

FINANCING CHANGE:

FIVE BOLD WAYS TO REVIVE THE DEAD ZONE & REBUILD SOILS



Wicked Econ Fests

A partnership between The Nature Conservancy and University of Minnesota's Institute on the Environment aims to break the mold of classic university-NGO collaborations. Opportunities to influence major decisions for conservation and human well-being involve increasingly complex issues related to economics, from subsidy design to corporate practice to financing options. In these fast-paced contexts, windows of opportunity arise—and close—quickly. Conservation faces a moment where the need to rapidly mobilize world class economics around “wicked” (complex, intractable) environmental problems is paramount.

The typical formula for university collaboration commonly falls short, so we have created Wicked Econ Fests. These one-time, problem-focused engagements convene leading economics, finance and policy experts with conservation practitioners for up to one week to tackle a specific decision-driven challenge. The workshops result in recommendations and the hand-off of advances in economic, finance, policy and conservation thinking to those who can drive recommendations to action.

This report is the result of the first workshop held at the University of Minnesota on April 12-14, 2016.

Financing Change: Five Bold Ways to Revive the Dead Zone and Rebuild Soils

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Executive Summary

The Mississippi River Basin faces a central challenge: How can agriculture and river management practices continue to provide crop production, water supply, flood regulation, transportation and other benefits without the current burden of environmental costs? We propose five bold finance opportunities to create rapid, widespread adoption of beneficial practices that can support agricultural production while tangibly rebuilding soil carbon and reducing water pollution in the Mississippi River Basin in the next five years.

Couple crop insurance premium subsidies with adoption of beneficial practices for nutrient, water and soil outcomes. Specifically, modify the Federal Crop Insurance Program to create a sliding scale with higher premium subsidies provided to farmers adopting beneficial practices.

Enable private service providers to drive targeted adoption of beneficial practices. Specifically, train and incentivize private service providers to support farmer adoption of precision technology and targeted use of beneficial practices in high impact areas.

Expand and target Farm Bill funding of beneficial practices in high impact areas for reductions in nitrogen loss and soil carbon improvement. Specifically, direct at least \$500 million annually in new funds to the Mississippi River Basin Healthy Watersheds Initiative (MRBI). In addition, target existing Conservation Reserve Program (CRP) funds to high impact areas as existing contracts expire, and redirect at least \$500 million of existing funds annually from the Environmental Quality Incentive Program (EQIP), CRP, and the Agricultural Conservation Easement Program (ACEP) to the MRBI.



Drive ballot initiatives or legislative actions to develop new state funds that support adoption of beneficial practices in high impact areas for reductions in nitrogen loss and soil carbon improvement. Specifically, support existing efforts in Iowa and Ohio and promote emerging efforts in Indiana and Illinois to develop public/private funds that invest in beneficial practices in high nitrogen-contributing sub-watersheds.

Direct post-disaster federal funds towards restoration in high impact areas for reductions in nitrogen loss and flood risk, and soil carbon improvement. Specifically, provide science and build capacity for federal, state, and local agencies to support and target floodplain management and reconnection, buyouts, and habitat restoration (wetland, oxbow, forest, etc.) in high impact areas.

These solutions could surpass the 2025 interim nutrient reduction goal for managing the Dead Zone challenge, and contribute meaningfully to the rebuilding of soils and greenhouse gas reduction.

If all five strategies were successful at the levels we propose, they could achieve approximately 30% annual nitrate reductions at the outlet of the Ohio and Upper Mississippi River Basins, surpassing the intermediate 2025 target and achieving approximately 60% of the long term target (45% reduction). Three strategies (crop insurance, private sector providers and alteration of the Farm Bill) are promising on their own, with the potential to achieve 60%, 40% and 30% of the interim 2025 target, respectively. In terms of climate mitigation and rebuilding soils, the crop insurance and private service provider mechanisms provide the greatest potential. Taken together, all five mechanisms could rebuild over 26 million metric tons of carbon in soils and provide the same greenhouse gas reductions per year (~47 MMTCO₂e) as taking 13 coal-fired energy plants offline. These proposed solutions all face political, financial, cultural or institutional challenges, but with focused efforts, we suggest they can be overcome to create unprecedented, meaningful nutrient reduction and soil rebuilding in the next five years.



Problem Statement

Development in the Mississippi River Basin over the last century has yielded many benefits for economic growth, food production, transportation and other sectors. At the same time, conversion and management of land for agriculture, straightening and management of rivers for transportation and flood control, and the adoption of some agricultural technologies and practices have contributed to massive soil loss, reduction of soil carbon, high levels of nutrient pollution, and climate change. Climate change itself now heightens challenges for food production, river management, and conservation as rainfall becomes more intense and flashy, droughts intensify, and habitats change.



In light of these challenges, some restoration activities, river management practices, and agricultural practices have emerged as cost effective means to avoid these negative impacts, contributing to rebuilding soil carbon and reducing nutrient pollution. We call these ‘beneficial practices’. While the potential benefits of many of these practices are known, they are not widely adopted.

Beneficial Practices

We refer to beneficial practices as those agricultural or river management practices that have proven ability to reduce nutrient pollution and/or improve soil carbon sequestration. Many of these agricultural practices also have the potential to improve crop yields or reduce farm costs (e.g. through improved nutrient management or soil fertility). All financing mechanisms we recommend currently do, or reasonably could support at least one of the following ‘beneficial practices’: subsurface tile management, conservation tillage, treatment wetlands, cover crops, nutrient management, perennial crops, land retirement, saturated buffers, floodplain restoration and reconnection, and wetland or forest restoration in floodplains. These practices are defined in Appendix A, and cross-walked with financing mechanisms in Appendix C.

Opportunity Statement

The Mississippi River Basin presents a unique opportunity to beneficial practices that have the potential to rebuild soil carbon, reduce nutrient pollution, regulate floods, improve agricultural production, and provide conservation. The opportunity for improvement in the Basin is large, and has been addressed by several multi-sector analyses and efforts. Reducing the Gulf of Mexico Dead Zone can be done most efficiently through targeted efforts in high nutrient source regions that have been identified through extensive modeling efforts. The Ohio and Upper Mississippi River Basins have been identified as key watershed areas that disproportionately influence nutrient export to the Gulf of Mexico. The Mississippi River/Gulf of Mexico Hypoxia Task Force has set an interim goal of reducing annual nutrient export from these basins 20% by 2025, working towards an eventual 45% annual reduction needed to manage the Dead Zone. On the carbon side, cultivated soils have lost 50-70% of their original carbon stocks worldwide.



With the massive amounts of agricultural lands under active management in the Basin, there is a large opportunity to rebuild soils, and mitigate climate change while also improving crop yields. We focus on four states (Iowa, Illinois, Indiana and Ohio) in the heart of the corn belt that hold great potential to deliver crop production, water quality, soil fertility and climate mitigation benefits. Achieving widespread adoption of beneficial practices in these areas could efficiently contribute to the public goal of reducing the Dead Zone, and could dramatically rebuild soils.

Financing Change: Identifying Plausible Finance Mechanisms

There are many factors that currently limit widespread adoption of beneficial practices in the Mississippi Basin. Some factors are technical, including capacity limitations regarding the use of technology, methods or practices or a lack of familiarity with beneficial practices and the opportunities that exist to support their adoption. For example, farmers may not be aware of the full range of government programs already in place that provide incentives for adoption, or city or river managers may not be certain of whether beneficial practices are allowed or supported under common programs. Other factors are regulatory, relating to laws or regulations that make it difficult or impossible to adopt beneficial practices. Cultural norms also exist that may

discourage the adoption of these practices. For example, some farmers may not be interested in adopting cover crops because they can be seen as weeds, or as a sign of neglect on a farm. Finally, there may be financial factors that limit adoption, including programs that incentivize other practices (effectively dis-incentivizing beneficial practices), high costs of adopting new technology, or capital constraints to purchasing precision equipment or other relevant tools.

In this report, we address **financial mechanisms** as the entry point to opportunities, identifying five promising means to drive rapid adoption of beneficial practices in the next five years. We address a subset of other factors as they relate to barriers and opportunities for the success of the recommended financial mechanisms. A full exploration of regulatory, technical and cultural factors and opportunities was beyond the scope of this report.

After exploring 32 specific opportunities to finance adoption of effective practices (see Appendix B for the full list), we recommend five with the potential to drive large-scale, rapid adoption of beneficial actions in the Mississippi River Basin. In choosing mechanisms for financing change, we considered whether opportunities could drive large-scale, rapid adoption of beneficial practices through any of the following pathways:

- reallocating substantial existing funds to geographic locations or activities with high potential for impact
- providing substantial, new funding for adoption of activities with best potential for impact
- driving adoption of high return on investment activities
- reducing or removing incentives for activities that worsen nutrient pollution and soil carbon problems
- creating better access to large, currently underspent funds that can support beneficial practices

In addition, we preferred mechanisms that would target areas or groups of actors with potential to drive significant long term benefits. Through consideration of existing funding levels, known barriers to adoption, and published reports and peer reviewed literature, the authors reached strong agreement on the following five recommendations to pursue.

Recommendations

Couple crop insurance premium subsidies with adoption of beneficial practices for nutrient, water and soil outcomes. Specifically, modify the Federal Crop Insurance Program to create a sliding scale with higher premium subsidies provided to farmers adopting beneficial practices.

Proposed change

Crop insurance funding from the Federal Crop Insurance Act, and farmer participation in Risk Management Agency subsidized crop insurance programs are very high, greatly exceeding those of current conservation-oriented programs. In 2010, 86% of planted U.S. corn acres participated in federally subsidized crop insurance programs. Farmer participation rates, based on acres of major crops planted, are nearly 9 times greater for federal crop insurance than conservation programs at current funding levels.

Crop insurance provides an important service to farmers and society by providing a safety net against production and market risks that are not profitable for the private sector to provide. The USDA subsidizes crop insurance to encourage farmer participation and reduce or avoid ad-hoc disaster payments. Tying crop insurance premium subsidy level to nutrient and soil outcomes presents a high impact, voluntary approach to reward and encourage conservation that provides important societal benefits like clean water and carbon storage. This approach has the potential to drive widespread adoption of beneficial practices for nutrient pollution reduction and soil carbon rebuilding without adversely affecting the ability of farmers to produce crops or manage risk.

The USDA's Risk Management Agency provides substantial premium subsidies, on average 62% of total premium costs. Farmers are eligible for this subsidy if they comply with a limited set of conservation requirements relating to wetland drainage, prairie conversion and excessive soil erosion. There are currently no explicit connections that link crop insurance premium subsidy availability with nutrient and soil management. We recommend making that link explicit. This linking could be achieved in many ways, but we recommend an option that creates a sliding scale for premium subsidies. For example, crop insurance premium subsidies could range from 35-100%, with higher subsidies provided to those adopting beneficial practices. Ideally, the beneficial practices selected would not reduce yields or increase costs, would be easy to verify, and would not increase risk. The practices promoted through this change in the program may need to vary regionally to take account of differences in temperature,

rainfall, soil type, or lack of locally appropriate information on the application of the practice in the area.

The financial viability of this recommendation, both to farmers and the federal budget, will depend on the specific program design, eligible beneficial practices, NRCS or other federal programs engagement in implementation, net impacts on crop insurance program participation, and the resulting risk exposure of participants in RMA programs. The crop insurance program is nationwide. Testing the proposed program changes in the focal four state area could present a viable pilot that allows learning and adjustment before any such changes are applied nationwide.

Potential impact

The potential impacts of linking crop insurance subsidies to beneficial practice adoption are quite large because the program is so widely subscribed. Nearly all (78-97%) of corn producing acres in the four state area are enrolled in the crop insurance program. To calculate a first approximation of how this policy change could impact nutrient pollution and soil carbon, we made a conservative estimate that an additional 30% of the acres currently enrolled in crop insurance would adopt beneficial practices (nutrient management and cover crops only) within five years. Based on that level of adoption, and published values for nitrate loading and practice-specific nitrate reduction rates in the region, we estimate an 84,000 metric ton Nitrate-N reduction per year (see Appendix D). The Mississippi Basin nitrogen reduction targets are set for Total Nitrogen, while we only calculated Nitrate-N reductions for our scenarios. Our estimates give a conservative view of impact, as other nitrogen forms may also be reduced with recommended actions. **Our estimated Nitrate-N reductions from this policy scenario alone could contribute around 60% of the 2025 reduction target.**

Using the same 30% of corn producing acre adoption rate, and published practice-specific soil carbon impacts (see Appendix D), we estimated that this policy change across the four state area would increase soil carbon sequestration by approximately 9 million metric tons of CO₂ equivalents (MMTCO₂e) per year, equivalent to taking 3 coal-fired power plants offline. When additional greenhouse gas reductions from nutrient management are considered, **this scenario for crop insurance policy change could create an approximate 18.8 MMTCO₂e annual reduction in greenhouse gas (GHG) emissions, equivalent to taking 5 coal-fired power plants offline.**

Barriers and Opportunities

Political resistance from some farm organizations and insurance companies is expected. This may be countered with the argument that linking crop insurance to environmental benefits would immunize the \$9-12 billion dollar crop insurance subsidy from cuts proposed by Congress or special interest groups. By linking important public benefits such as clean water to the program may make it more attractive to taxpayers.

Many surveys indicate that clean water is seen as an important issue for many Americans.

Another potential barrier could be limited USDA capacity and/or willingness to implement spot checks needed to verify compliance. Historically, there has been some reluctance to enforce compliance. This barrier could be overcome by creating separate compliance teams within USDA, or within other agencies who do not have direct ties to program management. Capacity barriers could also be reduced by initially focusing on beneficial practices (e.g. conservation tillage, cover crops) that are easy to observe with low cost, non-confrontational methods such as remote sensing and field inspection. Increased oversight of spot checks by Congress, the Office of Management and Budgets, or a similar entity would help ensure proper performance of the program.

Finally, the additional subsidy from the expanded premium may not be sufficient to cover all costs of adopting beneficial practices, making adoption less attractive or infeasible. This barrier could be overcome by directing some existing or new funds from other programs towards closing any gap.

Enable private service providers to drive targeted adoption of beneficial practices. Specifically, train and incentivize private service providers to support farmer adoption of precision technology and targeted use of beneficial practices in high impact areas.

Proposed change

Farmers (~293,200 in the four states) often rely on a number of private service advisers to help make agriculture enterprise management decisions. These advisers (e.g., Certified Crop Advisors, agronomists, and fertilizer and seed representatives) help determine inputs (fertilizer, pesticide, irrigation, etc.) and other management decisions and serve as a direct conduit for new technology and products. There are approximately 3,000 agronomy retail locations and 920 Certified Crop Advisors. Together, these advisers are a relatively small group of individuals that influence nearly all farmers in the four-state region. We recommend training and incentivizing these private service advisers to support widespread farmer adoption of precision technology and targeted use of beneficial practices in high impact areas.

Most of these service providers already have the capacity to aid adoption of precision technologies (such as geo-referenced soil sampling, variable rate nutrient application, GPS-enabled yield monitors). Precision business management (PBM) has emerged as a set of tools that integrate data and allow farmers to enhance landscape design

decisions across an entire agricultural enterprise. PBM can enable adoption of beneficial practices such as nutrient management practices, and others. AgSolver's Profit Zone Manager is one example of a PBM tool. With greater training and business case development, service providers could use PBM processes to recommend beneficial practices to hundreds of thousands of farmers while improving farm-level economic performance, optimizing crop productivity and reducing environmental risk.

Ideally, service providers would aid in the use of existing precision technology and adoption of practices known to improve site-specific soil properties including cover crops, advanced nutrient management (4Rs), conservation tillage, pollinator habitat, treatment wetlands, buffers and biomass filters, and drainage improvements.

While some service providers operate under a business model that could be easily expanded to support these beneficial practices, most do not. A majority of the fertilizer retailers and advisers use the volume quota model to sell fertilizer, which creates a disincentive for adoption of some beneficial practices, and fails to create a positive incentive for support of others. We recommend altering the current business model to a sale of services model that would more directly encourage service providers to assist in the adoption of beneficial practices. The incentive to provide advice on adoption of best practices could come from farmers who increasingly see the positive return on investment from precision technology and some beneficial practices and so demand services that support those practices. Alternatively, the incentive may come from federal agency programs that provide payments for adoption of beneficial practices such as existing Farm Bill conservation programs or emerging programs such as the USDA 'building blocks' program to address climate change. There may be powerful synergies between enabling private service providers and the kinds of targeting of federal programs we suggest in other recommendations. Yet another opportunity to transition the service provider business model may come from demand from farmers to meet sustainability goals set by supply chain companies who pass those goals on to producers.

Potential Impact

The potential impacts of engaging private service providers as drivers of beneficial practice adoption are quite large because service providers touch nearly every farmer. Our approximation of impact for this change assumed that service providers could encourage farmers to adopt just one of two beneficial practices (nutrient management or cover crops) on 30% of all existing cropland in the four state region within five years. Based on that level of adoption, and published values for nitrate loading and practice-specific nitrate reduction rates in the region, we estimate an approximate 53,000 metric ton Nitrate-N reduction per year (see Appendix D). **Our estimated Nitrate-N reductions from this change alone could contribute nearly 40% of the 2025 reduction target.**

Using the same 30% adoption rate of a single practice, and published practice-specific soil carbon impacts (see Appendix D), we estimated that this change would increase soil carbon sequestration by approximately 8 MMTCO₂e per year, equivalent to taking 2 coal-fired power plants offline. When additional greenhouse gas reductions from nutrient management are considered, **this scenario for service provider practice changes could create an approximate 15 MMTCO₂e annual reduction in greenhouse gas (GHG) emissions, equivalent to taking 4 coal-fired power plants offline.**

Barriers and Opportunities

Hundreds of service providers would need to be trained in precision business management and beneficial practices for rapid uptake to occur through this mechanism. Additional socialization of these practices would need to occur at all levels of the company or agency to better understand the practices and their connection to water, soil and air quality. The agribusiness returns for supporting such training may not be immediately obvious to managers. The opportunity could be improved by working directly with service providers to collect and interpret additional data needed to demonstrate the business case for beneficial practices. The Certified Crop Advisor program could provide consistent and rapid training in precision business management that could speed this transition.

Further progress could be made through stronger corporate leadership from companies already supporting a service sales business model and/or adoption of beneficial practices. Current leaders in this field include Field to Market partners, 4R certified retailers, Land 'O Lakes, Dupont/Pioneer and Farmers Edge. Easily accessible, ongoing, low cost training could also be provided to help overcome the capacity roadblock.

Supply chain incentives present a viable means to drive service provider change but they are currently not directed towards beneficial practices for nutrient reduction and soil carbon improvement. This connection could be improved by creating a clearer business case tying food supply chain company sustainability goals to the outcomes that beneficial practices can create. Similarly, better connections can be made between USDA climate regulation goals and beneficial practice outcomes. Integration of PBM tool outputs (e.g. AgSolver) as metrics for these or similar programs would help strengthen the connections.

Once a beneficial practice is recommended to a farmer by a service provider, adoption may face additional barriers including capital constraints for purchasing precision technology and management constraints including fertilizer storage and transportation challenges. These barriers can be overcome through existing and additional cost share programs for equipment purchases and fertilizer storage and transport solutions.

Additional barriers exist around data management and sharing necessary for PBM usage, including current constraints on data sharing and interpretation, and data security. These could be overcome through a secure data sharing platform and secure cloud or data storage locations and curators.

Expand and target Farm Bill funding of beneficial practices in high impact areas for reductions in nitrogen loss and soil carbon improvement. Specifically, direct at least \$500 million annually in new funds to the Mississippi River Basin Healthy Watersheds Initiative (MRBI). In addition, target existing Conservation Reserve Program (CRP) funds to high impact areas as existing contracts expire, and redirect at least \$500 million of existing funds annually from the Environmental Quality Incentive Program (EQIP), CRP, and the Agricultural Conservation Easement Program (ACEP) to the MRBI.

Proposed change

Under the current Farm Bill, approximately \$6 billion is directed annually to conservation programs. These programs are administered by the USDA Natural Resource Conservation Service (NRCS) and Farm Service Agency (FSA), and include the Conservation Reserve Program (CRP, 37.0% of the budget), the Environmental Quality Incentives Program (EQIP, 28.5%), the Conservation Stewardship Program (CSP, 25.4%), the Agricultural Conservation Easement Program (ACEP, 7.2%), and the Regional Conservation Partnerships Program (RCPP, 1.8%).

Recently, USDA has begun to change its approach to distributing these funds, and has started to consider environmental and economic contexts in targeting efforts. Yet, there is the potential to further refine targeting so that beneficial practices are adopted in specific geographies with the potential to create optimal, cost-effective outcomes.

We recommend that conservation funds under the next Farm Bill be maintained and increased. We further recommend that Farm Bill conservation program funds be targeted towards the most cost-effective areas for water quality improvements and soil carbon sequestration, starting now and continuing into any future Farm Bills. Specifically, we recommend expanding the existing Mississippi River Healthy Basin Initiative (MRBI) from its current \$30 million to at least \$1 billion annually. This could be achieved by directing \$500 million in new funds to MRBI and by targeting \$500 million in resources currently dedicated to EQIP, CSP and ACEP to the Mississippi River Basin. Additionally, as acres expire from the CRP, new funding and acres should be targeted to the Mississippi River Basin.

Potential Impact

The potential impacts of growing and redistributing Farm Bill conservation funds is large because of the scale of existing and proposed funding to these programs.

Our scenario of impact for this change assumed that \$500 million in new funds is distributed proportional to existing Farm Bill conservation programs, and that \$500 million in redirected, targeted funds results in 20% higher per acre nutrient reduction benefits due to targeting. Based on that level and type of adoption, and published values for nitrate loading and practice-specific nitrate reduction rates in the region, we estimate an approximate 40,000 metric ton Nitrate-N reduction per year (see Appendix D). **Our estimated Nitrate-N reductions from this policy change alone could contribute nearly 30% of the 2025 reduction target.**

Using the same allocation of new and more targeted funds, and published practice-specific soil carbon impacts (see Appendix D), we estimated that this change would increase soil carbon sequestration by approximately 5.7 MMTCO₂e per year. When additional greenhouse gas reductions from nutrient management are considered, **this scenario of Farm Bill changes could create an approximate 8 MMTCO₂e annual reduction in greenhouse gas (GHG) emissions, equivalent to taking 2 coal-fired power plants offline.**

Barriers and Opportunities

The Farm Bill is re-negotiated on a 5-year legislative cycle, with the next possible Farm Bill in 2019. New funds allocation will not be possible until that time, but planning activities for specific Farm Bill priorities can begin in earnest now. Continued and further improved targeting of existing Farm Bill funds to more impactful geographies can be done by NRCS and FSA on an ongoing basis.

Another barrier for this mechanism is that increasing funding of these Farm Bill programs means competing with other demands for limited federal dollars. Improving the evidence that beneficial practices provide societal (taxpayer) benefits will be necessary. This is one of the same needs identified for the private service provider mechanism, so both could be advanced through efficient business-case development for beneficial practices.

A barrier to geographic targeting of existing or future funds lies in a lack of agreement about which metrics or criteria should be used to guide targeting. A stakeholder process could be used to reach consensus on focal criteria and metrics.

As in other mechanisms, there are technical, financial and transactional costs to farmers adopting beneficial practices. For some Farm Bill programs, there are large transaction costs related to administrative activities. Reducing paperwork

requirements or providing further support for these tasks would allow more farmers to enroll in these programs.

Others simply are not aware of the programs, and increased funding or targeting will only lead to increased adoption of beneficial practices if outreach efforts are increased. For some beneficial practices (e.g. land retirement), there are additional opportunity costs including foregone production and additional management costs. Some of these costs could be offset by other benefits to the enrollee through non-crop or livestock enterprises, such as leasing lands for hunting or other recreation activities, or from non-market benefits tied to personal values around improving environmental quality and providing habitat.

Drive ballot initiatives or legislative actions to develop new state funds that support adoption of beneficial practices in high impact areas for reductions in nitrogen loss and soil carbon improvement. Specifically, support existing efforts in Iowa and Ohio and promote emerging efforts in Indiana and Illinois to develop public/private funds that invest in beneficial practices in high nutrient-contributing sub-watersheds.

Proposed change

State-based water or conservation funds provide an opportunity to generate new conservation funding in our focal four-state region. Although there are large federal funding programs that aim to address nutrient and soil carbon loss, state funds can often be better targeted to the most critical watershed areas to reduce nutrient loss, or utilized to fund the most effective techniques that manage nutrient laden waters and depleted soils. State conservation funds could be more flexibly directed to fill funding gaps (through matches with federal or private funds), or to fill implementation gaps (supporting beneficial practices other approaches do not, such as edge-of-field or in-stream practices).

Based on the recent development of state conservation funds in Minnesota and other states, we conservatively estimate that new funds could provide an additional \$300 million annually across the four-state region. We recommend supporting existing efforts to develop and fund new state conservation funds in Iowa and Ohio, and emerging efforts in Illinois and Indiana. Potential revenue sources for these funds could come from several sources including revolving loan funds, state bond issuance, user fees, and industry sources. For new funds to produce desired improvements in nutrient pollution and soil carbon, they must be structured to support known, beneficial practices targeted to high-contributing sub-watersheds.

Potential Impact

The potential impacts of creating new state conservation funds is large because they can provide relatively large, flexible funds that can be efficiently targeted to areas of high impact. We assumed that a conservative \$300 million in new funds become available each year, and that funds are used to support beneficial practices in a mix identified in the Iowa Nutrient Reduction Strategy (95% of enrolled acres adopt cover crops, 34% of enrolled acres also treated by a wetland, 5% of enrolled acres retired). Based on that mix of beneficial practices and published values for nitrate loading and practice-specific nitrate reduction rates in the region, we estimate an approximate 18,000 metric ton Nitrate-N reduction per year (see Appendix D). **Our estimated Nitrate-N reductions from this state policy scenario are less promising, contributing 13% of the 2025 reduction target. Other scenarios for this approach that succeeded in garnering higher levels of funding would yield greater benefits.**

Using the same level and mix of beneficial practices and published practice-specific soil carbon impacts (see Appendix D), we estimated that this change would increase soil carbon sequestration by approximately 3.5 MMTCO₂e per year. When all greenhouse gas reductions are considered, **this scenario of state conservation fund growth could create an approximate 4.5 MMTCO₂e annual reduction in greenhouse gas (GHG) emissions, equivalent to taking 1 coal-fired power plant offline.**

Barriers and Opportunities

Although current conditions in some states such as harmful algal blooms have brought attention to these issues, the political lift necessary to secure passage of new state funds is variable and opportunities will differ. As an example, political action will be needed in Indiana, as the state does not allow public referendums. However, in Ohio, there can be public or legislative ballot initiatives, so a public campaign may be more effective for introducing a ballot measure.

Barriers in states that have already begun scoping new funds include reluctance of either the state legislature (Iowa) or the administration (Ohio) to increased spending. Additionally there may be reluctance on the part of state agencies to support additional funding that is not directly administered by the state. To overcome these barriers Ohio and Iowa are considering sources outside of general revenue reallocation or a tax increase. In Iowa proponents are proposing a special revolving fund. In Ohio, new funds are being proposed as a state bond issuance to be paid back by water user fees and a revolving loan component would be the revenue source. In either case, governance of the new mechanisms is challenging. Ohio is exploring a concept to create a public-private steering and advisory council that would allocate funding.

Direct post-disaster federal funds towards restoration in high impact areas for reductions in nitrogen loss and flood risk, and soil carbon improvement.

Specifically, provide science and build capacity for federal, state, and local agencies to support and target floodplain management and reconnection, buyouts, and habitat restoration (wetland, oxbow, forest, etc.) in high impact areas.

Proposed change

Federal disaster programs direct more than \$3 billion a year from several federal agencies to prepare for and respond to disasters including storms and floods. Current flood and storm defenses and responses often focus on actions that replace or refurbish existing built infrastructure in the same locations where it existed before the disaster. Actions can include rebuilding levees, improving or repairing flood water control systems, and buying buildings and land in the floodplain to avoid future loss or damage of property. There are alternative beneficial practices that also could be used to meet some flood protection, resilience and recovery needs. For example, restoration and reconnection of floodplains allows flood waters for some storm events to move more freely within a river's banks and downstream rather than being pressed over banks or levees. Restoration of habitats such as wetlands, oxbows and flood-adapted forests can contribute to slowing flood waters and absorbing them. Even property or home buyouts could be targeted so that buyouts happen in critical areas where flood damage is frequent and where restoration of the river system can contribute most to future flood regulation.

We recommend that a portion of post-disaster federal funds be directed towards these beneficial practices. Such practices provide flood regulation benefits, but they also contribute to reductions in nitrogen pollution and soil carbon sequestration.

Potential Impact

The potential impact of redirecting federal disaster response funds is large because of the amount of funds available. To estimate impact, we assumed that \$100 million in federal disaster funds are redirected to beneficial practices each year. All funds in the scenario are used to conduct buyouts, or purchase floodplain lands and reconnect floodplains. Based on published values for nitrate reductions in floodplains, we estimate an approximate 3,000 metric ton Nitrate-N reduction per year (see Appendix D). **Our estimated Nitrate-N reductions from this federal funding scenario are fairly small, contributing only 2% of the 2025 reduction target. Other scenarios that redirected higher levels of funding through federal disaster response would yield greater benefits.**

Using the same buyout scenario and published practice-specific soil carbon impacts (see Appendix D), we estimate **this scenario of federal fund redirection could create**

an approximate 0.07 MMTCO₂e (73,000 MTCO₂e) annual improvement in soil carbon sequestration and reduction in greenhouse gas (GHG) emissions, equivalent to taking <1 coal-fired power plant offline.

Barriers and Opportunities

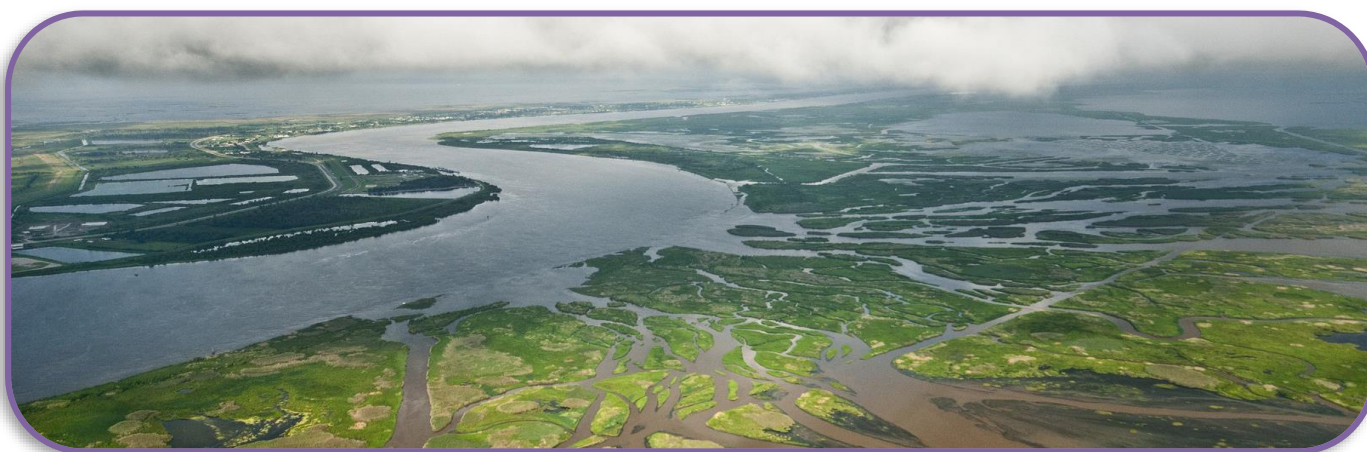
We present a highly conservative scenario for redirecting federal disaster funds because of several major barriers. Some regulatory constructs that govern ‘allowable uses’ of disaster recovery or mitigation funds do not allow the use of funds for activities such as wetland restoration or floodplain reconnection. Others allow such uses, but the transition is recent and familiarity with these uses is limited in communities that write proposals for federal disaster funds.

Another major barrier is access to pre-identified opportunities to use beneficial practices before or after disasters. The typical time needed to construct maps or recommendations of where and how to use beneficial practices usually exceeds the timeline for disaster response if the process is not started well in advance. Few staff in relevant federal (FEMA, USACE), state (floodplain manager, DNR), local municipalities, levee districts or farms have the data or capacity to construct timely response plans that include beneficial practices. This barrier could be overcome by creating rapid response teams to work with relevant agency staff in the wake of disasters.

Alternatively, pre-disaster planning could be done to identify key geographies with high potential for flood risk reduction, nutrient reduction, and carbon sequestration benefits from beneficial floodplain practices. Ideally, these solutions could work together, with pre-existing plans developed and rapid response teams available to disseminate plans and help refine plans to meet specific challenges created by a given disaster event. While these barriers are high, and more major transformation of the funding programs is needed to create meaningful benefits, the outcomes from this mechanism are likely to persist over the long term (e.g. >50 yrs), making this mechanism a worthwhile consideration.

Conclusions

Applying the five finance mechanisms we recommend could surpass the 2025 interim nutrient reduction goal for managing the Gulf of Mexico Dead Zone, and contribute meaningfully to greenhouse gas reduction. If all five strategies were successful at the levels we considered, they could achieve approximately 30% annual nitrate reductions at the outlet of the Ohio and Upper Mississippi River Basins, surpassing the intermediate 2025 target (20% reduction) and achieving approximately 60% of the long term target (45% reduction). Three strategies (crop insurance, private sector providers and alteration of the Farm Bill) are promising on their own, with the potential to achieve at least 60%, 40% or 30% of the 2025 target, respectively. In terms of climate mitigation and rebuilding soils, the crop insurance and private service provider mechanisms provide the greatest potential. Taken together, all five mechanisms could rebuild over 26 million metric tons of carbon in soils and provide the same greenhouse gas reductions per year (~47 MMTCO₂e) as taking 13 coal-fired energy plants offline. These impact scenarios give one set of general approximations of how much impact these finance mechanisms could leverage. More aggressive scenarios of adoption would lead to even greater benefits for nutrient pollution reduction, soil improvements and greenhouse gas reductions. All proposed solutions face political, financial, cultural or institutional challenges, but with focused efforts, we suggest they can be overcome to create unprecedented, meaningful nutrient reduction and soil rebuilding in the next five years.



Appendices

Appendix A: Beneficial Practice Definitions

Treatment wetlands (also called constructed wetlands): man-made systems engineered to approximate the water cleansing (nutrient cycling) process of natural wetlands. In agriculture, constructed wetlands are used to filter runoff from cropland, feedlots, aquaculture operations and agricultural processing facilities.

Cover crops: grasses, legumes or forbs planted to provide seasonal soil cover on cropland when the soil would otherwise be bare. Categories of cover crops include winter cover crops (planted in late summer or fall to provide soil cover over winter), catch crop (planted after harvesting the main crop, primarily to reduce nutrient leaching), smother crop (planted primarily to outcompete weeds), green manure (crop incorporated into the soil while still green to improve soil fertility), and short rotation forage crop.

Nutrient management (4R's): proven best practices through the 4Rs, which refers to using the Right source of nutrients at the Right rate and Right time in the Right place.

Land retirement: removing annual cropland from production and into a perennial cover for an extended period of time. For example, enrolling crop land in the Conservation Reserve Program for 10-15 years, or use of a perpetual conservation easement.

Floodplain restoration/reconnection: floodplains are land adjacent to rivers that are inundated during high flow periods. Floodplain restoration returns a river's altered floodplain to its original conditions before having been affected by the construction of levees and the draining of wetlands and marshes. Floodplain reconnection reestablishes hydrological connection between portions of the floodplain and the river.

Wetland restoration in floodplain: re-connecting oxbows, floodplain scours, abandoned channels and other wetland features within the floodplain.

Forest restoration in floodplains: reestablishing forests within a river floodplain.

Conservation tillage: any tillage practice that leaves additional residue on the soil surface for purposes of erosion control on agricultural fields. Conservation tillage includes no-till and strip till that involve planting directly into crop residue that either has not been tilled at all (no-till) or has been tilled only in narrow strips (strip-till).

Subsurface tile management: raising the water level at the outlet of a tile drainage system, reducing drainage outflows, thereby reducing nitrate export and providing an increased anaerobic zone for denitrification.

Saturated Buffers: installed tile lines under a vegetated buffer area perpendicular to the tile drainage outlet. The system includes a control structure that can be used to manage the water table level under the buffer, allow the vegetation to use the nutrient rich water and to increase denitrification. Under this system, the buffer can reduce overland flows and sedimentation, while reducing nutrient transport from subsurface outflows.

Perennial crops. planting of crops which are alive year-round and are harvested multiple times before dying.

Appendix B: Plausible Finance Mechanisms for Driving Change

The authors of the report generated a list of plausible changes that could be made to finance rapid, massive adoption of beneficial practices in the focal states (Iowa, Illinois, Indiana, Ohio). This list documents the full set of opportunities the group generated and considered. We used expert opinion to filter this list based on the criteria mentioned in the main text, approximating which had the greatest potential to drive massive, rapid uptake of beneficial practices that reduce nitrogen pollution and increase soil carbon. Only the set included in our recommendations were quantitatively analyzed for impact, so our final recommendation list may not capture the five most potentially impactful options.

- Existing NRCS funds reallocated among existing programs to support beneficial practices.
- Existing NRCS funds geographically reallocated to most impactful areas for nitrogen pollution reduction.
- Portion of existing EQIP funds redirected to MRBI (mechanism for geographic reallocation).
- Portion of existing EQIP funds redirected to beneficial activities.
- Increase funding of CRP in the next Farm Bill.
- Target existing CRP funds to high impact areas as existing contracts expire.
- Portion of existing CRP funds redirected to beneficial activities (specifically partial-field activities).
- Increase contract limit on Conservation Stewardship projects to allow greater support of larger projects.
- Expand Conservation Stewardship program to allow engagement of landlords and renters.
- Terminate the Conservation Stewardship program to allow redirection of funds to other programs that more directly support beneficial activities.
- Expand Conservation Compliance, which currently is limited to preventing producing crops on highly erodible land or a converted wetland, to include nutrient management
- Enable better enforcement of existing Conservation Compliance through existing state enforcement teams.
- Existing USACE Operations and Management funds reallocated to beneficial activities.
- Create supply chain incentives for adoption of beneficial activities. (Farmers receive price premium after adopting beneficial activities).

- Create supply chain requirement for adoption of beneficial activities. (Companies only buy from farmers who have adopted beneficial activities).
- Capital gains tax break on land transfers if beneficial practices have been adopted
- Provide property tax relief for wetland restoration in states with increasing property taxes.
- Directing municipal or county sales tax to pay for adoption of beneficial practices
- Create sliding scale crop insurance premium subsidy (e.g. 25-100%) with higher insurance premium subsidies for farmers who adopt beneficial practices.
- Make current crop Insurance premium subsidies accessible only to farmers who adopt beneficial practices.
- Direct post-disaster federal funds towards high impact areas for reductions in nitrogen loss and flooding risk, and soil carbon improvement.
- Direct post-disaster federal funds towards beneficial practices.
- Increase funding to ACEP in next Farm Bill.
- Expand ACEP to include support for beneficial practices that reduce nutrient pollution.
- Achieve full appropriation of Navigation and Ecosystem Sustainability Program (currently approved for over \$1 billion but very little appropriated).
- Establish new state funds to provide targeted support of beneficial practices through legislative initiative.
- Establish new state funds to provide targeted support of beneficial practices through ballot measures.
- Securitize state conservation funds into bond that supports beneficial practices
- Develop new municipal programs that support beneficial practices that provide synergies between local benefits (e.g. drinking water, flood control) and nitrogen pollution reduction and soil carbon benefits.
- Train and incentivize private service providers to support farmer adoption of beneficial practices in high impact areas.
- Change private service providers' business model from sales incentive to service incentive
- Allowing service providers to write approved conservation and engineering plans instead of NRCS or with an expedited approval process

Appendix C: Crosswalk of Recommended Finance Mechanisms and Beneficial Practices

Each recommended finance mechanism has the potential to incentivize a different set of beneficial practices. We list the set of beneficial practices considered here. This is not an exhaustive list of such practices, but was the subset chosen by the group as widely recognized for causing meaningful changes in nutrient pollution and soil carbon. They are not listed in order of expected impact. Red boxes identify the practices that are, or likely could be supported by each finance mechanism.

Beneficial Practices	Crop Insurance	Farm Bill	Private Service Providers	State Funds	Federal Disaster Funds
Treatment Wetlands					
Cover Crops					
Nutrient Management (4R's)					
Land Retirement					
Floodplain Restoration, Reconnection					
Wetland Restoration in Floodplain					
Forest Restoration in Floodplains					
Conservation Tillage					
Subsurface Tile Management					
Saturated Buffers					
Perennial Crops					

Appendix D: Methods and Assumptions for Estimating Impacts from Recommended Finance Mechanisms

Summary of Approach

We aimed to create order-of-magnitude, first approximation estimates of how much impact each finance mechanism could be able to have in terms of nitrate reduction, soil carbon sequestration and greenhouse gas emission reductions. These estimates are intended to give a rough indication of whether or not the recommended changes can provide meaningful progress towards nutrient pollution reduction, soil rebuilding and climate mitigation. Much further analysis would be needed to accurately estimate likely impacts, and any such analysis should also consider the costs of the beneficial practices along with the costs of implementing the recommendations. Our assessments here are wholly focused on the biophysical changes we might expect from scenarios of beneficial practice adoption that each recommendation might create. In general, our estimates used information on per acre averages representative of the four focal states. Our estimates also did not consider interactions among beneficial practices, although we recognize these do exist and may lead to non-additive benefits from adoption of multiple practices (e.g. McLellan et al. 2015). There are many other scenarios that could be considered for each recommendation presented here. All those we considered aim to be conservative in the level of adoption and targeting of beneficial practices that may be achievable in the next five years.

For the Farm Bill (re)allocation, State Conservation Funds and Disaster Relief Funds, we began with estimates for annual total budget. We divided this budget by a funding specific *practice weighted* implementation cost to obtain the potential acres impacted. We estimated the total annual nitrate reduction by multiplying the potential acres impacted by the specific practice weighted nitrate reduction rate in lb/acre/year. For soil carbon we used a funding specific practice weighted measure of metric tons of CO₂ (MTCO₂) sequestered per year. For greenhouse gas emission reductions, practice specific emission reduction estimates measured as metric tons of CO₂ equivalents (MTCO₂e) (including carbon dioxide, methane, nitrous oxide from process and upstream emissions) were used (Eagle et al. 2012).

For Crop Insurance and Technical Service scenarios, we used related but slightly different methods. Potential acres impacted by these programs include the entire cropland of the four state region. We assumed that 30% of the total acres would be impacted by these programs. We then followed similar methods to estimate nitrate reduction and soil carbon impacts.

Funding Mechanism	Beneficial Practices Supported*	Potential Acres Impacted	Expected Acres Impacted	Total Annual Nitrate Reductions (Metric Tons of Nitrate-N/yr)	Total Annual Soil Carbon Sequestration (MTCO ₂ e)	Net Annual GHG Reduction (MTCO ₂ e)
Crop Insurance	NM, CC	57,797,130	17,339,139	84,275	9,406,658	18,813,317
Technical Services	NM, CC	73,348,311	22,004,493	53,475	7,928,745	15,055,706
Farm Bill	LR, W, CC	10,183,424	10,183,424	39,873	5,687,850	8,320,672
State Conservation Funds	LR, W, CC	5,172,414	5,172,414	17,712	3,555,773	4,605,961
Federal Disaster Funds	LR, W	13,333	13,333	3,372	73,333	73,333
Total				198,707	26,652,359	46,868,989

* Nutrient Management (NM), Cover Crops (CC), Land Retirement-CRP (LR), Wetland restoration (W)

Detailed Methods

Crop Insurance

Using the USDA-NASS Census of Agriculture report we obtained total acreage in cropland for each state and for the entire 4 state region we are analyzing. The total cropland acreage in the four states in 2012 was 73,348,311 acres. For an estimate of acres under the federal crop insurance program we used data from the USDA-ARMS database on percentage of corn production acres insured through the federal program for each state. These numbers ranged from 78-97% of planted corn acres. There was a total of 57,797,130 acres of cropland enrolled in the crop insurance program in each state in 2015. After consultation with the group we estimated a conservative additional 30% of these acres would adopt two beneficial practices under our new sliding premium proposal. Pragmatically, we assumed that the beneficial practices most likely to experience this rate of adoption were nutrient management (4Rs) and cover crops.

For estimates of nitrate reduction we used estimates from the Iowa Nutrient Reduction Strategy. As nutrient management can include numerous complementary practices, a 20% reduction in nitrate loading was selected as representing a conservative estimate of stacking various nutrient management practices (side-dress/incorporation, optimizing rates, spring applications, and/or use of inhibitors). A nitrate reduction for cover crops was considered additive to the reductions from nutrient management, and all farms adopting practices were assumed to adopt both nutrient management and cover crop practices. For estimates of nitrate loading we used numbers from Kling et al.

(2014) that reported loading at 21.647 lb of nitrate per acre in our focal basin areas. We multiplied the percent nitrate reduction by the total loading to obtain an annual per acre nitrate reduction estimate for the policy. We estimated the four-state potential impact by multiplying this number by acres expected to adopt beneficial practices.

Soil carbon and net greenhouse gas estimates were derived from a national assessment of greenhouse gas mitigation potential from agricultural land management in the United States (Eagle et al. 2012). Estimates reflect averages compiled from an extensive literature review and are annual net reductions in greenhouse gases as measured by CO₂ equivalents. The soil carbon impact was based on reported soil carbon sequestration increases from winter-kill cover crops. Net greenhouse gas reductions includes soil carbon sequestration as well as reductions in nitrous oxide emissions from altered fertilizer, in addition to methane and upstream emissions related to the specific practice. All published values were taken from Eagle et al. 2012, Table 33.

Technical Service

Calculation of impact for this funding mechanism followed a very similar process to crop insurance, with two main differences. We assumed that all potential acres in cropland in the 4 states (73,348,311 acres) are influenced by private service providers. As with crop insurance, we estimated that an additional 30% of cropland could be affected by beneficial practices through the work of technical service providers. As a conservative estimate, we assumed that service providers could be successful in encouraging adoption of only one of two beneficial practices (precision nutrient management OR cover crops; not both practices). For nitrate reduction and carbon sequestration impacts, we used a weighted average (50% each) of the benefits from nutrient management and cover crops to reflect likely adoption of one practice on each affected farm. We used the same sources to determine practice-specific nutrient reductions, soil carbon improvements and GHG emission reductions.

Farm Bill (Re)allocation

For this mechanism we began with the intent that \$1 billion dollars would be allocated to particular Farm Bill programs. Half (\$500 million) would capture the reallocation of funds from CRP, ACEP and EQIP programs to the MRBI. The other \$500 million reflects new funds that would be provided equally across all existing Farm Bill conservation policies. We estimated the cost per acre of implementing these policies. Using data from the USDA FSA, we reflect the average cost of CRP program practices for the 4 state region (\$125.65/acre/yr). Using information from the USDA-OBPA, we found similar costs per acre for practices under ACEP and EQIP and calculated the average cost per acre (\$84.37/acre/yr). For the \$500 million that could be reallocated to these programs we allocated funding between programs based on funding levels from the

2014 Farm Bill (37% for CRP, 55% for EQIP and CSP, and 8% for ACEP) to obtain half of our weighted cost per acre. The weighted per acre cost is \$98.20.

For the \$500 million in new funds, we assumed proportional distribution relative to current distribution among programs but a 20% improvement in nitrate reductions from spatial targeting. A 20% improvement was selected as an approximation based on Legge et al. 2013.

We divided \$1 billion dollars by \$98.20 to obtain new acres funded through this shift in funds resulting in a figure of 10,183,424 acres. For the weighted lb/acre reduction estimates we used the estimates from the Iowa Nutrient Reduction Strategy that CRP lands in Iowa reduce 85% of nitrate loading. USDA-FSA numbers showed an estimate that USDA conservation programs lead to a 50% reduction in “nutrient reductions”. Following the same weighting process as above, giving 50% to each of the pots of \$500 million we calculated the reductions in nitrate loading. Using estimates from Eagle et al. (2012), we followed the same estimates for carbon sequestration improvements.

State Conservation Funds

We started with the assumption that approximately \$100 million would become available from three of the four focal states in the next 5 years. This assumption was based on activity already underway in Ohio and Iowa to create state conservation funds, and the likelihood that one additional state could be encouraged to create such funds in the next five years. The amount considered to be available per fund is based off of existing funds in Minnesota. We considered \$300 million per year across all four states to be a plausible level of funding for this mechanism.

State conservation funds can be used flexibly to cover a range of beneficial practices. To determine the mix of practices in this scenario, we followed the Iowa Nutrient Reduction Strategy (2012) which assumed a per acre cost of \$58/acre for beneficial practices, based on the annualized per acre cost for a portfolio of practices to achieve a 42% nitrate-N reduction for the state, scenario NCS3. The portfolio represented 95% of acres in cover crops, 34% treated by a wetland and 5% in land retirement.

Given the available budget and per acre beneficial practice cost, we calculated that the potential acres impacted would be 5,172,414 acres. Using a weighted average of the beneficial practice portfolio referenced above and per practice nitrate reductions from the same Iowa Nutrient Reduction strategy, the average nitrate-N reduction per acre was estimated at 34.875% ($=95\% \text{ acres Cover Crops} \times 29.5\% \text{ nitrate reduction/acre of cover crops} + 5\% \text{ acres in wetlands} \times 52\% \text{ nitrate-N reduction} + 5\% \text{ acres in CRP} \times 85\% \text{ reduction in nitrate-N}$). The 5% wetland acre target is a best estimate of acres needed to treat 34% of cropland acres. Using the weighted nitrate reduction from beneficial

practice implementation and the base loading number from Kling et al. (2014) we obtained our measure of nitrate reduction.

Soil carbon and greenhouse gas emission reductions were based on the national averages from Eagle et al. 2012 referenced previously.

Federal Disaster Funds

While billions of dollars of federal funds flow after major flooding events, we explored a very conservative scenario where \$100 million of those funds are redirected to beneficial practices each year. We keep the funds relatively low because the majority of funds are currently spent on major infrastructure projects, and transition to investment in other solutions will likely be slow. We assume that these funds could be directed towards flood mitigation plans (actions in advance of floods) and floodplain restoration after floods. We applied all funds to the purchase of lands (buyouts) at an estimated \$7500 per acre based on recent real estate analyses of the Upper Mississippi Basin (Kris Johnson, pers. comm.). At that rate, funds would allow purchasing of 13,333 acres per year. Based on McLellan et al. 2015 (see Table 3 within and the floodplain reconnection row), we assume that floodplains reduce nutrient loading by 557 lb/acre/yr. Multiplying this number by the acres we could affect resulted in a nitrate-N reduction estimate.

Carbon and GHG estimates vary widely depending on land-use and practices that are implemented as part of floodplain reconnection. For soil carbon estimation, we used an average per acre carbon sequestration for converting annual cropland to forest (5.5 MTCO₂ per acre) as a rough approximation (Anderson et al. 2008).

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