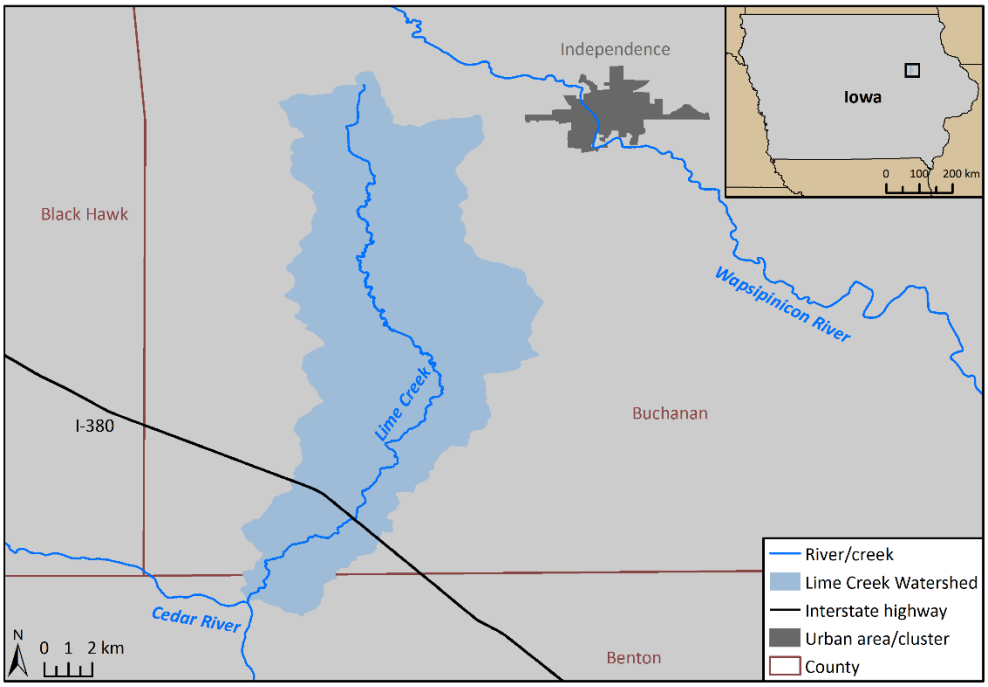
Agricultural Producer Perspectives on the Adoption of Conservation Practices, Water Quality, and Climate Change in the Lime Creek Watershed

Buchanan and Benton Counties, Iowa



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Introduction

The Mississippi River Basin (MRB) contains prime farmland that has produced high-value, nutrient intensive crops for food, fiber, and fuel. Prairie, forest and river ecosystems that support diverse plant and animal communities are also found within the MRB. Because of an increase and intensification of agricultural production in the MRB since European settlement, plant and animal habitats have degraded. Aquatic and riparian ecosystems have been particularly impacted by intensive agricultural practices. Increases in sediment and nutrient loading, exacerbated in part by channelization and tile drainage, have resulted in impaired water quality throughout the MRB. Nutrient loading has led to extensive eutrophication that has culminated in the creation of a hypoxic zone in the Gulf of Mexico. Midwestern states within the MRB contribute the greatest contribution of nutrient loads to the Gulf of Mexico hypoxic zone. Recent implementation of tile drainage and reversion of Conservation Reserve Program lands to cropland in the basin may increase the effects of nutrient loading and dramatically reduce wildlife habitat.

To address water quality and wildlife issues in the MRB, a partnership between researchers at the US Geologic Service, Oregon State University, and Purdue University created a project to investigate the barriers and opportunities of adoption of conservation practices by agricultural producers in three sub-watersheds in the MRB. This investigation also gauged rates of adoption of different conservation practices which increase water quality or habitat that qualify for federal cost-share programs. Understanding what factors influence farmers' management decisions can help researchers understand why practices are adopted or have a high likelihood of adoption now or in the future. Understanding decision making as it relates to adoption can inform water quality and habitat models that predict what may happen to hypoxic areas in the Gulf of Mexico in the future if there are precipitation and temperature changes in the MRB.

The following data are the results of interviews in Lime Creek Watershed located in Buchanan and Benton Counties in northeastern Iowa. Interviews were conducted with 16 agricultural producers in February and March, 2016.

Major findings:

- Producers are more willing to adopt conservation practices that improve soil health and prevent erosion
- The mean weight for reducing soil erosion was higher than other criteria indicating that on average, interviewees give more weight to reducing soil erosion when making decisions on practice adoption than other decision criteria and;
- Producers are willing to increase adoption of conservation practices which are already adopted widely in the watershed which help prevent erosion (e.g. grass waterways)

Recommendations:

- More outreach about off-farm benefits of conservation practices with a focus on water quality and;
- Highlight how adopting conservation practices can help to decrease risk of future government regulation

How these findings will be used:

The results of this study will be combined with data collected in other watersheds around the Mississippi River Basin to help develop WRESTORE, a web-based social computing application to help farmers and other landowners with conservation planning. For more information on WRESTORE please visit: http://wrestore.iupui.edu/ . With the effort of those who participated in the study we will be able to develop a way of incorporating user information to tailor advice on conservation practices provided through WRESTORE.

Methodology

In February and March, 2016 agricultural producers who operate lands in Buchanan and Benton Counties were interviewed to discuss their current use of conservation practices and their willingness to change their use of conservation practices in the future due to projected climate changes in the Upper Midwest. Agricultural producers were recruited with the help of Richard Sloan, a producer and coordinator of the Lime Creek Watershed group.

We conducted semi-structured interviews with oral open-ended and closed-ended questions and written closed-ended questions. An interview guide with questions of open-ended and closed-end questions can be found in Appendix A and B. Open-ended questions asked agricultural producers what the advantages and disadvantages of adopting different conservation practices on their property (see Appendix C for description of conservation practices). Closed-ended questions asked producers to gauge their willingness to adopt conservation practices on a five-point scale with one representing least likely to adopt and five representing very likely to adopt. Conservation practices would address either water quality, wildlife conservation, or both. Practices included were:

- Cover crops
- Constructed wetlands
- Drainage water management
- Filter strips
- Grassed waterways
- No-till
- Riparian buffer strips
- Strip cropping

Agricultural producers were then provided maps of climate projections describing future temperature and precipitation changes in the Upper Midwest (see Appendix D). The interviewer described the maps, how to interpret the climate projections, and how they were developed. Producers were then asked if they would increase or decrease their level of adoption (e.g., increase/decrease the extent of current use and increase/decrease likelihood of implementing a currently unused practice) or if their level of adoption would stay the same.

Towards the conclusion of the interview, the interviewer asked the producer to fill out a form where producers chose between different decision making criteria that may influence their adoption of conservation practices. We used the Analytical Hierarchical Process (AHP; see Appendix B) which asked producers to make pair-wise comparisons between the following criteria:

- Decreasing net costs
- Decreasing fertilizer losses
- Decreasing flooding
- Decreasing erosion losses
- Increasing biodiversity
- Decreasing climate change risks

Producers were asked to compare two criteria on an 18-point scale of relative importance of one decision criteria in comparison to the other. Due to time constraints one interviewee was unable to participate with this portion of the interview. The purpose of the AHP is to understand how producers make trade-offs between different decision criteria and to assess which criteria have greater weight in their decision-making. Knowing the weight of each criteria has on producer decision-making will help explain why producers are more willing to adopt a conservation practices than other practices.

Results

In February and March, 2016 we conducted 16 interviews of agricultural producers in the Lime Creek Watershed in Iowa. The producers who were interviewed were primarily raised corn and soybean crops but some producers also raised other crops such as wheat, oats, and livestock. For the purposes of this report agricultural producers are defined as row crop farmers. We asked questions related to producer attitudes and beliefs towards water quality and climate change and their level of conservation practice adoption now and in the future under a different climate regime.

Water Quality and Climate Change Beliefs and Attitudes

Water Quality

There was fear that the law suit between the City of Des Moines and farmers in their watershed may precipitate an increase in government regulations or a similar lawsuit filed by the City of Cedar Rapids. Interviewees mention the need to address nitrates and phosphates in the watershed but also believe agriculture is one source of many which influence water quality. Interviewees recognize the connection between their efforts to implement conservation projects and increasing water quality. All interviewees discussed the efforts of the watershed group and the monitoring of drainage in different parts of the watershed. Interviewees mentioned that their efforts were motivated by the watershed listing on the 303-D list and subsequent federal grants to help address water quality problems.

Producer Quotes:

> “Because [Des Moines is] using water out of the river and then having to clean it up. And theoretically it's costing them more and they're blaming that on those watersheds up above. Okay, that's all fine and good but does it cost them more because they're using twice as much? You don't hear any of that stuff. So I don't really know why. Obviously that's made an imprint on people because it's happening, and they're having to fight it. Are there nutrients in the water? Yes. Are we the only source of that? No, because all you have to do is go to a town that a guys does his lawn, and where does that go? It goes into the street. It doesn't have a chance to go down, basically. It goes into the street, and then where does it go? Into the sewer. You know, and then where does it go? Into the river. So how much is in there, and how much is out here? I mean obviously we're putting on a lot more, but I'm not sure that we're using it.”

> “So it was 1980, the limnologists or whatever had studied the mouth of Lime Creek… and they had nine (mussels) species and I think four of them were rare, or something like that. It was apparently pretty good, you know. So then, 10 years later or whatever, they can't find any of them in the same place. So it was like 100% lost. So these nine-- Well then they moved farther upstream and studied where the rocky substrates were better and they figured out this was in the flood plain in the Cedar River, you know, so there's sedimentation issues that were probably part of the-- which should be periodic, you know. They did find six of the nine species in Lime Creek. And so there's quite a bit of satisfaction that they at least have that and some of them are still the rare species that-- we do have a cold water habitat. We're listed-- the DNR has us as, I forget if they call it outstanding water quality or outstanding streams or-- it's something like that. Bear Creek over this way and Lime Creek this way both have sections where it's special habitat and fish diversity, the native-- we have farmers who have maintained a fair number of the trees along the stream so there's shading of the water that is important for the temperature of the water and all these interactions and so on. I do feel like I'm farming on a hill in between a couple of streams that are protected habitat, so that's kind of my incentive to be like, "Well, hey, we can't just wipe this stuff out, because then where will the kids go?”

Climate Change

Most noted that there are cycles to climate patterns, that climate is continuously changing, and it is difficult to predict climate patterns in the future. There is some recognition that humans may be a contributor to changes in climate but also believe that there is not enough data to support how much humans are responsible for the changes that are or will occur. This contributed to skepticism about the need to act to address climate change.

Producer Quotes:

“That's a bandwagon that people are getting on that I don't think is-- our climate is changed forever. They say it's melting more, we're going to flood the oceans. I don't really believe that.”

“…our business models include the protection of the natural services an ecosystem provides. And that's been the challenge to make sure that-- I guess that's the argument that the people who say, "Well, no, it's [climate change] a hoax. There is no climate change caused by humans." And it's like, "Well, that doesn't even make sense with the physics of the situation. We know that we're having a big, huge impact on the environment." I look across the fields and imagine what it was like a few hundred years ago when it was all prairie. And it's like, "Do you think we're having a big impact on the environment?" Look out your window. Most people look out the window and see more people instead of just a diverse and a wild, natural environment. We tend to think about people's problems and we don't think about how it affects our world.”

“I do believe that climate change is happening. I don't know if - as a human race - we should just throw our hands up in the air and say, "Oh my gosh, it's all our fault." We might have something to do with it. We might not. We might have everything to do with it to a small degree. There's always changes going-- it's just a really long-term trend because, in North America, we don't have hardly any data since before 1870, around here in the Midwest. And on the East Coast, of course, not much data before 1700. So maybe this happens every 5-700 years. I don't know; maybe you do. Maybe you'll find out in your career. I don't know. But then again, maybe we are burning too many fossil fuels and cutting down too many trees, and tearing up too much sod. Which gas is the largest greenhouse gas contributor? Is it methane or CO2?”

Adoption of Conservation Practices

To better understand what agricultural producers think the advantages and disadvantages of conservation practices are and which practices they are more likely to adopt now and in the future, we collected both qualitative and quantitative data. We present the quantitative results first to show which conservation practices producers are willing to adopt now and after they were presented climate information. Qualitative data is presented second to provide a better understanding about what producers think about each practice and why they are more or less willing to adopt those practices.

Results of the Analytical Hierarchical Process (AHP; n = 15) indicate that decreasing erosion losses from agricultural land is the largest influence on producer decision-making when evaluating whether to implement a conservation practice. Decreasing fertilizer loss, overall net costs, and decreasing flooding are also influencing farmer decision-making. In comparison to these decision criteria, increasing biodiversity and decreasing climate change risks are not as large of factors when producers are making decisions about adopting conservation practices. The AHP results indicate that producers give more weight to erosion control when making decisions about adopting conservation practices than decreasing flooding, biodiversity or risks of climate change.

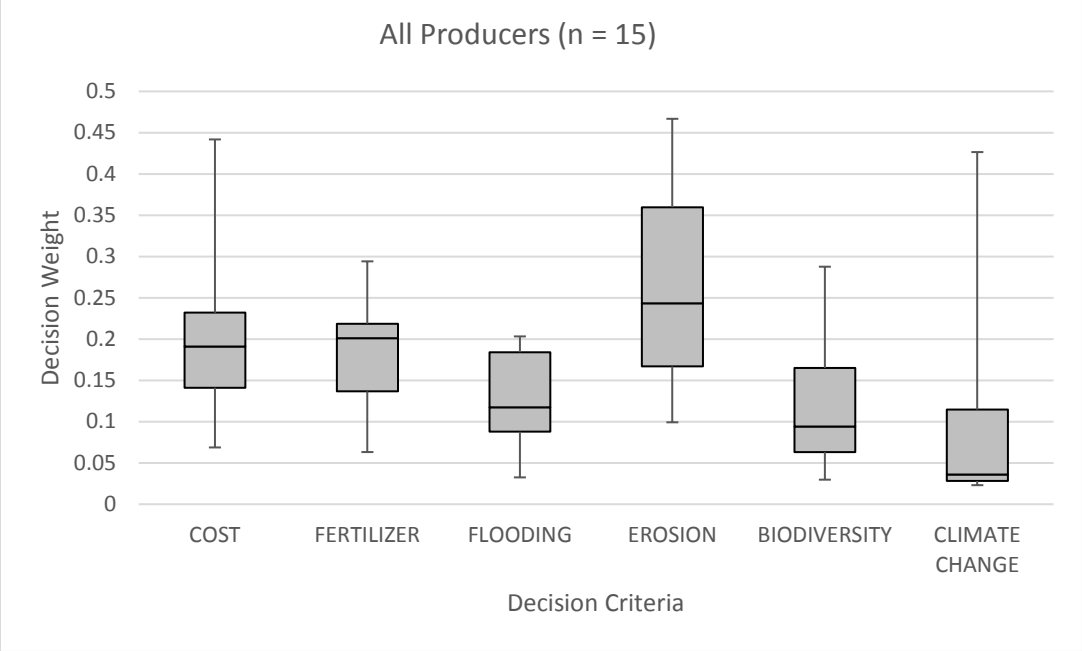


Figure 1. Weights of decision criteria on producer decision making

To measure agricultural producer's willingness to adopt conservation practices we created a mean of responses to the closed ended, five point Likert scale for each conservation practice (one meaning not willing to adopt, five meaning very willing to adopt). Table 1 shows the mean level of willingness to adopt different practices. Data suggests that there is a strong willingness to adopt grass waterways, no-till, cover crops, filter strips, and drainage water management. Agricultural producers are less willing to adopt strip tillage, constructed wetlands, and riparian buffers. After a discussion of the predicted temperature and precipitation changes that may occur in the upper Midwest, producers were asked whether their level of willingness to adopt would change after receiving additional climate information. To gauge producer's willingness to adopt, we did a simple count of those who would increase, decrease, or retain the same level of adoption. Data suggests that producers are willing to increase practices they are already willing to adopt; grass waterways, no-till, filter strips, and cover crops.

Table 1. Mean Willingness to Adopt Conservation Practices (n = 15)

Practice	Mean Adoption	Increase	Neutral	Decrease
Grassed Waterways	4.73	5	11	0
Cover Crops	3.67	7	9	0
No-Till	3.63	5	11	0
Filter Strips	3.44	5	11	0
Drainage Water Management	3.31	2	14	0
Constructed Wetlands	2.56	2	12	2
Riparian Buffer Strips	2.00	1	12	3
Strip Cropping	1.88	1	15	0

Mean adoption was on a 1-5 Likert scale; 1 = unlikely to adopt, 5 = very likely to adopt. Producers were asked whether their level of current adoption would be likely to increase, stay the same (neutral) or decrease due to climate change.

Interviewees were asked their perspectives on the advantages and disadvantages of each practice. Table 2 is a summary of interview responses that were reported by more than one interviewee. For practices interviewees were likely to adopt, the common advantages mentioned were erosion control (sheet and rill), feed for livestock, reduction in nutrient loss (retention of nutrients), and an increase in water quality. Disadvantages pertained to an increase in management or maintenance, adding to labor and equipment costs.

Table 2. Advantages and Disadvantages of Adopting Conservation Practices Identified by Interviewees

Practice	Advantages	Disadvantages
Filter Strips	- Erosion control (bank and sheet/rill) - Nutrient retention - Feed for livestock - Wildlife habitat - Improved access to field edges - CRP payments	- Not compatible with tile drains, roots may clog tile especially with switchgrass - Timing of mowing for weed management - Tree volunteers
No-Till	- Reduced costs (labor, fertilizer and chemicals, machinery, fuel) - Reduced time, management - Erosion control, water quality - Increased soil health, organic matter	- Too much soil moisture, drainage - Low soil temperature in spring - Delayed spring planting - Incorporation of nutrients, manure - Consistent seed depth when planted - Corn stalk residue - Development of uneven ground - Weed management - Soil compaction
Cover Crops	- Increased soil health, organic matter - Erosion control (wind, sheet/rill) - Water quality - Decreased soil compaction - Nutrient retention, decreased nutrient application - Weed management	- Timing of seeding with late harvest - Measurement of benefits to farm, delayed benefits - Can't apply manure - Less forage for livestock - Application of seed (aerial or drill) - Timing of killing off cover crop in spring
Grassed Waterways	- Erosion control (bank, sheet/rill) - Forage for livestock - Nutrient retention - Water quality - Wildlife habitat	- Maintenance over time, cleaning out sediment, reworking ground, re-seeding, mowing - Mowing restriction by NRCS
Riparian Buffer Strips	- Erosion control (bank) - Wildlife habitat	- No areas for use, not applicable except along ditches and streams - Maintenance - Wildlife (beavers) - Maneuvering equipment - Damming of creeks - Roots in tile
Drainage Water Management	- Water management (shut off, slow down drainage) - Use with bioreactors - Good for sandy soils, dry areas - Use for water quality monitoring - Nutrient retention	- Topography (slope, farm characteristics) - Want to drain land, not hold water back - Maintenance, having to open/close - "Blowing out" tile drains due to slope
Constructed Wetlands	- Wildlife habitat - Water quality	- Government regulations - Reversing past efforts to drain farmland - Taking land out of production
Strip Cropping	- Increased yields - Increase sunlight to corn - Decreased erosion (wind)	- Lose ground for equipment maneuvering - Shape of field - New equipment requirements

Discussion

The purpose of this study was to understand farmer's motivations to adopt conservation practices including perceptions of water quality and climate change. Interviewees discussed water quality as a major motivator in light of current events in Iowa and proximity of the watershed to Cedar Rapids. Interviewees showed an awareness of current water quality issues within the watershed and in the region, contributing to their motivations to adopt conservation practices.

The AHP results indicate that reducing soil erosion and nutrient loss are weighted more than decreasing risks of climate change or increasing biodiversity (wildlife) when making decisions about adopting conservation practices. However, there is wide variability in weights given to each criteria, indicating that there is not strong consistency in the weight interviewees give to one criteria in relation to another; for example, one interviewee may give more weight to reducing risks of climate change than reducing soil erosion when implementing a conservation practice while another interviewee may be give more weight to soil erosion.

Interviewees were asked about their perceptions of climate change. Most interviewees expressed skepticism about human contributions to climate change but acknowledged that climate changes over time. After being presented with climate scenarios of precipitation and temperature changes interviewees were asked if their use of conservation practices would increase, decrease, or stay the same. Many of the practices that would increase were practices that interviewees were already willing to adopt or would decrease or stay the same. This indicates that climate change may not be a motivator for adoption of conservation practices.

In their discussions of the advantages and disadvantages of conservation practices, many of the advantages are focused on on-farm benefits while off-farm benefits were secondary. For example, when producers spoke of the advantages/disadvantages of grassed waterways they spoke of more immediate outcomes, soil erosion or forage for livestock, while constructed wetlands focused outcomes that are more removed from their farm, wildlife or water quality. This is consistent with the weight given to reducing erosion control and loss of nutrients rather than benefits to biodiversity. Interestingly, many of the advantages were abstract (e.g. wildlife benefits), many of the disadvantages mentioned for each practice focused on problems with implementation or management of those practices or the requirement to change farming operations (e.g. delayed spring planting). This implies that if interviewees are thinking of using conservation practices to address environmental issues (e.g. water quality), the fact that some practices have more concrete disadvantages may weigh more heavily than abstract benefits.

These results will help researchers at Purdue University and Oregon State University create applications which tailor information and advice provided through online web applications. These applications are trying to help understand what practices may be applicable to farmers at the field scale and how to measure on-farm and off-farm benefits of those practices. By understanding the barriers, constraints, and motivations for adoption of conservation practices, we will be able to provide better suggestions and advice when farmers are using these tools.

Appendix A. Interview Guide

Interview Guide in Wabash Case Study

We are part of a team that is evaluating the impact of extreme climate events in agriculture in several sub-basins of the Mississippi River Basin. The knowledge we gain from interviews will allow us to understand how local stakeholders perceive the problem and why.

Your participation in this interview is completely voluntary. If you choose to participate in this interview, your responses will remain confidential and your name will never be used in any report or publication. You may skip any questions you do not want to answer and you can stop the interview at any time.

Are you willing to participate in the interview?

Do you mind if I record this interview for transcription purposes?

Opening questions

1. How long have you (or your family) farmed here?
2. Could you tell me about your farm?
    1. (If not answered) How many acres do you own and manage (rent/manage and own/rent out)?
    2. (If not answered) What kind of crops or livestock do you raise on your farm?

Goals for implementing Conservation Practices

3. Do you currently use any conservation practice on your farm?
4. If you consider implementing conservation practices what goals do you want to accomplish? Please briefly explain your answer (if more than one goal ask him/her which one is the most important and why)
5. In your opinion, is improving water quality an important goal for implementing conservation practices? Please explain your answer.
    3. And improving habitat for wildlife? Please explain your answer.
    4. And reducing impacts associated with changing patterns in rainfall and dry weather conditions? Please explain your answer.
6. Is any of the land you own or manage currently enrolled or enrolled in the past in the Conservation Reserve Program (CRP) of the Farm Service Agency (FSA)?
    5. (If not) Could you tell me about the main reasons? (E.g. subsidy, environmental requirements, etc.)
    6. (If yes) Could you tell me about your experience with the CRP? (Pros and cons, reasons why used in the past and not currently using it)

Implementing Conservation Practices (see definition of each conservation practice)

No-Till

7. Do you currently use No-Till on your farm? (If Yes, when? How? Why?)
8. What are the main barriers and incompatibilities to use it on your farm? And motivations?
9. In your opinion, what are the benefits of using No-Till?
10. Do you think using No-Till on your farm can improve water quality in downstream creeks and rivers? And habitat for wildlife? And reduce the impacts of extreme climatic events?
11. How do you think using No-Till on your farm could impact your short- and long-term profit? Decreasing fertilizer and erosion losses? Decreasing flooding? Are there any other criteria that you may consider for using No-Till?
12. Under current climatic conditions, on a scale from 1 to 5 (1 = Not willing to implement and 5 = Very willing to implement), how willing are you to use No-Till on your farm? (briefly explain the main reason for your answer)

Strip Cropping

13. Do you currently use Strip Cropping on your farm? (If Yes, when? How? Why?)
14. What are the main barriers and incompatibilities to use it on your farm? And motivations?
15. In your opinion, what are the benefits of using Strip Cropping?
16. Do you think using Strip Cropping on your farm can improve water quality in downstream creeks and rivers? And habitat for wildlife? And reduce the impacts of extreme climatic events?
17. How do you think using Strip Cropping on your farm could impact your short- and long-term profit? Decreasing fertilizer and erosion losses? Decreasing flooding? Are there any other criteria that you may consider for using Strip Cropping?
18. Under current climatic conditions, on a scale from 1 to 5 (1 = Not willing to implement and 5 = Very willing to implement), how willing are you to use Strip Cropping on your farm? (briefly explain the main reason for your answer)

Filter Strip

19. Do you currently use Filter Strip on your farm? (If Yes, when? How? Why?)
20. What are the main barriers and incompatibilities to use it on your farm? And motivations?
21. In your opinion, what are the benefits of using Filter Strip?
22. Do you think using Filter Strip on your farm can improve water quality in downstream creeks and rivers? And habitat for wildlife? And reduce the impacts of extreme climatic events?
23. How do you think using Filter Strip on your farm could impact your short- and long-term profit? Decreasing fertilizer and erosion losses? Decreasing flooding? Are there any other criteria that you may consider for using Filter Strip?
24. Under current climatic conditions, on a scale from 1 to 5 (1 = Not willing to implement and 5 = Very willing to implement), how willing are you to use Filter Strip on your farm? (briefly explain the main reason for your answer)

Riparian Forest Buffer

25. Do you currently use Riparian Forest Buffer on your farm? (If Yes, when? How? Why?)
26. What are the main barriers and incompatibilities to use it on your farm? And motivations?
27. In your opinion, what are the benefits of using Riparian Forest Buffer?
28. Do you think using Riparian Forest Buffer on your farm can improve water quality in downstream creeks and rivers? And habitat for wildlife? And reduce the impacts of extreme climatic events?
29. How do you think using Riparian Forest Buffer on your farm could impact your short- and long-term profit? Decreasing fertilizer and erosion losses? Decreasing flooding? Are there any other criteria that you may consider for using Riparian Forest Buffer?
30. Under current climatic conditions, on a scale from 1 to 5 (1 = Not willing to implement and 5 = Very willing to implement), how willing are you to use Riparian Forest Buffer on your farm? (briefly explain the main reason for your answer)

Cover Crops

31. Do you currently use Cover Crops on your farm? (If Yes, when? How? Why?)
32. What are the main barriers and incompatibilities to use it on your farm? And motivations?
33. In your opinion, what are the benefits of using Cover Crops?
34. Do you think using Cover Crops on your farm can improve water quality in downstream creeks and rivers? And habitat for wildlife? And reduce the impacts of extreme climatic events?
35. How do you think using Cover Crops on your farm could impact your short- and long-term profit? Decreasing fertilizer and erosion losses? Decreasing flooding? Are there any other criteria that you may consider for using Cover Crops?
36. Under current climatic conditions, on a scale from 1 to 5 (1 = Not willing to implement and 5 = Very willing to implement), how willing are you to use Cover Crops on your farm? (briefly explain the main reason for your answer)

Grassed Waterways

37. Do you currently use Grassed Waterways on your farm? (If Yes, when? How? Why?)
38. What are the main barriers and incompatibilities to use it on your farm? And motivations?
39. In your opinion, what are the benefits of using Grassed Waterways?
40. Do you think using Grassed Waterways on your farm can improve water quality in downstream creeks and rivers? And habitat for wildlife? And reduce the impacts of extreme climatic events?
41. How do you think using Grassed Waterways on your farm could impact your short- and long-term profit? Decreasing fertilizer and erosion losses? Decreasing flooding? Are there any other criteria that you may consider for using Grassed Waterways?
42. Under current climatic conditions, on a scale from 1 to 5 (1 = Not willing to implement and 5 = Very willing to implement), how willing are you to use Grassed Waterways on your farm? (briefly explain the main reason for your answer)

Constructed wetlands

43. Do you currently use Constructed wetlands on your farm? (If Yes, when? How? Why?)
44. What are the main barriers and incompatibilities to use it on your farm? And motivations?
45. In your opinion, what are the benefits of using Constructed wetlands?
46. Do you think using Constructed wetlands on your farm can improve water quality in downstream creeks and rivers? And habitat for wildlife? And reduce the impacts of extreme climatic events?
47. How do you think using Constructed wetlands on your farm could impact your short- and long-term profit? Decreasing fertilizer and erosion losses? Decreasing flooding? Are there any other criteria that you may consider for using Constructed wetlands?
48. Under current climatic conditions, on a scale from 1 to 5 (1 = Not willing to implement and 5 = Very willing to implement), how willing are you to use Constructed wetlands on your farm? (briefly explain the main reason for your answer)

Drainage Water Management

49. Do you currently use Drainage Water Management on your farm? (If Yes, when? How? Why?)
50. What are the main barriers and incompatibilities to use it on your farm? And motivations?
51. In your opinion, what are the benefits of using Drainage Water Management?
52. Do you think using Drainage Water Management on your farm can improve water quality in downstream creeks and rivers? And habitat for wildlife? And reduce the impacts of extreme climatic events?
53. How do you think using Drainage Water Management on your farm could impact your short- and long-term profit? Decreasing fertilizer and erosion losses? Decreasing flooding? Are there any other criteria that you may consider for using Drainage Water Management?
54. Under current climatic conditions, on a scale from 1 to 5 (1 = Not willing to implement and 5 = Very willing to implement), how willing are you to use Drainage Water Management on your farm? (briefly explain the main reason for your answer)

Water quality and Habitat for wildlife

55. In your opinion, do you think creeks and rivers where you farm have water quality problems?
56. What do you think the main contributors to creeks and rivers pollution are in your area? Why do you think that or how come?
57. To what extent do you think that agriculture contributes to water quality problems in your area? And to damage habitat for wildlife?
58. Do you think it is farmers' responsibility to help protect water quality? And habitat for wildlife?
59. To what extent are you interested in improving water quality through changing your farm-management practices?

60. Have you implemented conservation practices on your farm to improve water quality and/or increase wildlife habitat?
- If yes, can you describe which conservation practice you implemented and explain why you chose that practice?
- If no, can you explain the main reason why you did not implement any conservation practice?

61. What other practices would you consider implementing on your farm in order to improve water quality and/or increase wildlife habitat?
- Can you explain the main reason(s) (barriers) for not implementing such practices?

Climate change

62. How does climate impact your crop yield?
63. Within the last 10 years, have you noticed an increase in the frequency of weather extremes events on your farm (droughts, floods, heatwaves and freezing spells)? And changes in temperature and precipitation? If so, what impact have these had on your crop yields? Are there certain times during the growing season that your crops are most vulnerable to these events? Least?
64. Have you changed your farm-management practices to reduce or minimize impacts and risks associated with weather extremes (droughts, floods, heatwaves and freezing spells)? And changes in temperature and precipitation?
65. If yes, what changes have you implemented? Please briefly explain the reason(s).
66. If no, can you explain the main reason(s) why you have not changed your farm-management practices?
67. What other practices would you consider implementing on your farm to reduce or minimize impacts and risks associated with weather extremes events (droughts, floods, heatwaves and freezing spells)? And changes in temperature and precipitation?
- Can you explain the main reason(s) (barriers) for not implementing such practices (e.g. uncertainty, long time horizon to make decisions)?

68. How do you think changes in climatic patterns in the next 10 or 20 years will affect your agricultural production? With respect to droughts, floods, heatwaves and freezing spells?
69. These are predictions of future climate in your region (show respondent projections), do you agree with these predictions? Please briefly explain your answer (if they do not say it, ask if they believe or not in climate change and if they think it is human made).
70. Taking into account these future climatic predictions, would you be more inclined to change your farm-management practices? Please briefly explain your answer.
71. If yes, what changes would you implement? With respect to droughts, floods, heatwaves and freezing spells? And changes in temperature and precipitation?
72. If no, can you explain the main reason(s) for not implementing any change?
73. Would you be more interested in enrolling some of your land you own or manage in the Conservation Reserve Program? And abandoning farming? Please briefly explain your answer.

74. If these future climate predictions in your region were right (show respondent climate change projections), on a scale from 1 to 5 (1 = Not willing to implement and 5 = Very willing to implement), how willing would you be to use No-Till on your farm? Why? Ask the same question for all conservation practices:
    a. Strip Cropping
    b. Filter Strip
    c. Riparian Forest Buffer
    d. Cover Crops
    e. Grassed Waterways
    f. Constructed wetlands
    g. Drainage Water Management

Marginal land

75. Do you have any marginal land? (If yes: Why marginal? Poor soil, slope, river bank, environmental sensitivity Acreage? If no go to Q31
76. How do you use this (marginal) land?
77. Have you had marginal land enrolled in a conservation program? (if yes: what programs and for how long?)
78. What do you think the advantages and disadvantages are to owning marginal land?
79. What do you consider to be marginal land (generally)? (Poor soil, slope, river bank, environmental sensitivity)
80. What do you think the advantages and disadvantages are to owning marginal land?
81. Has what you consider to be marginal land changed over time? (What has changed? How? Why? Year to year? Season to season?)
82. (If having marginal land) Is the marginal land you own or manage currently enrolled or enrolled in the past in the Conservation Reserve Program? Please briefly explain the reasons of your answer.

83. Just so I can get an overall picture of the demographics of the people who participated in this program, could you tell me your:
84. Age (year born)
85. Highest grade in school you have completed? (If college, what coursework/degree?)

Thank you for taking the time to talk with me today.

Appendix B. Analytical Hierarchical Process (AHP)

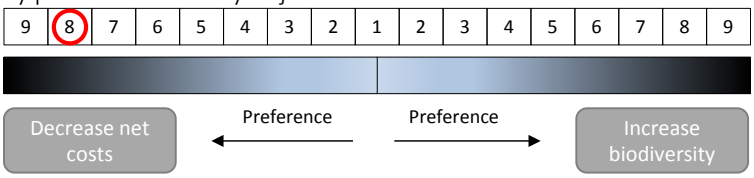
Pairwise comparisons of 6 objectives for implementing conservation practices through Analytical Hierarchical Process (AHP)

- Decrease net costs
- Decrease fertilizer losses
- Decrease flooding
- Decrease erosion losses
- Increase biodiversity
- Decrease climate change risks

Next, through pairwise comparisons, I will ask you to determine which objective you like the best in terms of implementing conservation practices on your farm. We have made a relative scale to measure how much you prefer the objective on the left side as compared with the objective on the right side.

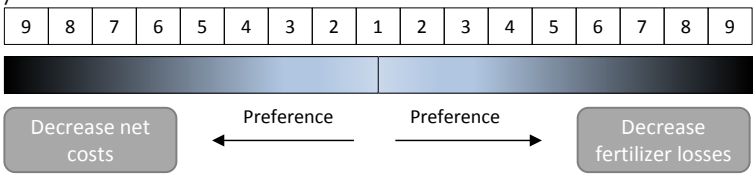
Example

The figure below shows an example where respondent considerably likes the objective on the left (Decrease net costs) better than the objective on the right (Increase biodiversity). Therefore the circle is on the number 8 on left side. If respondent did not have any preference for any objective over the other one then the circle would be on number 1.



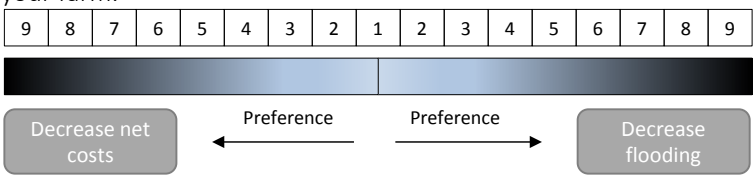
Decrease net costs VS. Decrease fertilizer losses

Please circle the number where you consider your preference of one objective over the other for implementing conservation practices on your farm.



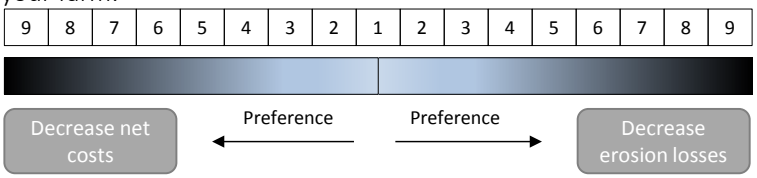
Decrease net costs VS. Decrease flooding

Please circle the number where you consider your preference of one objective over the other for implementing conservation practices on your farm.



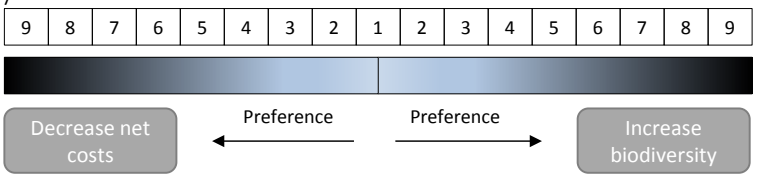
Decrease net costs VS. Decrease erosion losses

Please circle the number where you consider your preference of one objective over the other for implementing conservation practices on your farm.



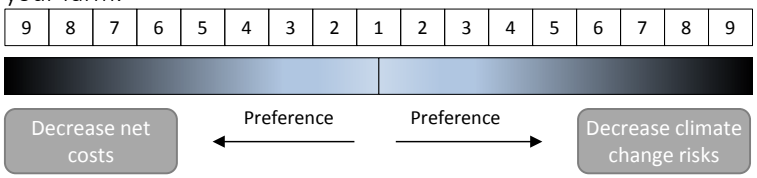
Decrease net costs VS. Increase biodiversity

Please circle the number where you consider your preference of one objective over the other for implementing conservation practices on your farm.



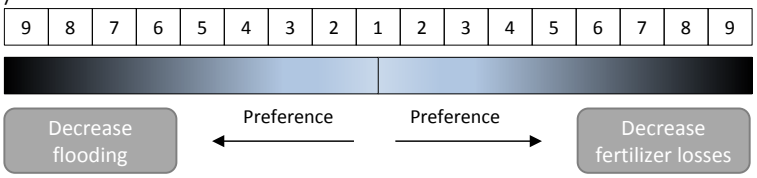
Decrease net costs VS. Decrease climate change risks

Please circle the number where you consider your preference of one objective over the other for implementing conservation practices on your farm.



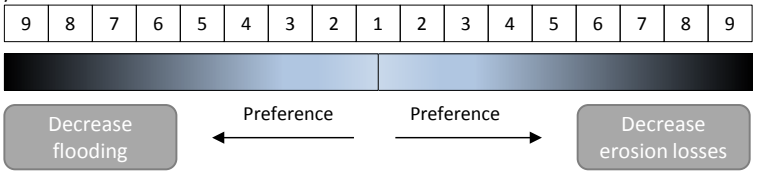
Decrease flooding VS. Decrease fertilizer losses

Please circle the number where you consider your preference of one objective over the other for implementing conservation practices on your farm.



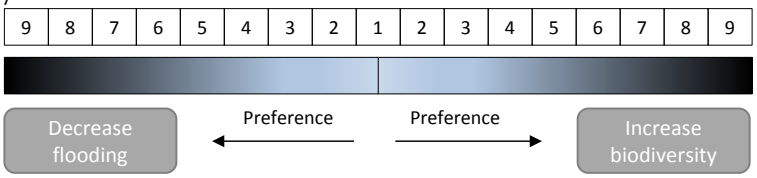
Decrease flooding VS. Decrease erosion losses

Please circle the number where you consider your preference of one objective over the other for implementing conservation practices on your farm.



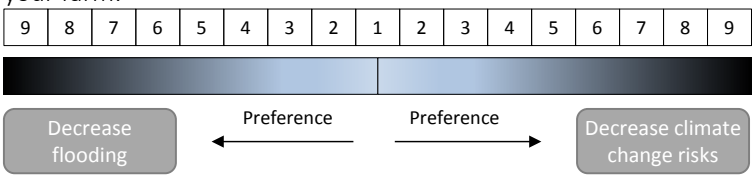
Decrease flooding VS. Increase biodiversity

Please circle the number where you consider your preference of one objective over the other for implementing conservation practices on your farm.



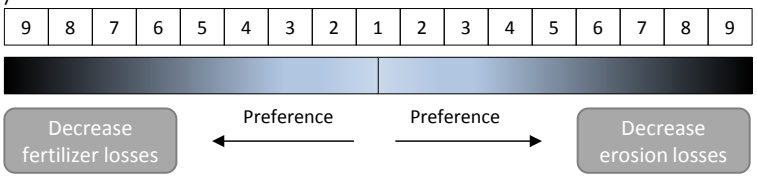
Decrease flooding VS. Decrease climate change risks

Please circle the number where you consider your preference of one objective over the other for implementing conservation practices on your farm.



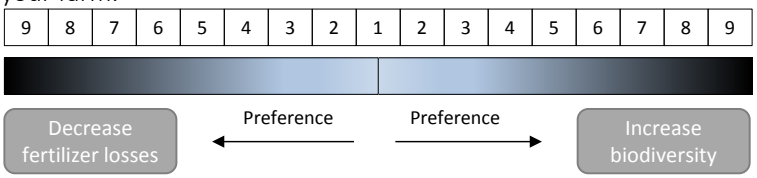
Decrease fertilizer losses VS. Decrease erosion losses

Please circle the number where you consider your preference of one objective over the other for implementing conservation practices on your farm.



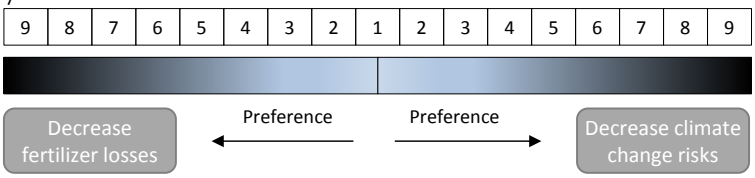
Decrease fertilizer losses VS. Increase biodiversity

Please circle the number where you consider your preference of one objective over the other for implementing conservation practices on your farm.



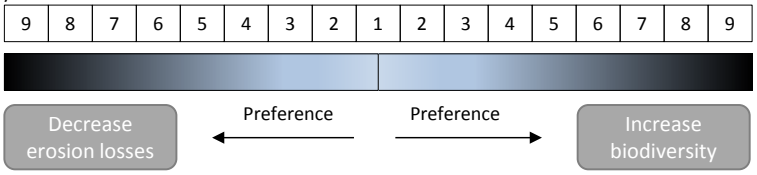
Decrease fertilizer losses VS. Decrease climate change risks

Please circle the number where you consider your preference of one objective over the other for implementing conservation practices on your farm.



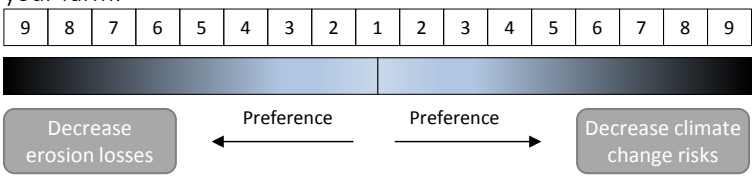
Decrease erosion losses VS. Increase biodiversity

Please circle the number where you consider your preference of one objective over the other for implementing conservation practices on your farm.



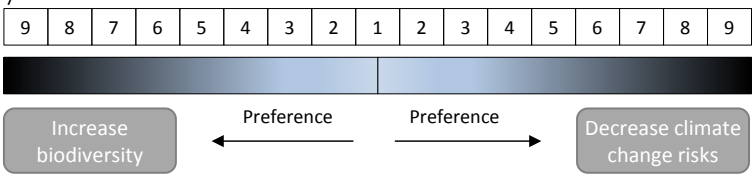
Decrease erosion losses VS. Decrease climate change risks

Please circle the number where you consider your preference of one objective over the other for implementing conservation practices on your farm.



Increase biodiversity VS. Decrease climate change risks

Please circle the number where you consider your preference of one objective over the other for implementing conservation practices on your farm.



Appendix C. Conservation Practice Description

Definition of the conservation practices used in the interviews (adapted from NRCS Field Office Technical Guide Standards, http://www.nrcs.usda.gov/)

1. No-Till Maintaining crop residue on the soil surface year around by limiting soil disturbance to manage the amount, orientation and distribution of crop and plant residue.	
2. Strip-Cropping Growing planned rotations of row crops, forages, small grains, or fallow in a systematic arrangement of strips in a field to reduce soil erosion and improve water quality.	
3. Filter Strip An area of vegetation established for removing sediment, organic material, and other pollutants from runoff and wastewater.	
4. Riparian Forest Buffer An area of trees and/or shrubs located adjacent to watercourses or water bodies.	
5. Cover Crops Growing a crop of grass, small grain, or legumes primarily for seasonal protection and soil improvement.	
6. Grassed Waterways A shaped or graded channel that is established with suitable vegetation to convey surface water at a non-erosive velocity using a broad and shallow cross section to a stable outlet.	
7. Constructed wetlands An artificial ecosystem consisting of a shallow basin established with hydrophytic vegetation that is constructed to intersect and treat the flow of a waste stream or contaminated runoff.	
8. Drainage Water Management Managing water discharges from surface and/or subsurface agricultural drainage systems with water-control structures.	

Climate changes in the Wabash River Basin

Figure 1: More extreme heat events

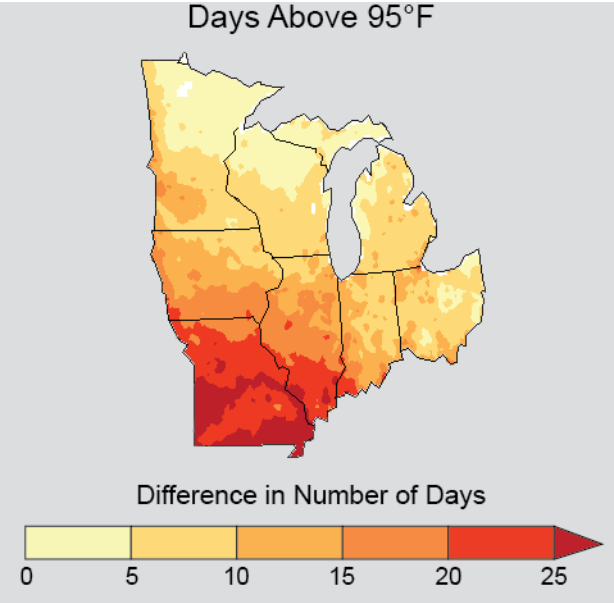


Figure 2: Longer growing season

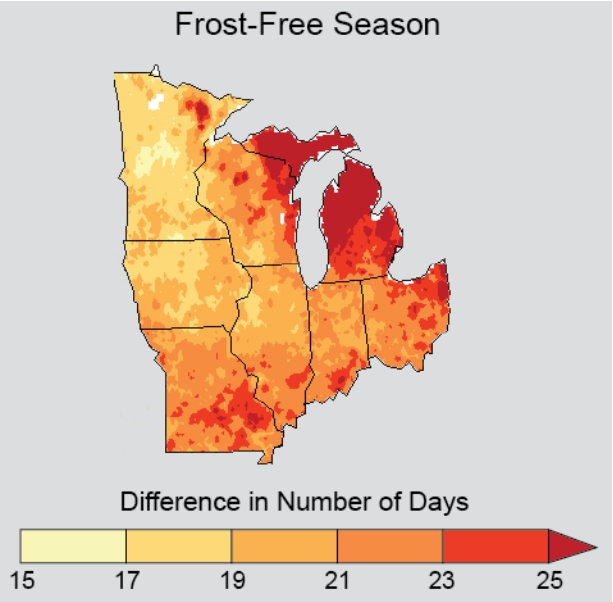


Figure 3: Longer dry spells (droughts)

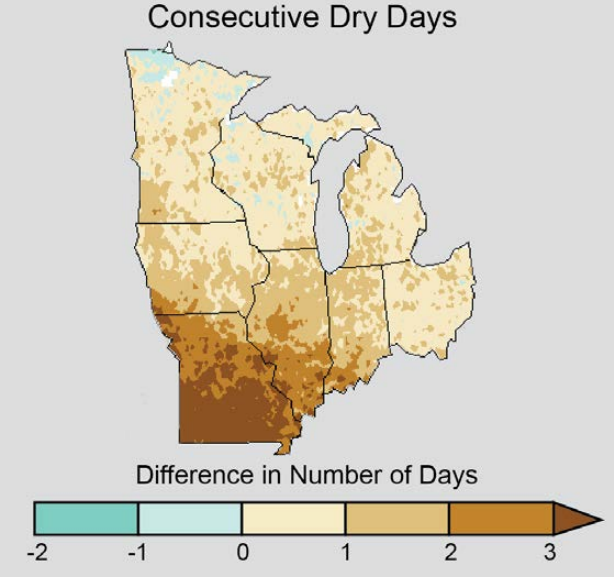


Figure 4: Heavier rains (floods)

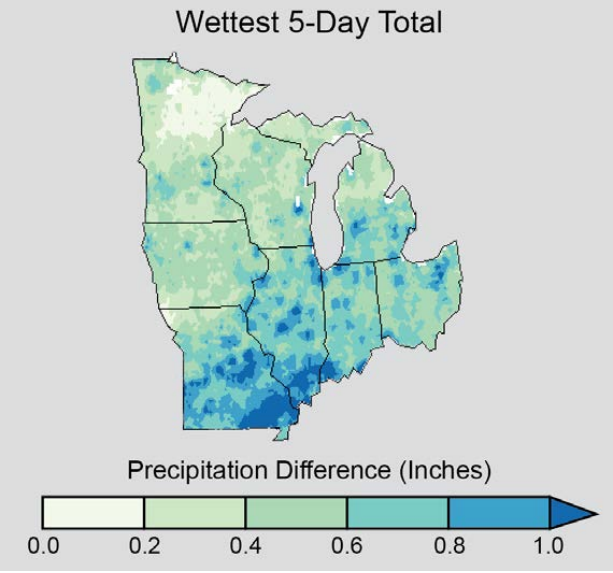


Figure 5: Warming temperatures

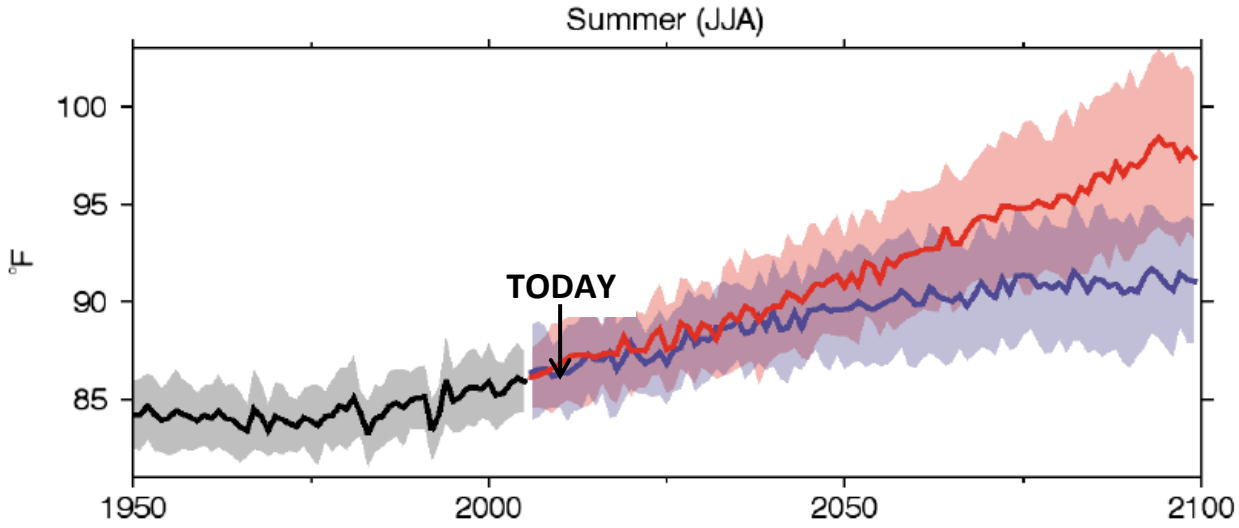
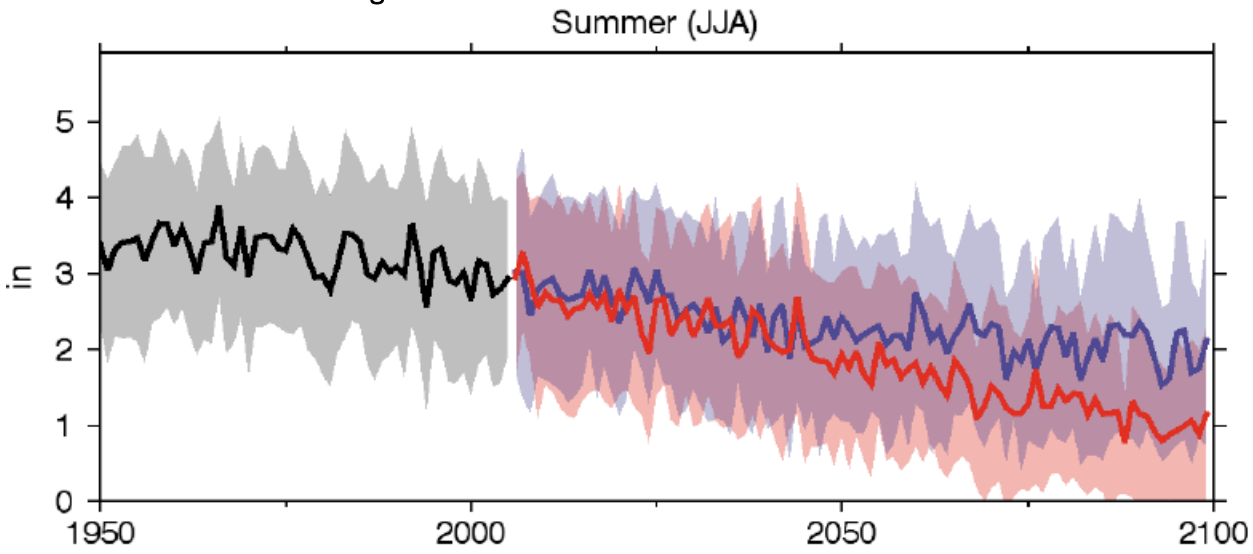


Figure 6: Less soil moisture storage



Sources

Figures 1 – 4*: Pryor, S. C., D. Scavia, C. Downer, M. Gaden, L. Iverson, R. Nordstrom, J. Patz, and G. P. Robertson, 2014: Ch. 18: Midwest. Climate Change Impacts in the United States: The Third National Climate Assessment, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 418-440. doi:10.7930/J0J1012N.

Figures 5 – 6: Alder, J. R. and S. W. Hostetler, 2013. USGS National Climate Change Viewer. US Geological Survey, http://www.usgs.gov/climate_landuse/clu_rd/nccv.asp, doi:10.5066/F7W9575T).

* Differences between the 1971-2000 and 2041-2070 averages for the worst-case scenario are shown.