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Illinois Climate Change Policy

Executive Summary:

As levels of CO_2 and other greenhouse gases increase, climate change is expected to continue and the climate will invariably change. The midwest is expected to experience increasingly high temperatures, which are predicted to result in major crop damage due to changes in range, temperature stress, and phenology. The loss of valuable crops will result in a sinking economy for Illinois, a state that is dependent on the money generated by agricultural products. Current policies, like the Illinois Climate Change Advisory Group, and the Chicago Climate Action Plan, emphasize mitigation by slowing switching to green technologies and reducing impact, but they have low standards, nor were not always implemented. Future policies from the State must include a carbon tax or a cap-and-trade program, and. Overall, it is recommended that Illinois implement a mix of mitigation and adaptation focused policy, like carbon taxes, and monitoring programs, to secure its future in agriculture and the global economy.

Introduction:

Agriculture is a large part of the economy in Illinois, and it produces over $19 billion annually; 54% of that can be attributed to corn, and 27% to soy. Illinois is dependent on the money earned from agriculture to fuel its economy, so the Illinois economy is dependent upon having suitable farmland. As of right now, 89% of Illinois farmland is considered to be prime for crops, but that is all subject to change under climate change (Illinois Department of Agriculture 2014). Increasing carbon dioxide is the driving force behind anthropogenic climate change, which puts many parts of the environment at risk of severe changes, range shifts, temperature stress, and altered phenology. These changes will invariably impact the state of agriculture in Illinois and consequently the economy of our state. Actions must be taken toward climate change mitigation in order to preserve our environment and cropland, which will in turn protect the economy of the state and its citizens. Currently, Illinois lawmakers have begun to take steps toward reduce climate change, but these steps are not aggressive enough to make a substantial impact on carbon emissions and climate change mitigation. The state offers various financial incentives for green practices and is also doing a lot to fund research and to make moves within the state government to be more sustainable, but we don't have any legislation limiting business' carbon emissions nor do we have any policies aimed at moving to renewable energy sources (American Council for an Energy-Efficient Economy 2016). Illinois should consider striving for more aggressive policies, like California's Global Warming Solutions Act of 2006, that significantly reduce CO_2 emissions across the board as well as incentivising green farming practices. Illinois should also consider implementing a Carbon Tax or cap and trade program to start to phase out fossil fuels, and make renewables and green technology more competitive. As well as funding statewide programs aimed at invasive monitoring and removal. With these

suggestions, Illinois could become a leader in climate change mitigation and renewable energy in years to come.

Literature Review:

Climate change is the heating of the Earth due to greenhouse gas emissions. As more greenhouse gases, like carbon dioxide or methane, are released into the atmosphere, the more energy from the sun is re-reflected and trapped in the atmosphere. This radiative energy is what causes the Earth's climate to warm. Climate will have a large impact on the temperature in the midwest and Illinois in specific. Historical and current data show that there is trend toward increasing annual temperatures across the midwest. Figure 1 (below) shows that historical temperature anomaly follows an increasing trend that has accelerated over time Figure 2 (below) shows that the simulated average seasonal temperatures for each season are expected to increase significantly relative to 1971-1999 (National Oceanic and Atmospheric Administration 2013). These figures together show that temperature has been increasing in the Midwest for a long time, and that it is unlikely to stop in the future. Now it is important to look at and understand the implications increasing temperatures have for the environment and agriculture.

Changing Habitat:

Changing climate will result in massive ecological and economical impacts in agriculture due to rising temperatures. Temperature increases are expected to exceed the threshold for some species resulting in organisms moving to find suitable habitats (Kahl et al. 2011). Crops and organisms that are unable to undergo range shifts will experience stressors due to changing temperatures and changes in phenology.

Range Shifts:

As temperatures increase across Illinois, weeds, pests, and diseases that only thrived in warmer regions will be able to spread throughout the state, and increase the amount of damage inflicted on crops. Weeds cause 34% of the world's crop loss, and cause $4.7 billion in losses for soybeans alone and $8.4 billion for North American crops as a whole (Table 1). If weeds and other invasive plants spread this number can be expected to increase. Many of the most noxious weeds in regards to agriculture are only found in tropical or subtropical regions because they are killed off by the low temperatures in other environments. Increasing temperatures due to climate change will increase the regions within which these noxious weeds, like prickly sida and Johnsongrass, can be found (Walthall 2012). For example, higher winter temperatures have been shown to facilitate the Northwards migration of the highly invasive Kudzu due to lack of killing freezes (Bradley 2010). There is also the concern that as climate changes, people will seek plants that are more tolerant of dry, hot conditions, thus increasing the risk of introducing new invasives (Bradley et al. 2010). Invasive plants and weeds are of concern because they have the potential to grow in the corn and soybean fields and reducing crop yields through competition.

Insects have caused $3.7 billion in losses for soybeans alone and crop losses estimated at $7.5 billion for the whole of North America (Table 1). Increased temperature will allow insects to spread to areas that they have not occupied in the past. It has been predicted that higher minimum winter temperatures will allow invasive pests, like the corn earworm, and the

European corn borer, to expand their ranges because they would no longer be killed off every winter (Walthall 2012). These insects, if found in Illinois, could cause extensive damage to crops and substantially hurt the economy.

Crop losses due to pathogens is estimated at 11% of global production. Pathogens cost $3.2 billion in soybean losses, and $50.5 billion for North American crops as a whole (Table 1). As temperatures increase, pathogenic viruses, fungi, and bacteria are expected to spread to new areas that were once out of there reach due to range limitations of the vector and the pathogen itself (Walthall 2012). Mycotoxin producing fungi are pathogens for many crops and is deadly to humans and livestock.This pathogen thrives in high temperatures, and under current climate change simulations, is expected to spread to new regions and increase in incident. This will result in major crop losses and pose huge risks to human and livestock health in the future (Wu 2011).

Phenology:

Temperature plays a large role in the life cycles of many things, including, plants, insects, and pathogens. As temperature increases, the phenology, or biological timing of these things will be altered. For plants, phenology is when fruit is produced or when bud burst occurs. For insects, it's when they reproduce and lay eggs, or the populations dies off. For pathogens, phenology controls the vectors species and the reproduction of the pathogen. While this benefits crops, this also benefits invasive weeds. Increasing temperatures will result in a longer growing season. This would allow noxious weeds and invasive plants to spread at higher rates as they have more time to reproduce and spread their seeds.Thus, giving them a competitive advantage over traditional crops, and ability to take over fields (Bradley 2010).

As air temperature increases, every aspect of an insect's' life cycle is accelerated, and they mature faster as a result, and the warming winter's means that there is reduced winter mortality. So insect pests are able to produce more generations over longer amounts of time, which increases the amount of crop damage they are able to inflict (Walthall 2012, Rosenzweig 2001).

Current Policy:

Formed in 2006, the Illinois Climate Change Advisory Group is an initiative aimed at enhancing and building on the state's existing climate policies. This group was created under Executive Order 2006-11. The main goal of the group was to identify, analyze, and recommend policies to reduce greenhouse gases emissions and increase the use of green practices. The group looked at 6 different categories when analyzing climate policies: transport, power/energy, and cap and trade. Within these categories the Advisory Group came up with, and voted on 24 potential climate strategies. Of these 24, 19 were supported with no dissent, and covered fuel standards for vehicles, increased energy efficiency, increased renewables, changes in land use, and waste. The 5 contentious strategies that still passed with majority were greenhouse gas emission standards for automobiles, carbon dioxide emissions standards for electricity generation, 20% carbon offset requirements for new fossil fuel power plants, and a cap and trade program for power generators and large industrial sources (Illinois Climate Change Advisory Group 2010).

As a result of the recommendations of the Illinois Climate Change Advisory Group, Governor Blagojevich signed into law the Illinois Power Agency Act (IPAA), which included a Renewable Portfolio Standard, and an Energy Efficiency Portfolio Standard, and created the Illinois Power Agency. The Renewable Portfolio Standard states that energy provided to residential and small businesses must be 25% renewables by 2025. The Energy Efficiency Portfolio Standard requires that electric utilities must meet a 2% energy use reduction, through energy savings programs, by 2015. This agency and these policies are still being used and could be updated to be even more aggressive. The state could set higher goals in renewables and energy use reduction (Illinois Climate Change Advisory Group 2010). Governor Blagojevich also signed the Midwestern Greenhouse Gas Reduction Accord, the main role of which would have been to set greenhouse gas reduction standards and to implement a cap and trade program, but no action was taken on the Accord due to the fact that several states had switched positions on climate change (Center for Climate and Energy Solutions 2010). In December 2007, the federal Energy Independence and Security Act (EISA) was signed into law. It covers a four of the Illinois Climate Change Advisory Group's recommendations: Energy efficiency standards for light bulbs, energy efficiency standards for appliances, increased corporate average fuel efficiency requirements, and low carbon fuels standards (Illinois Climate Change Advisory Group 2010). As this is a federal act under the Environmental Protection Agency, this act is at risk of being overturned as the Environmental Protection Agency is being defunded under the current administration and therefore, it is not a reliable piece of legislation. Overall, the Illinois Climate Change Advisory Group and the recommendations they produced fail in the lack of follow through and the lax standards that were set. If Illinois wants this policies to be effective they need to set up the programs and regulations, and make them aggressive to maximize their effect.

Throughout the state, there are some cases of citywide climate policies, like the Chicago Climate Action Plan implemented in 2008. The Chicago Climate Action Plan (CCAP) outlines various measures the city will attempt to implement in order to reduce greenhouse gas emissions and therefore mitigate climate change. The goal is to implement a 25% to 1990 carbon emissions levels by 2020, which is a reduction of 15.1 million metric tons of carbon dioxide emissions equivalents ($MMCO_2e$). This plan has five components through which to achieve its goal: energy efficient buildings, clean and renewable energy, improved transportation options, reduced waste and industrial pollution, and adaptation. Strategy 1, Energy Efficient Buildings, wants to reduce greenhouse gas emissions from buildings by retrofitting commercial, industrial, and residential buildings, updating the city's energy codes, building rooftop gardens, and requiring new buildings to meet new green standards. This strategy has achieved a reduction of 0.33 $MMCO_2e$ in two years. Strategy 2, Clean and Renewable Energy, aims to upgrade power plants, improve their efficiency, build renewable energy, and promote household renewable power. This has resulted in a 0.11 $MMCO_2e$. At the time of the report (2010), Chicago has the nation's largest urban solar field, producing 10 MW of energy, as a result of this action. Strategy 3, Improved Transportation Options, is planned to invest in existing transit, expand public transit incentives, develop walking and biking paths, improve fleet efficiency, switch to green fuels, achieve higher fuel efficiency standards, support intercity rails, and improve freight movement. This strategy has only resulted in a 0.2 $MMCO_2e$ reduction. Strategy 4, Reduced Waste and Industrial

Pollution aims to increase the amount of waste that is reduced, reused, or recycled. It also aims to reduce the use of traditional refrigerants, and to capture stormwater on site. This has resulted in 0.26 $MMCO_2e$ reduction. Strategy 5, Adaptation, is different from the other strategies in that it focuses on the effects of climate change instead of greenhouse gas emissions. It looks at managing heat, implementing innovative cooling, protecting air quality, managing stormwater, implementing green urban design, preserving green spaces, engaging the public and businesses, and planning for the future (City of Chicago 2010).

The Chicago Climate Action Plan is a very well rounded and well thought out action plan, but is very urban specific, which is its downfall when looking beyond the city limits. It is important that cities become as green as possible, and Chicago is doing an upstanding job, showing other cities what a Climate Action Plan for their area may look like. When looking at scaling this plan up or down to be implemented on a statewide level or for a smaller city, there is no part of the policy that addresses agriculture or waterways. It also doesn't provide a framework for funding or implementing public transit options where none exist. Hence, while the specificity gives it its strength in its context, that same specificity is its downfall when looking to apply this plan in other area.

Policy Options and Recommendations:

To drive future policies and insure their efficacy, the state of Illinois needs to follow the lead of other states and invest in climate change research to inform their policies (Berendzen 2011). Without proper research, there is no way to whether or a policy would be effect, which would waste taxpayers dollars. Research will also be of particular importance in directly adapting agriculture to the effects of climate change. The state of Illinois should invest in research regarding the spread of weeds, pests, and pathogens through the state.

One direction for future policy is to focus on mitigation-related policies, policies that are aimed at reducing and minimizing the effects of climate change through actions like greenhouse gas reduction. An easy start would be to take Chicago's Chicago Climate Action Plan and implement its policies statewide. The guidelines and regulations are already laid out and, while it is not perfect, it would need very few alterations before being put into action. This plan does lack some key points, like agriculture regulations that would be needed for a statewide plan, but policies for sustainable agriculture could be drafted and implemented separately. Looking toward the future, a more aggressive reduction in carbon dioxide emissions must be made if we want to mitigate the impacts of climate change. The Midwestern Greenhouse Gas Reduction Accord already has the guidelines for a cap and trade system set out, but just needs to be implemented. This would be a good first step to seriously reduce carbon emissions. A framework could be put in place to eventually transition this system to lower and lower amounts of carbon emissions. This coupled with policies that incentivise the switch to alternative energies would severely reduce the carbon footprint of the state of Illinois, while generating economic activity.

More importantly, options for climate adaptation must be evaluated. If we truly want to minimize the impacts of changing temperatures on agriculture and the economy as enumerated above, then we need to look at how we can prevent them from happening because there is no halting climate change now. One possible option is to incentivise the shift from monocultures to crop diversification. Crop diversification has been shown to increase the resistance of a field to

pests and disease (Lin 2011, Delgado 2011). This will reduce crop losses due to pests and pathogens. The state should also consider putting more funding into the state parks and state forests to be put toward invasive species monitoring. The money would be used to hire rangers to monitor the landscape for new invasions and to remove them before they can take hold. Some money should also be put towards trying to eradicate existing invasive species from the state.

My recommendations are that the state of Illinois implement an updated version of the Midwestern Greenhouse Gas Reduction Accord, incentivise sustainable, diverse farming, and strengthen existing climate change policies all the while putting money towards climate research to most effectively manage the threat and impacts of climate change.

Conclusion:

Climate change policy in the state of Illinois is weak. We have very few actual policies regulating greenhouse gas emissions or setting statewide standards. The strongest policies we have either fell through, or are only present in the city of Chicago. Illinois needs to reevaluate its existing policies, while simultaneously implementing new, progressive policies, a cap and trade system. Climate change is expected to have severe impacts on agriculture, the backbone of our economy, in Illinois. It will increase and exacerbate the effects of noxious weeds, insect pests, and pathogens on corn and soybean crops throughout the state if actions are not taken. Without climate-minded policy, the state will experience large losses in agriculture, specifically corn and soybeans, the crops that generate the most revenue for our state. If informed actions are taken to mitigate and adapt to the impending rise in temperatures across the state, Illinois stands to become a national leader in climate change action and in the economy.

Figures:

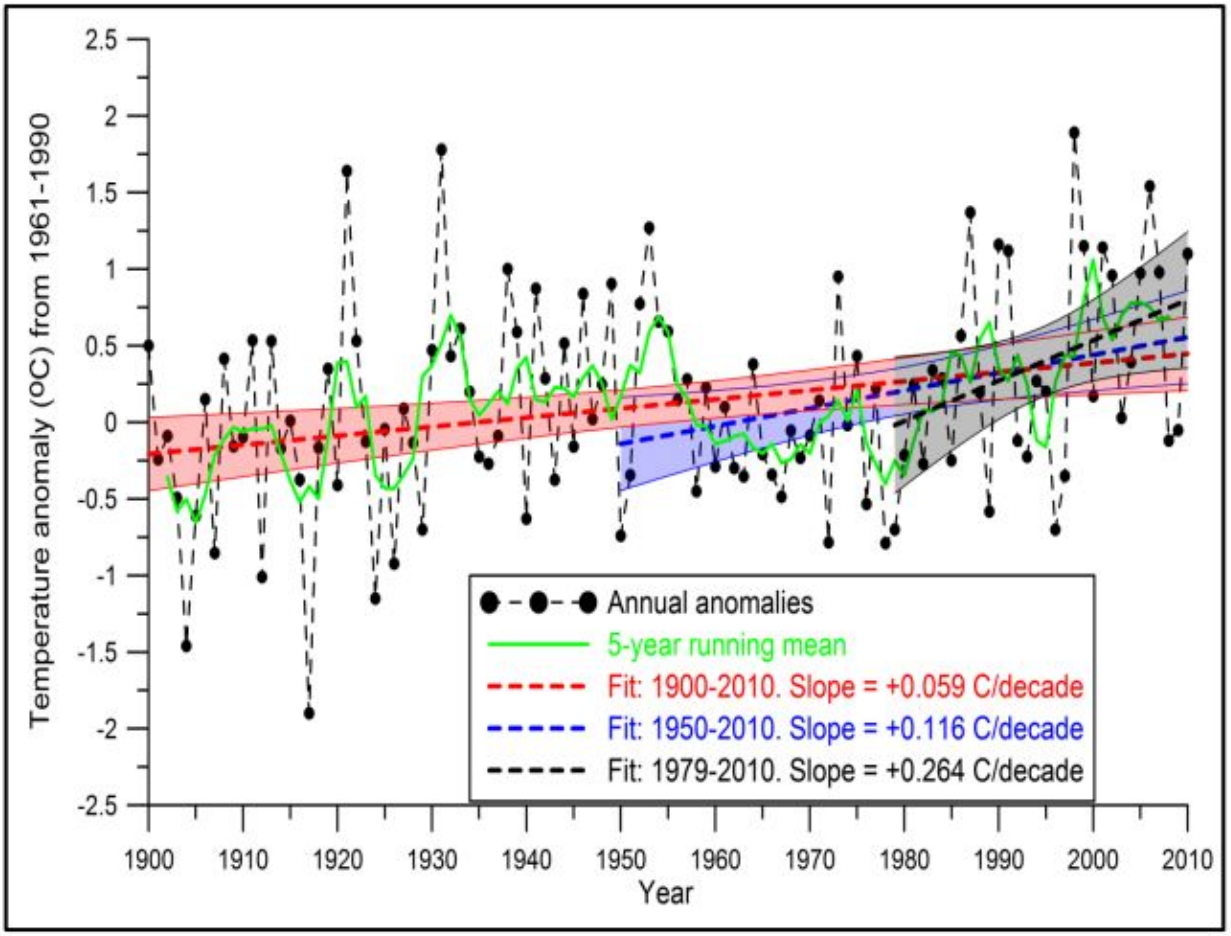

Figure 1. Historic annual temperature anomalies for 1900-2010. The anomalies data is relative to 1961-1990. Also pictured are a 5-year running mean, and best fit lines for 1900-2010, 1950-2010, and 1979-2010. Trend lines show increasing rates of temperature change. Adapted from "Regional climate trends and scenarios for the U.S. national climate assessment" by the National Oceanic and Atmospheric Administration, 2013, *NOAA Technical Report NESDIS 142-3, p.54*. Copyright 2013 by National Oceanic and Atmospheric Administration. Adapted with permission.

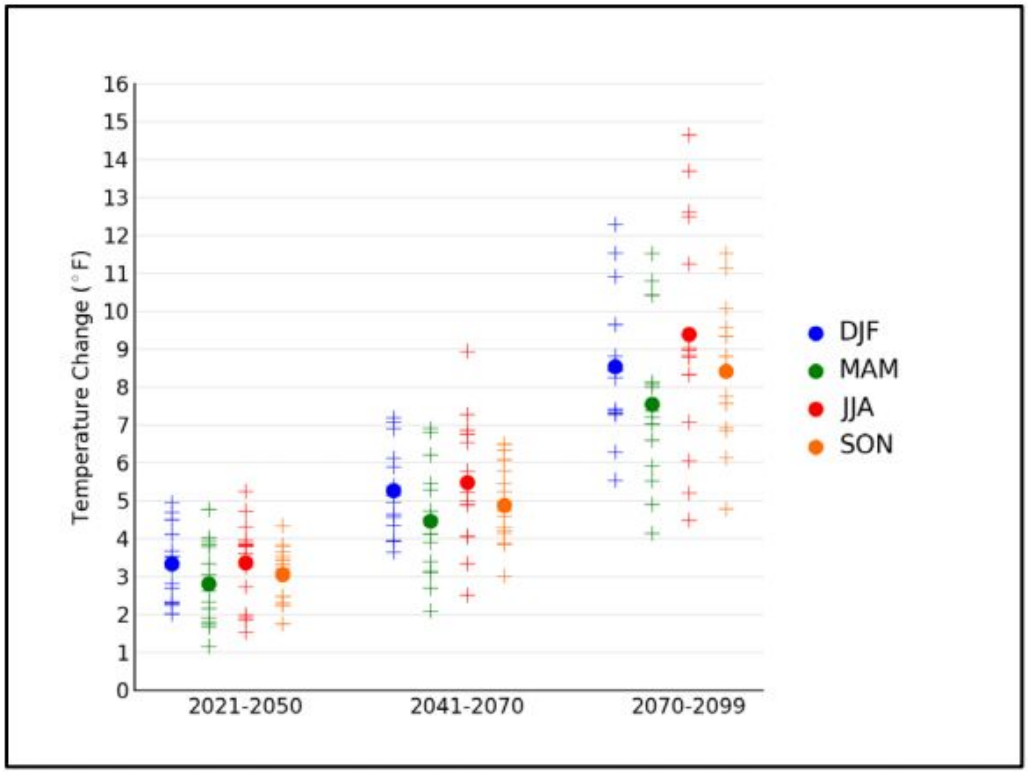

Figure 2. Simulated average temperature change by season compared to 1971-1999. DJF (December, January, February), MAM (March, April, May), JJA (June, July, August), and SON (September, October, November). Adapted from "Regional climate trends and scenarios for the U.S. national climate assessment" by the National Oceanic and Atmospheric Administration, 2013, *NOAA Technical Report NESDIS 142-3*, p.54. Copyright 2013 by National Oceanic and Atmospheric Administration. Adapted with permission.

Table 2 Global production of eight major crops and estimated losses for the eight crops by pest and region, 1988-1990.

Crop	Actual Crop Production (billions of US$)	US$ (billions) Losses due to			
		Pathogens	Insects	Weeds	Total
Rice	106.4	33.0	45.4	34.2	112.5
Wheat	64.6	14.0	10.5	14.0	38.5
Barley	13.7	1.9	1.7	2.0	5.7
Maize	44.0	7.8	10.4	9.3	27.4
Potatoes	35.1	9.8	9.6	5.3	24.8
Soybeans	24.2	3.2	3.7	4.7	11.6
Cotton	25.7	4.3	6.3	4.9	15.5
Coffee	11.4	2.8	2.8	2.0	7.6
Region					
Africa	13.3	4.1	4.4	4.3	12.8
N. America	50.5	7.1	7.5	8.4	22.9
Latin America	30.7	7.1	7.6	7.0	21.7
Asia	162.9	43.8	57.6	43.8	145.2
Europe	42.6	5.8	6.1	4.9	16.8
Former Soviet Union	31.9	8.2	7.0	6.7	22.1
Oceania	3.3	0.8	0.6	0.5	1.9

Source: Oerke et al., 1995.

Table 1. Estimated losses broken down by pest and region for eight different crops. Losses are listed in U.S. dollars in billions. Note North America, and soybeans. Adapted from "Climate change and extreme weather events: Implications for food production, plant diseases, and pests" by Rosenzweig, C., Iglesias, A., Yang, X., Epstein, P., & Chivian, E., 2001, *Global Change & Human Health, Volume 2,* p. 96. Copyright 2001 by Kluwer Academic Publishers. Adapted with permission.

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