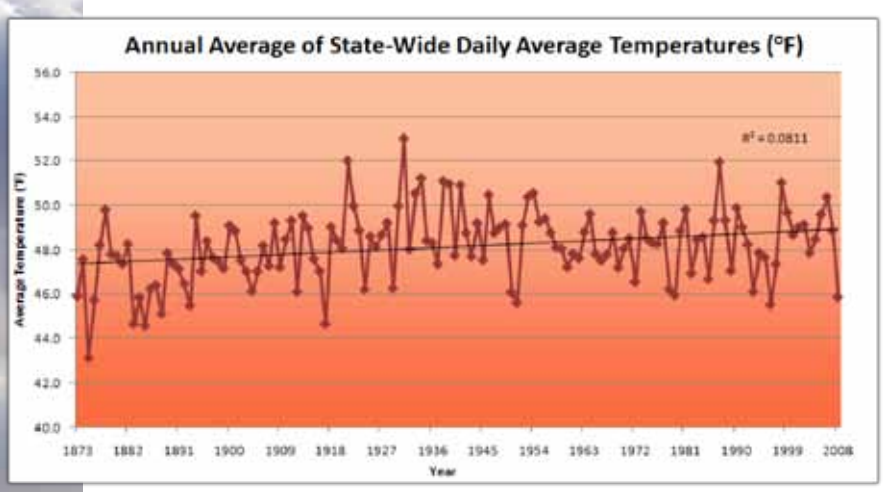

Figure 3. **Annual average state-wide daily average temperatures (°F) from 1873-2008.** *Note the increase in the first half of the 20th century and little change since then. Seasonal and day-night changes are proportionately larger and have greater impacts – with winter and nighttime temperatures increasing more than summer and daytime temperatures. (Iowa Climatology Bureau 2010.)*

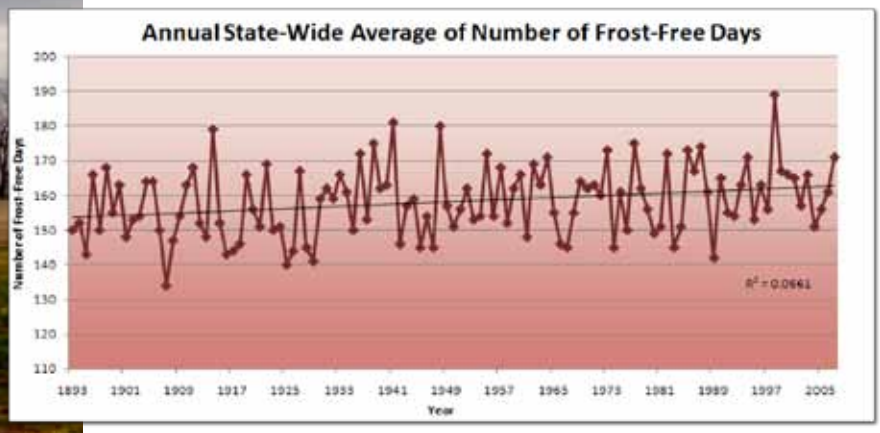

Figure 4. **Annual state-wide average of number of frost-free days from 1893-2008.** *The number of frost-free days has increased by 8-9 days over this 116-year period. This allows the growing season to begin earlier in spring and last later into the fall. (Iowa Climatology Bureau 2010.)*

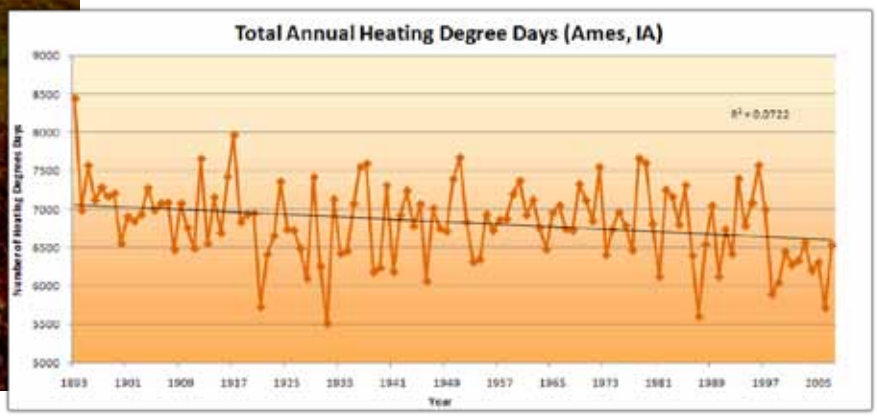

Figure 5. **Annual total heating degree days for Ames for 1893-2008.** *The substantial rise in winter temperatures has significantly reduced the number of heating degree days, and with it Iowa's space-heating requirements. (Iowa Climatology Bureau 2010.)*

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Agriculture in Iowa

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Recent climate trends have relevance to Iowa agriculture. Some of the observed trends are favorable to agriculture, but others are not. Farmers have responded to climate trends by planting corn and soybean earlier to take advantage of the longer growing season, installing more subsurface tiles to drain excess soil water faster, and purchasing larger combine heads to facilitate harvest in the fewer hours without dew.

Corn and soybean yields have been rising steadily since the 1940s. Improved management and genetics, higher fertility, and reduced drought stress have all been partially credited for this yield increase. However, crop production remains highly dependent on climate in conjunction with other variables. For example, higher monthly rainfall and increased transpiration from crops coupled with reduced winds have created favorable conditions for survival and spread of many unwanted pests and pathogens. A changing climate will impact future production through a variety of mechanisms.

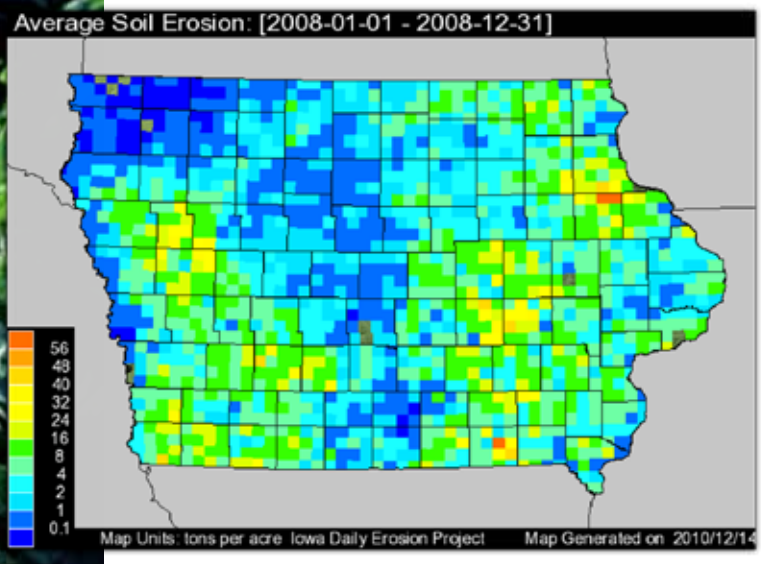

Figure 6. **Average soil loss in Iowa in 2008.** *The increased intensity and amount of rainfall during this flood year resulted in a soil loss of more than 50 tons per acre in some townships (orange). This contrasts with the "tolerable average" of 5 tons/acre/year (blue shades). The rise in the intensity and amount of rainfall have increased the erosive power of Iowa's precipitation. (Iowa Daily Erosion Project 2010)*

Increased precipitation is having a variety of impacts including:

- Delayed planting and associated yield loss, especially critical in poorly drained soils.
- Increased replanting of damaged croplands.
- Increased soil erosion (Fig. 6) and water runoff.
- Increased tile drainage, leading to greater nitrate-nitrogen loss and water quality degradation.
- Increased challenges associated with manure applications that are timely, nutrient-use efficient, and environmentally benign.

Combined increases in precipitation, humidity, and temperature are causing:

- Delayed nitrogen application and increased nitrogen losses.
- Enhanced development and establishment of crop pathogens and diseases.
- More potential weed problems and simultaneous reduction in herbicide efficacy.
- Greater use of agricultural pesticides and associated water quality issues.
- Potential reduction in productivity and lifespan of domestic livestock.
- Higher nighttime temperatures are contributing to shortening of the corn grain-filling period and the lowering of potential corn grain yields.

We must remember that climate extremes, not averages, have the greater impact on crop and livestock productivity.

4 Iowa's Plants and Animals

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Changes in Iowa's climate will force native plants and animals, including fish and game species, to adapt or move. Several results of a warming climate are already reported in the Midwest and around the globe:

- Plants, from backyard lilacs to forest wildflowers, are leafing out and flowering sooner.
- Birds are arriving earlier in the spring.
- Particular animals are now being sighted farther north than in the past.

Some native animals and plants could disappear from Iowa. For example, Iowa's wood turtle (Fig. 7) nests on river sand bars in mid-summer. Historically, this was a safe time to nest, but today's more intense mid-summer flooding is now washing out or drowning out most nests, accentuating declines of this state-endangered species.

Climate change will stress interactions among animals, plants, and their environment. As the stresses mount, even common backyard companions like the American robin could be rapidly replaced by entirely new species.

Game animals will be affected as well. For example:

- *Coldwater game fish* such as *trout* and *smallmouth bass* depend on cool groundwater and clear, sediment-free streams. They could be vulnerable to rising temperatures and, with more intense rainstorms, to increased sediment from eroding fields.
- *Ducks* nest in the prairie pothole wetlands of United States and Canada. Their populations may drop due to future drought in the west and loss of habitat to agriculture in the east. More wetland habitat in the eastern pothole region could compensate for losses due to western drought.

Specific impacts of climate change on game populations or state parks are virtually impossible to predict. However, in general, scientists expect major, irreversible alterations of native flora and fauna in the next 100 years, even with the most conservative climate-change projections. The Iowa Department of Natural Resources is planning vulnerability assessments for certain groups of animals, studies that are crucial to understanding future changes and should be fully funded.

Figure 7. **A nesting wood turtle**. *The Iowa numbers of this state-endangered species are declining in part because of increased flooding during the summer egg incubation period. (Dr. Jeff Tamplin, UNI)*

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Public Health in Iowa

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Climate change has had major effects on global health. Iowa is likely to see similar effects from a changing climate, including:

- *death and illness from extreme heat waves* which disproportionately affect the elderly,
- *pulmonary and cardiac problems* from increasing air pollutants (especially ozone and fine particulates) enhanced by higher temperatures,
- increases in *infectious diseases* transmitted by new species of insects that require a warmer, wetter climate, and
- an increased prevalence of *allergic rhinitis* and *allergic asthma*.

Allergic diseases are expected to become more widespread and more severe due to a northward expansion of the range of certain allergenic plants and climate-associated increases in pollen loads from both native and invading species. In addition, Iowa's higher humidities and rise in extreme precipitation events will worsen mold exposures, thereby increasing the ranks of allergic individuals and expanding medical costs.

Iowa's increased floods pose multiple health hazards in addition to death from the rising water (Fig. 8). These include:

- mobilization of hazardous chemicals into flood waters,
- dissemination of microbial pathogens from livestock facilities and sewage treatment plants,
- CO poisonings from use of gasoline-operated tools after floods, and
- molds contaminating flooded homes and businesses.

These problems were manifest in Iowa's 2008 floods, when researchers identified flood-related ailments that left many sick for weeks. Extreme events such as this are happening with greater frequency and severity. They will challenge our public health practitioners to do more to prepare for these events and to protect us when they occur.

Figure 8. **A Cedar Rapids home damaged by the 2008 flood**. *Residents returning to muck out and gut their homes after such events are faced with extensive mold growth, chemical and microbial pollutants, and other potential health hazards. With current rises in precipitation and streamflow, floodplain residents may be increasingly exposed to such hazards. (Linn County Public Health Dept.)*

6 Iowa's Economy, Infrastructure, and Emergency Services

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Changing climate is affecting all aspects of Iowa's economy, and will continue to do so in a major way

Changes in agriculture are expected to be the most prominent impacts. The current upward trend in crop productivity should continue until around 2030:

- A longer and warmer growing season and wetter climate should increase corn yields, and stabilize or lower feed and food costs of Midwestern commodities. Higher atmospheric CO_2 could increase soybean yields.
- However, these same environmental factors could also increase weed virulence, fungi, and insect issues, raising farming costs and decreasing anticipated yield gains. In addition, seasonal rainfall changes will impact spring planting and increase weather-related crop and livestock perils.

By mid-century, warmer and drier conditions are expected to decrease crop yields and negatively influence livestock health, appetites, reproduction, and range health.

Iowa's prominent insurance industry is currently responding to changes in the climate. It is:

- Undergoing transition in order to address climate change consequences nationally and in Iowa.
- Developing risk-reducing products and services
- Vulnerable to potential losses in areas where climate-change-related risks are yet to be identified.

As temperatures rise, Iowa consumers and state and local governments could realize *savings in heating costs*. Shifts in labor productivity and public service delivery costs will produce both economic gains and losses.

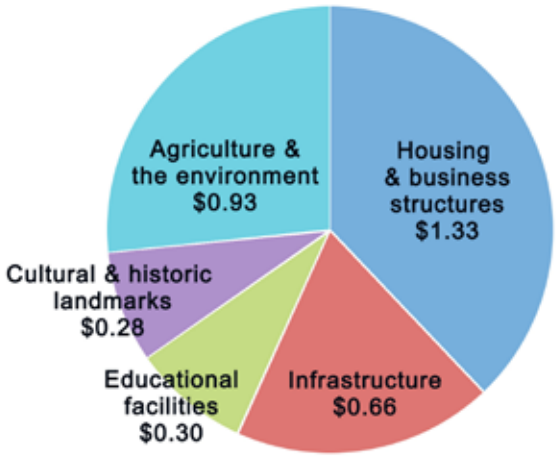

Figure 9. **Distribution of weather-related losses in Iowa in 2008.** *The consequences of weather-related events are costly to home owners, businesses, agricultural productivity, and public services and essential infrastructure. Climate change could increase the frequency of these types of losses. (Rebuild Iowa Advisory Commission 2008)*

If climate change results in more serious weather events, then *in addition to losses from these events* (Fig. 9), *disaster services and costs of mitigation and infrastructure maintenance will rise*. More costly civil engineering innovations and designs that withstand infrastructure-damaging weather occurrences will be required.

The economic ramifications of Iowa's changing climate will continue to unfold in coming decades, with declines in agricultural productivity anticipated from mid-century on as climate change produces warmer but drier conditions in Iowa. Consequences for the broader economy over that longer horizon are less certain.