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Nature's remedy: Improving flood resilience through community insurance and nature-based mitigation

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Contributors

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Photo credit: Northwest Missouri Regional Council of Governments

How can the successes of a levee-setback experiment on the banks of the Missouri River be expanded to help secure the physical, economic, and ecological well-being of communities across the United States?

In the quest to better protect inland communities from growing flood risk, it is clear that optimal strategies for resilience will need to address multiple challenges, including a persistent insurance gap and securing funding for infrastructure upgrades. Coupling community-based insurance with nature-based risk-reduction projects, such as preserving or restoring floodplains and wetlands, implementing levee setbacks, and designing appropriate flood storage to emulate river flood pulse, may offer a multi-faceted solution that these challenges require.

When it comes to the increased flood risk caused by climate change, vulnerable coastal regions get much of the attention. Yet, there are many inland regions — especially along major rivers — that are bearing the brunt of major flood events. Examples include flooding along the Mississippi River (and tributaries) in 2019, as well as major floods in California in 2017, South Carolina in 2015, and Colorado in 2013. Over the last decade (2010-2020), billion-dollar floods alone cost the United States a total of \$64.3 billion (<https://www.ncdc.noaa.gov/billions/>).

The Mississippi River basin has always been prone to flooding. However, as rivers within the basin became increasingly channelized and disconnected from the

original floodplain, the risk of catastrophic flooding and flood damages to human property rose as well. Flood risk and flood damages are projected to increase further in the basin because of climate change, which is expected to increase both the frequency and severity of floods.

This phenomenon was made starkly clear by the flooding along the Missouri, Mississippi, and Arkansas Rivers in 2018-19. In the case of the Mississippi River, flooding lasted over six months,¹ exacerbated by multiple days of extreme precipitation and flood infrastructure unsuited for extreme weather. Combined damages from flooding along these three rivers totaled \$20 billion, or almost half of all losses stemming from billion-dollar catastrophes in the U.S. in 2019, according to NOAA's National Centers for Environmental Information.²

The most staggering figure is the vast divide between insured and uninsured losses. Specifically with the Mississippi River flooding, Munich Reinsurance America, Inc. (Munich Re US) estimates that just \$200 million of these losses were insured, putting the bulk of the burden on impacted citizens, businesses, communities, and governments. According to National Flood Insurance Program (NFIP) policy data, less than 1% of homeowners have flood insurance across the Midwestern states (<https://nfipservices.floodsmart.gov/reports-flood-insurance-data>). Business properties are even less likely to be insured against flood.

Events like the 2019 Mississippi River flooding are expected to increase in frequency and severity if climate change remains unchecked. The impact could also be seen through dam breach scenarios, such as those experienced in Michigan by the Edenville and Sanford dams in May 2020.

And it is not just rural river communities that need to be concerned. Urbanization — which leads to the paving and development of former flood plains — has increased the likelihood of flash flooding, as illustrated by the severe flooding witnessed in the greater Houston area following 2017's Hurricane Harvey.

With such a wide gulf between uninsured and insured losses, the economic vitality of inland communities is at risk. Disruptive events caused by significant repetitive flooding destroy wealth among the uninsured and can depress growth for years, if not decades, as productive capacity is diverted to recovery.



Photo credit: Northwest Missouri Regional Council of Governments

In this paper, we examine the potential benefits of combining nature-based flood mitigation with a community-based flood insurance product. We examine whether a nature-based approach to reducing river flood risk — a levee setback — can be incorporated into insurance modeling. And we examine to what extent the levee setback, coupled with a community-based insurance product, will produce insurance premium savings. We use an actual levee setback project recently completed on the Missouri River as the basis for the insurance modeling and analysis. This paper is based on the assumptions made for that particular levee setback project and the specific conclusions of the study cannot be applied to any other risk. Going forward, “Project” is used to refer to the completed levee setback, whereas “study” is used to refer to the analysis of the potential benefits of pairing the levee setback or other nature-based mitigation with a community-based insurance product.

Why the gap between uninsured and insured losses is so high

Flood insurance ensures that individuals and businesses have the financial means to recover from a devastating event. In some cases, the infusion of funds can kickstart the process of helping the community better prepare for future threats. Yet, the take-up rates for flood insurance are low — it is estimated that just 15% of U.S. homeowners have flood insurance.³ According to another study, only approximately 5% of the single-family homes (as opposed to all homes) in the U.S. have flood insurance (<https://www.insurancebusinessmag.com/us/news/catastrophe/how-national-flood-services-is-helping-to-close-a-massive-insurance-gap-237315.aspx>). As noted earlier, the take-up rate is even lower in the Midwestern states (<1%).

There are multiple reasons for this. Many homeowners do not receive the education needed to understand their risks or make informed decisions. Humans are also prone to underestimating risk.

Cost can also be a determinative issue for buyers of insurance and underwriters alike. For buyers, the cost of a policy, especially in vulnerable areas, can be prohibitive. A homeowner may opt to forego a policy owing to the cost but may not be aware of the high costs that flood damage can impose. As the risk of flooding increases and mitigative measures are not taken, the cost of insurance policies for vulnerable homes, businesses, and communities increases further. This not only sends prices spiraling upwards; in some cases, it may force insurers to exit a market. Additionally, when risk is elevated, the ability for insurers to underwrite more flexible policies that protect, say, a portion of the home's value, diminishes.

The power of pooling

Insurance works best when the risks can be spread across a broad base of individuals. The likelihood of a total loss among a diverse range of policyholders is very small, reducing volatility and ensuring that the capital is there to support those individuals that encounter loss.

It is in this context that community-based catastrophe insurance (CBCI) (<https://www.mmc.com/insights/publications/2021/february/community-based-catastrophe-insurance.html>) becomes a viable and appealing solution to closing the insurance gap. With CBCI, a local government or community-based organization can procure a collective policy for the community that homeowners and businesses can subscribe to. With a more diverse mix of underlying subscribers, policies can be written more affordably. This especially benefits lower-income homeowners and those in higher-risk areas, who might otherwise be priced out of insurance policies.



Photo credit: U.S. Army Corps of Engineers



Photo credit: Northwest Missouri Regional Council of Governments

With the wave of innovation in recent years, insurance companies have the technology, data, and analytics to underwrite policies that better align with the changing nature of flood risk. This also gives them the insights to better educate and inform vulnerable communities on risk, including communities near major rivers as well as those that are not near a major river but, for various reasons, are still prone to flash floods.

Without risk mitigation, resilience is incomplete

It is impossible to lean solely on insurance to protect communities, especially if climate change and flood risk continues to grow.

Risk mitigation — steps taken to reduce the severity of losses from a flood, such as wetland restoration or levee construction and improvement — serves two purposes. First and foremost, risk mitigation helps reduce the severity of the impacts created by extreme precipitation and flooding and ensures that residents are better protected. Overall losses can be reduced.

Second, risk mitigation also helps guarantee that insurance can be underwritten more affordably, because mitigative measures reduce the underlying value at risk. This enhances the options for risk transfer — sending a portion of the risk to other parties, such as the government, state-organized risk pools, and private insurers.

When combined, risk mitigation and risk transfer offer a more complete and sustainable approach to resilience. From a top-down perspective, mitigation better protects communities; and from a bottom-up perspective, lower-cost risk transfer (insurance) provides more individuals and businesses with the means to recover, rebuilding their communities faster and better.

The promise — and power — of nature-based solutions

Risk mitigation is often associated with what are known as “grey” projects, which are industrially-constructed infrastructure, such as concrete seawalls.

Yet, in recent years, evidence has been building in support of “nature-based solutions” or “multi-benefit green infrastructure” that can be leveraged to mitigate underlying risk. Examples of these include the restoration of coral reefs, mangrove forests, and wetlands, which dampen storm surges along ocean shorelines, and river levee setbacks which move the levee inland and away from the river’s channel to create larger areas for water to flow safely, to better dissipate high-water volumes, and reduce destructive water velocity levels.

Researchers from the University of California, Santa Cruz, The Nature Conservancy (TNC), InsuResilience Secretariat and Munich Re US published a study (<https://doi.org/10.1016/j.ecolecon.2019.106487>) that examined the viability of an integrated insurance and nature-based mitigation solution, which is referred to as a resilience risk transfer (RRT). The research centered on whether a specific nature-based solution — coral reefs — could offer sufficient protection from storm surges to reduce insurance premiums over time, and whether those premium savings could be deployed to offset the costs of such a measure.

The study delivered a resounding “yes.” The data showed that, even under conservative assumptions, 44% of reef restoration costs could be covered from insurance premium savings in just the first five years, with savings multiplying over time.⁴

Here we consider whether a similar approach could be taken for inland flood mitigation using a nature-based

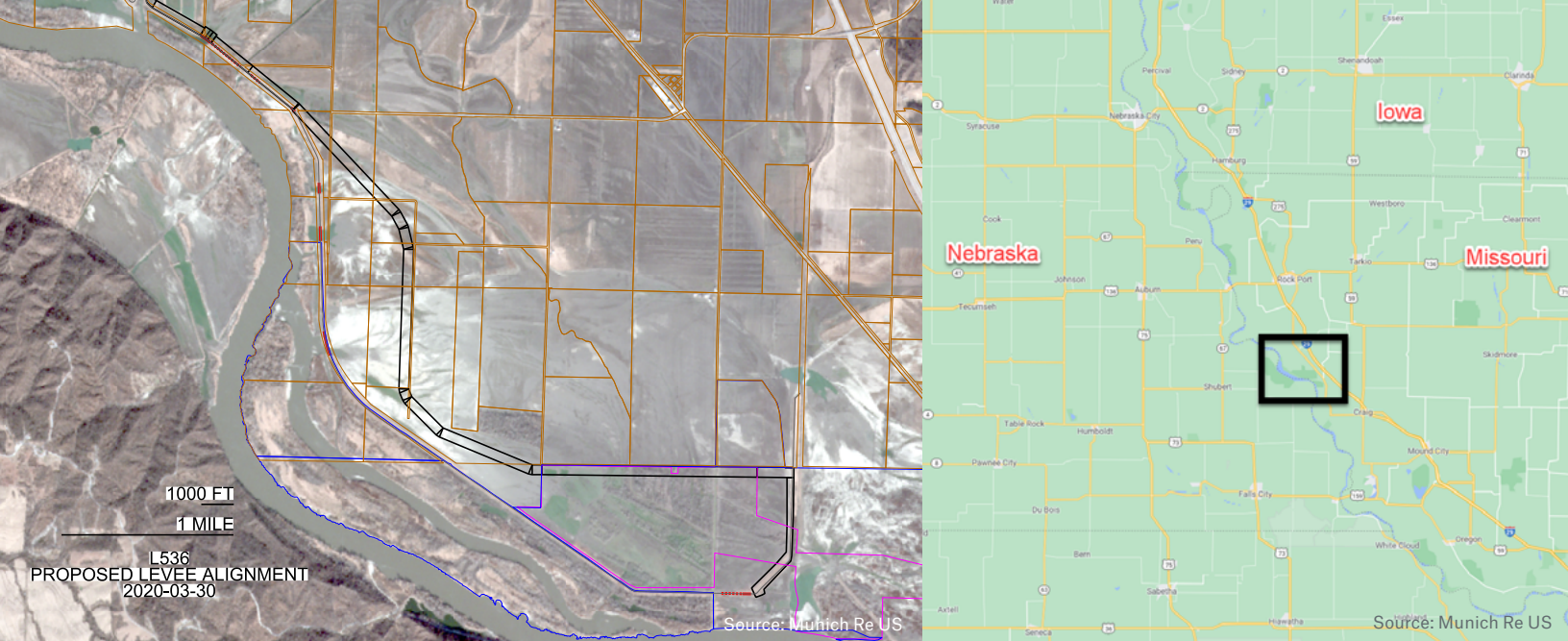


Figure 1: Project area of the Levee Setback L536 on the Missouri River.

mitigation solution — levee setbacks. Our study (study) analyzes the flood risk reduction associated with setting back a levee further from the Missouri River (L536 Large Scale Levee Setback Project). We find that, in general, modeling used by insurers to determine expected losses from river flooding can account for the risk reduction benefit of a levee setback, with resulting reductions in expected losses and reduction in insurance premiums.

Levees are relied upon to keep water separated from residential, commercial, or agricultural land, sending it down pre-ordained routes. However, most of today's levees were built many decades ago and were not designed for the extreme precipitation of today's climate. They also were not designed for the extensive reduction of floodplains that has occurred as a result of urbanization over the last few decades. When water has nowhere to be absorbed, it increases the volume and velocity of downstream river systems. When levees are overwhelmed (e.g., overtopping, full or partial breaches), they fail to dramatic effect, as evidenced by the impacts of Hurricane Katrina in New Orleans.

One way to enhance the efficacy of levees is to move them further inland from the river — a method known as a levee setback — to create a dedicated area into which the increased water volume can expand. A levee setback widens the path for a river to flow, which reduces water velocity and water levels, thereby reducing the probability of levee failure. This is especially useful at river "pinch-points," where the river narrows or existing levees narrow the river.

In addition to flood protection, levee setbacks offer extensive ecological benefits to the surrounding areas, improving local biodiversity and water quality. When water is allowed to expand over a wider area, the flow of water slows, allowing sediment to drop out of the water column and settle. This effect creates unique and ever-changing

topography with each flood pulse, which leads to diverse habitat. Floodwater movement across the floodplain creates habitat for plankton and aquatic insects. This provides needed spawning and nursery areas for many fish species during times of high water that, in turn, provide food for foraging birds and mammals. As water expands over a bigger area and slows down, increased plant life helps remove nitrogen and phosphorous from the water, improving the clarity and drinkability of the water. The opportunity for standing water also increases, allowing water time to sink into the soil and provide groundwater recharge.

Finally, additional wetlands with multiple benefits can be created within the "borrow pits" used for levee construction. Levees are made of a mixture of soil and gravel types taken from nearby landward borrow pits. Once the material is removed, the borrow pits are treated for wetland reestablishment, which creates additional landward habitat, landward water quality improvement areas, and additional landward groundwater recharge zones.

Levee setbacks provide an important example of how working with nature rather than defending against nature creates a more sustainable solution that is expected to be more cost-efficient over time. Resources can be better focused on mitigation, thereby reducing the likelihood of a severe impact on the community.

L536: The Missouri River Valley large-scale levee setback project

In August 2019, TNC and multiple partners set out to complete a large-scale levee setback project (Project) for the L536 levee along a segment of the Missouri River that had experienced flooding during unprecedented rainfall earlier in the year. The construction of the Project was completed in July 2021.

This Project spans a levee that was partially or fully breached in seven locations and was severely damaged over 10 miles during the 2019 floods. The original levees had been built many decades earlier and were not optimized for contemporary storms. The U.S. Army Corps of Engineers (USACE), who led the construction of the project, analyzed the project area and calculated that a levee setback would be more cost effective than repairing the existing levee at its original location. A setback, designed with modern parameters, would also offer superior protection. A recent modeling exercise done by USACE determined that the levee setback project would reduce water surface elevations for the river occurring in a 1 in 200-year flood event. Beyond the flood levels projected in a 200-year event, the levee system would overtop (USACE Memorandum, February 3, 2020 "SUBJECT: Request for Levee System L-536 Proposed Setback Benefits" provided to the authors).

Figure 2 shows the satellite imagery of the flood inundation at the L536 area during the 2019 flood event. The southern levee, barely visible and drawn as a purple line, was the old levee that was fully or partially breached in seven places. The new setback levee's footprint is denoted by the black polygon further north and inland. The hash-marked areas north of the new setback levee's footprint indicate the areas flooded in 2019 which benefit from lower flood risk as a result of setting back the levee.

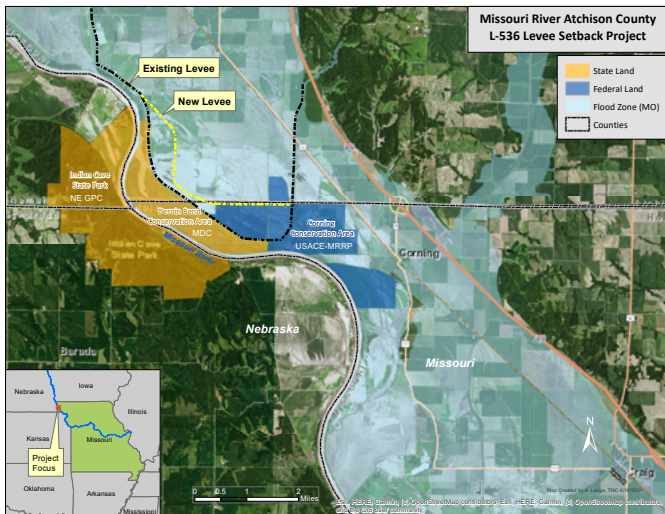


Figure 2: The potential impact of the setback levee on the 2019 flooding event.

The L536 Levee Setback Project creates more floodplain habitat on the riverward side of the levee, with cascading benefits for floodplain species and water quality. With this Project, 1,040 acres of floodplain have been reconnected to

the river because of the setback. It is likely that multiple rare or declining species of conservation concern will rebound in the area, such as the Wilson’s phalarope, flathead chub, and Blanchard’s cricket frog. As a part of the Project, 400 additional acres of wetlands will also be created from converted borrow pits.

This Project is especially promising because of the potential to replicate this approach in additional areas along the Missouri River, other riverside communities in the Midwest, and low-to-moderate-risk flood zones. If done well, levee setbacks in this region could strengthen overall resiliency along the Missouri River.

The cost of the L536 Large-Scale Levee Setback Project

For the L536 setback project to succeed, questions of cost and capital had to be addressed. Setbacks can require the acquisition of new land or easements behind the existing levees, which depends on property owners voluntarily selling portions of agricultural land. The process of acquiring real estate can be complicated, requiring careful due diligence and close coordination. More importantly, it requires capital, which many local taxing authorities (e.g., drainage and levee districts or local governments) and state governments are hard pressed to free up. Local governments are not always in a position to fund mitigation by themselves. Also, while Federal Emergency Management Association (FEMA) does operate programs to buy out homeowners in highly vulnerable areas, agricultural land in floodplains is not covered by these programs.

Impact of nature-based risk reduction on insurance premiums

Borrowing from the concepts of community-based catastrophe insurance and resilience risk transfer, Munich Re US and TNC were interested in exploring whether the model of integrating community-level insurance with levee setbacks could deliver financial benefits to help fund similar projects elsewhere. To answer this question, Munich Re US and TNC conducted this Study to quantify how the L536 Setback Project — and, by extension, other nature-based solutions — would reduce flood risk, and whether, hypothetically and without any other concurrent changes to the risk, insurance premiums could decrease over time.

Our hypothesis was that the risk reduction benefits of a levee setback could be quantified to demonstrate a reduction in insurance premiums over time, and that a community-level insurance policy could be constructed in a way where the captured premium savings could then be used to offset or replace the costs of funding the project.



Photo credit: U.S. Army Corps of Engineers

The analysis is focused on homes, but the concept is equally applicable to commercial properties and assets, upon whom the community relies for employment, as well as sales taxes and property taxes to finance its civic operations. Businesses also benefit by reduced downtime for production and the ability to better plan their activities.

Munich Re US utilized flood risk reduction modeling from the USACE, data and insights from various stakeholders as well as its own proprietary data, technology, and analytics to measure the benefits of mitigation, such as reduction in water surface elevations and the likelihood of catastrophic floods. The final premiums for the CFRI product were estimated based on the reduced level of risk and risk assessment for the region using Munich Re US's proprietary pricing model.

In short, we found that the annual flood insurance premiums for structures within the areas benefitting directly from the Project could be reduced by over 55% through the levee setback.

Examining homes benefitting directly from the L536 Levee Setback

The first step in our analysis was to examine the number of homes directly benefitting from the risk reduction associated with the Project. USACE provided the ZIP codes it believes benefit directly from the Project, and we identified the homes that were within 5 miles of the river in those ZIP codes, using publicly available data. (The assumption is that, in a relatively flat region, the impact of the flood protection is minimal beyond 5 miles from the river.) The location of the homes in the benefitting ZIP codes is depicted in the illustration below. Based on these assumptions, the total number of homes benefitting directly from the Project was found to be 1,455 single family homes.

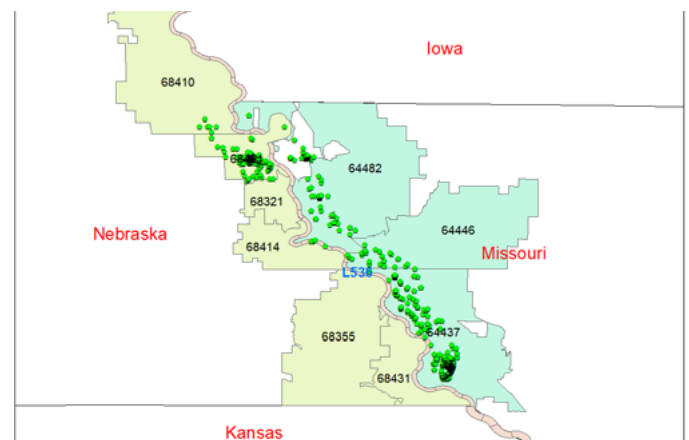


Photo credit: Munich Re US

Figure 3: Study area with the L536 benefitting ZIP codes and the homes analyzed for the CFRI product.

Next, we determined the current premiums paid by those homeowners purchasing residential flood insurance from the National Flood Insurance Program (NFIP), to compare those premiums to the premium for Community Flood Resilience Insurance (CFRI) that takes into account the risk reduction benefit of the levee setback.

We found that for Missouri and Nebraska the average NFIP premium is \$942 annually, while for the limited number of policies purchased by homeowners protected by the L536 levee, the average premium is \$1,166 (see Table 1). We chose to be more conservative in our assumptions and analysis by using the average NFIP policy premium throughout Missouri and Nebraska (i.e., \$942 annually) for our analysis. Using the average NFIP premium for homes currently protected by the L536 levee would result in an even greater difference between the current NFIP premium and the CFRI premium that incorporates the risk reduction of the levee setback.

Missouri and Nebraska

Flood Zone	Total Policy Count	Avg. Bldg. Cvg.	Avg. Policy Premium
A	9,968	\$140,027	\$1,190
B	319	\$186,238	\$1,005
C	556	\$166,658	\$719
D	2	\$77,750	\$1,824
N	170	\$34,900	\$600
X	4,942	\$181,265	\$585
Grand Total	15,967	\$153,852	\$942

L536 ZIP Codes

Flood Zone	Total Policy Count	Avg. Bldg. Cvg.	Avg. Policy Premium
A	141	\$120,601	\$1,248
C	1	\$30,000	\$673
Grand Total	142	\$109,072	\$1,166

Source: OpenFEMA (<https://www.fema.gov/about/reports-and-data/openfema>)

Table 1: Average NFIP Policy Information by Flood Zone in MO/NE and the L536 benefitting ZIP Codes (Source: NFIP Data)

In order to estimate and model the reduction in expected losses from the levee setback, we also obtained the historical NFIP claims data for Missouri and Nebraska, including the number of claims, average amount of claim, and breakdown between building and content claims. The claims within the corresponding L536 benefitting ZIP codes were minimal considering the low insurance take-up rate in the region.

Table 2: Average NFIP Flood Claims in MO and NE over the Period 1978 - 2018

1978 - 2018:

- 4,443 Claims

- Average Claim: \$14,597

• Building Claim: \$11,859

• Content Claims: \$2,636

• ICC: \$103

Source: OpenFEMA
(<https://www.fema.gov/about/reports-and-data/openfema>)

Our next step was to determine what the “standard of protection” was for the L536 levee, with and without the setback. Based on the 2003 Upper Mississippi River System Flow Frequency study (UMRSFF Study, Hydrology and Hydraulics Appendix F Missouri River, November 2003), there is incipient overtopping observed at the

100-year flood level and a freeboard of approximately 2 feet at the 50-year level. Based on that study, we concluded that the level of protection provided by the L536 levee without a setback was consistent with a 50-year standard of protection.

In connection with the Project, USACE modeled water surface elevation reductions resulting from the levee setback. This analysis determined that the maximum water surface elevation would be reduced by 0.94 feet for a 200-year flood event, as a result of the L536 levee setback. While we use the estimated standard of protection with caution, based on the analysis of the region, we consider the water surface elevation reduction to provide a standard of protection in the range of 160 to 200 years. We concluded that the levee setback is providing a 160-to-200-year level of protection, while the levee without the setback provided only a 50-year level of protection.

Flood modeling: Incorporating nature-based mitigation into flood insurance pricing

We use the KatRisk LLC probabilistic model for the flood modeling of fluvial (riverine) and pluvial (surface water/flash) risk. Flood models use fragility functions to introduce the probability that a flood defense (e.g., levee, dam, etc.) would experience a failure of a certain damage state or magnitude. In the KatRisk model, the probability of loss occurrence is calculated based on the flood depth at the corresponding return period (i.e., flood frequency). Using the information from the National Levee Database, the fragility functions in the model are used to quantify the



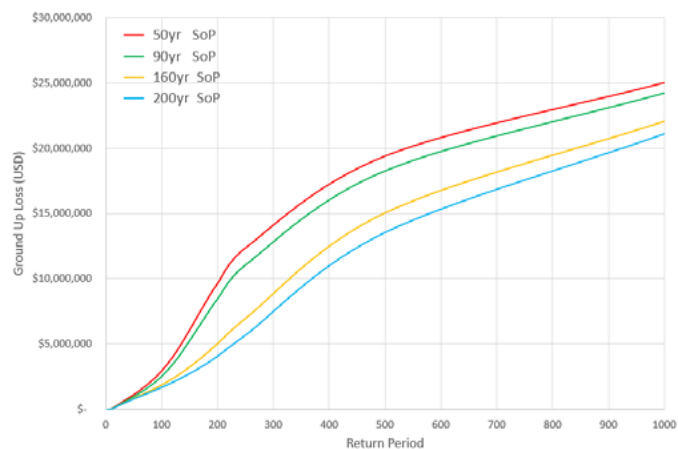
Photo credit: Route 3 Films

probability of loss over the regions protected by the levees. The default protection level (i.e., standard of protection – SOP) of the levees, for fluvial (river) flooding, is set to 50-year protection.

We analyzed the portfolio of homes included in this study for four different standards of protection (50-year, 90-year, 160-year, and 200-year) to understand the sensitivity of modeled losses. This standard of protection of the levee is applied to river flood modeling only (“fluvial flood,” as opposed to “pluvial flood,” caused by rainfall). Figure 4 shows a plot with the loss frequency curves for different standards of protection.

We then modeled the expected losses and premium for flood insurance without the levee setback and purchased on a voluntary basis by individual homeowners, versus the expected losses and premium for a community-wide flood resilience insurance taking into account the higher level of protection from the levee setback that community-wide participation affords:

Figure 4: Loss frequency curves for the portfolio with the various Standard of Protection (SOP) analyzed.



Source: Munich Re US

Indicative premium breakdown:

1. Individual Insurance (NFIP) without Levee Setback: Premiums cost \$581 (average) per structure (or \$845,355 for all structures), if purchased on an individual, voluntary, or mandatory basis, at a 50-year standard of protection, which is the standard to which levees in the region are currently expected to be managed.
2. Community Insurance (CFRI) with Levee Setback: Premiums cost \$298 to \$313 per structure (or \$433,590 to \$454,688 for all structures), if purchased on a community-wide coverage basis with nature-based mitigation that sets the levee standard of protection to 160-to-200-year.

While Community Flood Resilience Insurance (CFRI) should include all exposed locations within the community, the affordability of the program can be further improved by either excluding locations that have experienced repeated flood losses and extremely high-risk locations or individually pricing those locations. In the studied example, all locations within 500 feet of the riverbank were excluded (approximately 10 locations) from this product due to their higher risk. These properties would be included in the CFRI only if:

- Those properties were elevated above the “base flood elevation,” OR
- The property owners were willing to consider an appropriate deductible (which, in this case, was thought to be perhaps \$25,000).

This difference in cost between the two types of premiums (individual insurance vs. CFRI) was based on two factors. First, 23% of the overall benefit is due to the reduction of flood risk due to the levee setback, which reduced the likelihood of a catastrophic flood from a one-in-50-year event to a one-in-160-to-200-year event. Second, 77% of the overall benefit is due to the provision of community-wide insurance coverage for the 1,455 homes,

with a fee in lieu of premium collected from all homes covered, rather than the existing voluntary, structure-by-structure purchase of coverage, under which most homes choose not to purchase coverage. In cases like this, where existing flood insurance participation is rather low, we expect the reduction in premium to be significantly driven by the community-wide aspect of CFRI.

Community resilience and a healthier ecosystem

The economic implications of a CFRI program linked to a nature-based solution like the levee setback implemented in L536 go well beyond a reduction in risk premiums.

Reduced flooding decreases the likelihood of disruption to local and regional businesses caused by damage to roads and other key infrastructure. Decreasing flood risk also notably reduces the risk of closure of major highways and railways, an increase in resiliency that translates into a positive economic impact. It is also worth noting that insurance payouts to property owners are faster and typically more substantial compared to federal aid, which can take months or even years to trickle down.⁵ This speed of payment can vastly improve the insured property owner's ability to withstand and recover from a major event.

Additionally, the Project has already delivered significant ecological benefits to the region. As mentioned above, over 1,000 acres of floodplain were reconnected through the Project, promoting population growth among multiple declining species. In addition, 400 acres of land where soil and gravel were taken from borrow pits are being transformed into wetlands, which will create new habitats and help improve water quality. From a recreational standpoint, this Project will also expand areas for fishing and boating.

For insurers, the benefits of a joint CFRI and nature-based solutions approach enable them to continue to underwrite policies for a specific area and expand that ability as risk decreases. This helps further close the insurance gap, improving the resiliency of the communities they serve.

For local, regional, and state governments, a setback project like L536 coupled with CFRI ensures that they have more freedom to fund and support a flood risk mitigation project, without putting additional burden on their expenditures. Catastrophic events often deliver a double impact on local finances; first, with immediate expenditures for cleanup and recovery and second, the potential for depressed tax revenues, if businesses and homeowners struggle to recover.

The combination of CFRI policies and nature-based solutions also buys valuable time for communities. Mitigation is far easier to accomplish and far less costly

when a threat or an event has yet to be severe. The longer-term risk-reduction benefits of levee setbacks unlock more time and even resources for local governments to take additional measures, which further ensure resiliency. CFRI and other community-based insurance mechanisms give individuals more control over their own resiliency and the ability to dictate whether a flood is catastrophic or simply a temporary burden.

It should also be noted that the results of this study related to the reduction in expected losses and reduction in premiums associated with the levee setback are also applicable to commercial property flood insurance. Nature-based solutions, such as the levee setback, can be combined with a commercial property flood insurance policy, where the commercial property is benefitting from the risk reduction associated with a levee setback.

Using insurance savings to fund or finance levee setback land acquisition costs

The estimated cost to insure all 1,455 home locations under the NFIP, at a rate of \$942 per property, would be \$1,370,610; under the proposed CFRI program, at a rate of \$250, this community would experience a savings of \$915,923 (see Table 3). While the study only considered 1,455 single-family homes for this product, it can be noted that over 25% of the land acquisition costs of the L536 setback project could be recovered from this innovative community-based insurance program in a single year. In order to set back the L536 levee, state and local governments and non-profit conservation organizations like TNC provided the funds needed to acquire approximately 956 acres of land, at a total cost of over \$3.4 million with an average cost per acre for land acquisition of \$3,600 (see Table 4).

To give another sense of the quantifiable financial benefit of CFRI to such a project as the L536 setback, if we consider the community-wide savings as available for servicing municipal debt, this savings could support an amortizing 10-year bonding capacity of about \$8,500,000. Land acquisition is a commonly financed expense. In the context of bonding capacity — which not every community has the legal authority to access directly — the community can readily support the debt service for a project that brings it tangible financial and ecological benefits.

As noted above, approximately 25% of the land acquisition cost of the L536 project could be recovered with CFRI within its first year. It is reasonable to assume, however, that, without other concurrent causes of loss, insurance premium savings could persist over a number of years. The insurance premium savings could be used to finance land acquisition. Assuming that the insurance premium savings persist for 10 years, for purposes of illustration, we assume

that a local or state government authority (Authority) could issue bonds whose proceeds would be directed toward land acquisition for the levee setback and whose debt service would be paid for by the insurance premium savings. In order to capture the insurance savings and apply it to debt service on the bonds, the Authority could assess a temporary fee on homes at an amount less than the amount of the insurance savings per home. (We note that the authority to assess fees differs by state law and that we discuss here a fee by way of illustrating one way in which the insurance premium savings might be captured.)

Taking a reasonable municipal bond interest rate of 1.5% and assuming the bonds mature in 10 years and that the \$915,923 in annual insurance premium savings is dedicated to debt service on the bonds, the CFRI premium savings can support \$8,500,462 in amortizing financing for land acquisition — far in excess of the over \$3.4 million cost of land acquisition for the Project (see Table 4). Thus, local property owners do not need to be subject to a permanent fee, and such a financing program could also be used to jumpstart additional green infrastructure improvements along the river. In short, these improvements can bring further benefits to the 1,455 homeowners in excess of the original premium savings.

We can also calculate the amount of annual insurance premium savings over a 10-year period needed to cover debt service (including principal amortization) on municipal bonds issued in the amount of \$3,441,600 — the amount required to acquire the land for the Project. Assuming an interest rate for the bonds of 1.5% and a 10-year maturity, only \$370,831 in insurance premium savings is required to be dedicated to debt service on the bonds (see Table 5).

In other words, only a small portion of the insurance savings from the CFRI product needs to be captured to finance the underlying cost of land acquisition needed to accomplish the levee setback and reduce flood risk. The majority of the insurance savings can remain with the homeowner, which is yet another benefit of this approach.

Table 3: Savings from a CFRI product

Cost of NFIP (community-wide)	\$1,370,610
Cost of CFRI (community-wide)	\$454,688
Savings from CFRI	\$915,923

Source: Munich Re US

Table 4: Cost of the nature-based solution

Number of acres needed for levee setback and landowner participation	956
Average cost per acre (of easement or fee interest)	\$3,600
Cost of interests in land	\$915,923

Source: Munich Re US

Scalability across the US

As noted, the L536 setback is a project that has applicability across the Midwest. There are several factors that make the region, including other parts of the Missouri River, ripe for nature-based solutions. This region has a history of levee breaches; extensive data with regard to historical loss; risk modeling on current and future risk, which enables more accurate analysis of water surface elevation and reach in different conditions; similarities in topography; and, now, a proven roadmap for financing similar projects.

Indeed, this model can be broadened to include areas across the inland US that are not located along riverbanks. These are places that are considered low-to-moderate risk given that they are not next to a body of water, but would nonetheless be vulnerable to flash flooding in the event of extreme rainfall.

Table 5: Example of funding mechanism by accounting for the CFRI savings

	Ten-year sinking fund financing	Scaled to the setback of L536
Savings from CFRI	\$915,923	\$370,831
BBB muni financing rate	1.50%	1.50%
Amortizing bond supportable via savings	\$80,500,462	3,441,600
Possible acreage acquired or under easement	2,361	956

Source: Munich Re US



Photo credit: Northwest Missouri Regional Council of Governments

New ideas, old barriers

There are practical considerations that come with a joint CFRI and nature-based solutions product. These potential barriers are nothing new to the practice of resiliency or the insurance industry and, thus, nothing that cannot be overcome with inventive thinking and collaboration. But they must be a part of the conversation.

From a risk awareness standpoint, insurance can have the unintended consequence of encouraging homeowners and others to build or buy in very high-risk areas. This is often because policyholders feel a sense of security that can lead them to underestimate the risks of a catastrophic event. This tendency highlights why mitigation and risk transfer must go hand-in-hand, because combining mitigation with insurance can both reduce the risk of living in vulnerable areas and make sure that all people who need coverage are insured by keeping the cost of insurance down. CFRI policies linked to nature-based solutions require the community to provide the necessary mitigation needed to make insurance accessible for property and assets in high-risk areas. These policies can have the additional benefit of encouraging individual property owners to make smaller, yet effective mitigative actions.

Traditional reliance on “grey” mitigation measures, limitations on uses of funds, and additional costs are other potential obstacles to implementing nature-based mitigation. Government organizations are inclined to direct funding to projects with relatively shorter timelines and lower initial costs. Educating technical experts and decision-makers on the availability of nature-based solutions, accounting for their full benefits in analyzing their costs and benefits, and removing restrictions on uses

of funds are all ways to address these potential obstacles. While in some cases it may take years for premium reductions from CFRI and nature-based solutions to offset the upfront cost of mitigation, it should be understood that the premium reductions can be an important way to augment other funding sources. As with any other mitigative measure, the full benefit may not be felt until a major flood event occurs.

Resiliency is both about reducing risk and helping businesses and homeowners recover if they are subject to losses from flooding. If small businesses are not able to recover quickly, their chances of survival are greatly reduced. Giving local businesses and homeowners greater protection against floods and the ability to quickly rebuild and/or reopen if an event occurs is essential for a rapid recovery, which is critical for sustaining the local economy. As we’ve acknowledged already, federal aid typically flows in smaller amounts to private businesses and homeowners, which may be insufficient to enable full recovery.

The power of participation

Joint CFRI and nature-based solution projects benefit multiple stakeholders in the community and ease pressure on various governmental bodies. These projects have more support, momentum, and a greater likelihood of becoming reality if these stakeholders come together to drive projects forward.

Indeed, such collaboration was instrumental in the success of the L536 project. About 15 different public and private, federal and regional organizations were involved, with support ranging from levee construction to securing financing to multiple landowner negotiations.

Along these lines, public/private partnerships can be useful in financing mitigation projects that would otherwise be difficult for local governments to bear the cost of alone. Private businesses — especially those with major operations near floodplains — have an incentive to invest in projects that promote mitigation, due to the potential for disruption and losses. There is also the interdependency between what happens on the land and those that benefit from it. For example, flooding can impair the supply of crops that consumers across the country rely on and that companies in other areas process and sell. During the Mississippi River flooding, approximately 6.3 million tons of grains, with a value of nearly \$1 billion, were left unshipped because farmers were delayed in harvesting, construction products were put on hold, and barge traffic came to a halt.⁶

Attracting participation from these organizations may mean educating them on the trickle-down effects of a catastrophic event, and simultaneously the benefits of mitigation. Projects that define problems and beneficiaries too narrowly may miss out on this support.

While experimentation and problem solving are hallmarks of any emerging practice, the lessons of the L536 Large-Scale Levee Setback Project offer a roadmap for future CFRI and nature-based solution projects. What's remarkable about the Project is that, even with the variety of stakeholders and the number of solutions that needed to be devised in real time, it only took 23 months from the first project meeting to the completion of the levee. The ability to complete future projects quickly and efficiently will attract even more participation.

The benefits of combining CFRI with nature-based solutions

It is estimated that for every \$1 spent on mitigation, \$6 in losses are prevented.⁷ Given that the instances and severity of flooding continue to increase, the value and the impact of mitigation grows too.

Many homeowners and businesses cannot move out of harm's way. For them, sound physical protection, either from nature-based solutions or "grey" infrastructure, and insurance, is what separates resiliency from the potential for total loss. Mitigation and risk transfer are essential to the well-being of people and communities.

Resiliency is far from binary. We are discovering that the formula for success is found in the crossroads between various solutions. Risk transfer and mitigation are useful individually; together, their impact is magnified. The same goes for various types of mitigation; a blend of nature-based solutions with "grey" infrastructure can deliver the benefits of both, while alleviating pressure on one mechanism or another to absorb and/or dispel excess water.

The urgent challenge that climate risk presents calls for inventive solutions. Addressing the fast-changing nature of floods and storm surges will require new means for reducing vulnerability while being mindful of costs and delivering maximum benefit to the community.

It is in this context that joint CFRI and nature-based solutions become an appealing approach. As with any new method, the benefits must be proven and quantifiable. The work that TNC, Munich Re US, and others have done in measuring the impacts of the L536 Missouri River levee setback will be essential for demonstrating the value of joint mitigation and risk transfer initiatives, not just fiscally, but ecologically as well.

Education, collaboration and, ultimately, a willingness to invest in the future well-being of communities will drive projects that improve flood resiliency forward. When the old paths to physical and financial security from catastrophe no longer serve US communities, stakeholders must be curious and willing to work together to solve unique problems with inventive solutions. The quantifiable successes of joint CFRI and nature-based solution projects are a testament to what communities are capable of when it comes to dictating their own resilient futures.



Photo credit: U.S. Army Corps of Engineers, Omaha Division

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