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MEMORANDUM

To: **CMAP's Environment and Natural Resources Working Committee**

From: CMAP Staff

Date: April 10, 2017

Re: Causes of flooding and existing impacts

Urbanization and climate change are leading to more frequent and intense flooding events in northeastern Illinois. GO TO 2040 calls for integrating land use policies and site planning with water resources and identifies compact development, redevelopment, water conservation, and green infrastructure as techniques. Amidst growing evidence of increasing frequency and intensity of storm events, the extent and costs of urban flooding, and the continued costs of riverine flooding, CMAP intends to build on GO TO 2040's approach and refine how stormwater management is addressed in ON TO 2050, the next regional plan. Recommendations for this refinement will ultimately be summarized in a stormwater strategy paper. This memo is the first in a series to develop the strategy paper and focuses on providing a better understanding of the causes and impacts of flooding in the Chicago Region.

Flooding is a temporary condition where an area of normally dry land is partially or completely inundated with water, either from the overflow of water from a stream or river (riverine flooding) or from rainfall overwhelming the capacity of drainage systems, such as storm sewers, or local ponding of water (urban flooding).

Causes and drivers of flooding

While flooding is a natural process, development and changing precipitation patterns due to climate change have changed the way water flows through the landscape. The reasons behind flooding can be quite complex and are the result of a combination of factors. CMAP staff have identified the main causes of flooding in the region to establish a core understanding for future recommendations. The interrelated factors have been organized into five different categories: environmental conditions, climate change, development extent and location, stormwater system design and maintenance, and regulatory structure. CMAP also identified several drivers that perpetuate flooding of particular areas or continue to place homes and businesses at risk.

Environmental Conditions

Flat topography: The largely flat topography of the Chicago region contributes to flooding in two different ways. Flat topography means that the drainage areas of our region are relatively large and this broad area accumulates larger volumes of water as it moves down the system. At the same time, the flat or gently sloping terrain contains depressional areas in the landscape. During rain events, water can start to pool in these locations and, absent a secondary drainage system, may have nowhere to go until infiltrated into the ground.

Saturated or poorly drained soils and high groundwater table: The Chicago region is home to a variety of soil types, including both clay and hydric soils that each can contribute to flooding in different ways. Clay soils largely prevent the infiltration of water, so rainwater can pool or become runoff. In areas of saturated or poorly drained soils, precipitation cannot be easily absorbed into the ground.[1] Some portions of the Chicago region have a high water table, which can result in flooding due to fully saturated soils.

Climate change

Northeastern Illinois has already experienced, and is projected to see even greater, changes in temperature and precipitation from climate change. This can result in increases in flooding due to increased frequency and intensity of storm events, reduced soil capacity from drought, and increases in winter rain and denser, heavier snow.

Increased frequency and intensity of storm events: Nationwide, the heaviest rainfall events have become heavier and more frequent. Between 1979 and 2009, the region experienced 40 percent more precipitation than the prior 30-year period. Storm events are also getting bigger: up to 40 percent of total annual precipitation in recent years came from the top 10 rainiest days.[2] This has important implications for flooding as the amount and time interval of precipitation can impact how much of the rainwater is absorbed by soils or handled by drainage systems. Storm events with steeper and higher peak discharges can result in more flooding as the soils and sewers quickly reach capacity. A higher frequency of heavy storms can create wet periods, with a higher risk of flooding from a subsequent storm due to saturated soils, full detention ponds, and higher water levels of rivers and streams. A two to three-inch storm during a wet period may do more damage than the same precipitation falling during a more typical period.

Reduced soil capacity from increases in temperatures and drought: Climate change is expected to also bring extended dry periods to the region, particularly in the summer months.[3] Coinciding with high temperatures, these droughts could dry soils and reduce stormwater

[1] Hydric soils are soils that form under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions. See USDA Natural Resources Conservation Service, https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/use/hydric/?cid=nrcs142p2_053959

[2] State of Illinois Department of Natural Resources. 2015. Report for the Urban Flooding Awareness Act. www.dnr.illinois.gov/WaterResources/Documents/Final_UFAA_Report.pdf.

[3] Melillo, Jerry M., Terese (T.C.) Richmond, and Gary W. Yohe, Eds., 2014: Climate Change Impacts in the United States: The Third National Climate Assessment. U.S. Global Change Research Program, 841 pp. doi:10.7930/J0Z31WJ2.

infiltration. While on the face of it, drought could be thought to reduce flooding, the decreased infiltration capacity of soils could result in more stormwater runoff when storm events return.

Increases in winter rain and denser, heavier snow: Climate change is anticipated to result in more winter precipitation falling in the form of rain rather than snow. When snowfall does occur, it is projected to be more intense, with more snowfall accumulation per event and denser, heavier snow.[4] Snowfall can result in flooding if large amounts of it melt in a short period of time. The risk of flooding increases when the ground is frozen, drainage systems are blocked by snow or ice, and rainfall occurs on top of packed snow.

Regulatory Structure

Standardized approach: Driven by efforts to maintain a more level playing field between different areas as well as logistically administer regulations and anticipate requirements, fairly static and standardized requirements are often used to manage stormwater despite unique site conditions. While some county ordinances are setting watershed specific detention release rates, which establish rates of flow out of a detention area so that downstream areas are not flooded or eroded, most detention release rates are set at the county scale and may not reflect conditions unique to that watershed. In addition, many communities may not wish to impose stormwater requirements that exceed their neighbors in order to appear more attractive to development.

Redevelopment triggers requirements: While new stormwater management techniques continue to evolve and are more frequently incorporated into new development, the implementation of these practices in previously developed areas hinges on redevelopment. Projects that meet specific area thresholds are required to comply, potentially leaving out a sizeable portion of redevelopment projects. In addition, stormwater management regulations are often required on a site-by-site basis unless part of a larger subdivision process. As such, more shared, distributed systems are often harder to execute under current rules without a separate stormwater master plan process. While some land uses and the public right-of-way will see more frequent transformation, much of the region's residential land uses may remain in their current condition for decades without additional actions to retrofit areas for stormwater management. In addition, some communities do not require stormwater management best management practices within public right-of-ways beyond state road design standards; despite the significant contribution of runoff generated by streets.

Outdated floodplain boundaries: Floodplain boundaries can change in response to new development upstream as well as changes in precipitation over time. However, the pace at which regulated floodplain boundaries are updated as well as the precipitation data on which they are based has not kept pace with changing conditions.[5] As a result, more currently existing development could now be within the actual floodplain and new development may not be designed based on existing or future conditions. Some communities are responding by

[4] Jaffe, M. and Woloszyn, M. 2014. An Initial Assessment of Winter Climate Change Adaptation Measures for the City of Chicago. *Sea Grant Law and Policy Journal*, Vol. 6, No. 2, pp. 5-25.v

[5] National Public Radio Morning Edition. September 15, 2016. Outdated FEMA Flood Maps Don't Account for Climate Change. See http://www.npr.org/2016/09/15/492260099/outdated-fema-flood-maps-dont-account-for-climate-change

remapping the boundaries themselves, requiring additional freeboard, or regulating to the 500-year floodplain. In addition, not all streams have been modeled and lack delineated floodplains, which therefore is not always part of the development review process.

Static precipitation design standards: Stormwater management and floodplain management standards are based on specific sized storm events that rely on historically observed data as an indicator of future events. Given climate change, the changing nature of precipitation means that past data is no longer a good estimate of future conditions.[6] Yet regulations require adherence to these stationary precipitation design standards and do not account for the changing nature of precipitation and flooding.[7] While new regulations typically refer to updated floodplain boundaries if they are available, the incorporation of new precipitation data into infrastructure design standards has been slow. For example, some communities referred to rainfall frequency data published in the 1960s long after the release of Bulletin 70 in 1989.

Development extent and location

Development has been constructed in a variety of locations that either contribute to downstream flooding or are in locations that are more prone to flooding due to environmental conditions.

Habitat loss and degradation: Agriculture and urbanization have led to large-scale removal of natural habitat and subsequent alteration of natural drainage patterns. Wetlands and other permeable landscapes have provided storage and infiltration for rainwater volumes. In recent years, the loss of storage volume provided by some of these resources have been mitigated for via regulations. In addition to habitat loss, the species composition of remaining natural areas has been altered and may no longer provide the conditions for the same hydrological functions.

Increased impervious cover: Development results in the creation of impervious cover, which prevents the infiltration of rainwater into the ground and generates additional stormwater runoff absent other infiltration, retention, or detention measures. As the volume of stormwater runoff increases, areas downstream from these locations can be impacted by higher runoff volumes and experience urban flooding. These increased volumes ultimately enter rivers and streams, contributing to overbank flooding. County stormwater regulations require new development above specific area thresholds to retain or detain a portion of stormwater runoff, while smaller development sites may not be subject to these same requirements.[8,9]

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[6] Recent research explored the translation of future climate scenarios into a product that engineers and planners could use to quantify climate change impacts and levels of uncertainty. Markus, Momcilo, et al. 2007. Changing estimates of design precipitation in Northeastern Illinois: Comparison between different sources and sensitivity analysis. Journal of Hydrology (2007) 347, 211– 222.

[7] State of Illinois Department of Natural Resources. 2015. Report for the Urban Flooding Awareness Act. www.dnr.illinois.gov/WaterResources/Documents/Final_UFAA_Report.pdf.

[8] Area thresholds vary by county, for a comparison, see State of Illinois Department of Natural Resources. 2015. Report for the Urban Flooding Awareness Act. County ordinances and standards, p. 36. See https://www.dnr.illinois.gov/WaterResources/Documents/Final_UFAA_Report.pdf.

[9] Some municipalities apply a lower area threshold for stormwater requirements. For example, the City of Berwyn reduced the area threshold by half of what Cook County requires after a review of potential development sites revealed that very few proposals would trigger requirements.

Lack of coordination and expertise in development process: Development and infrastructure decisions in one location can have localized or downstream impacts, yet those impacts are not always properly understood or evaluated during the development process. For example, lower capacity communities may lack the time or expertise to adequately review development proposals. In addition, development decisions can have impacts across department and jurisdictional boundaries.

Development in the floodplain: Construction of homes and businesses have occurred within the floodplain, which is an area of higher documented flooding risk. Development in the floodplain can reduce the storage capacity and increase flooding risk downstream. Starting nationally in 1968, floodplains were recognized in development regulations to keep people and investments out of flood risk areas. In the Chicago region, a significant portion of development predates these regulations. Other development has been allowed to occur in the floodplain if it is designed to specific design standards. However, development in the floodplain is only required to be designed with one foot of freeboard above the base flood elevation, which is dissimilar from safety standards for other infrastructure.

Inadequate drainage systems for environmental conditions:
Development in areas with hydric and poorly draining soils and areas with a high groundwater table, absent an adequate drainage system, can cause yard ponding and basement flooding or seepage. Basements are prevalent in the region and rainwater can enter through cracks in the foundation, joints between the foundation wall and floor, or basement window wells. Poor soil drainage is exacerbated by building construction which often compacts the surrounding ground and further restricts its ability to infiltrate water.

Stormwater system design and maintenance

In addition to the location and extent of development, the specific design and maintenance of our built environment may be directly contributing to downstream or localized flooding.

Legacy of conveyance design: Much of the Chicago region was constructed before the advent of modern stormwater management principles. The designs of this earlier development focused on conveying runoff from impervious surfaces as quickly as possible and eliminated natural drainage and infiltration capacity. Often these developments rely on the local sewer or street infrastructure, such as curbs, gutters, and ditches, to send stormwater to a local waterbody, instead of managing it close to its source. Roof downspouts, driveways, parking lots, and streets were directly connected to the local sewer network without employing methods to reduce the rate or volume of runoff. Given this drainage structure – without a focus on managing the stormwater onsite or establishing overland flowpaths – storm events that overwhelm a portion of the system often lead to flooding elsewhere. Densely developed areas may encounter site constraints that favor conveyance designs.

Reduced vegetated groundcover and compacted soils: Development often results in compacted soils and landscaping changes that favor non-native plants with shallow root systems, which can reduce rainwater infiltration and generate excess runoff.

Inadequate design capacity: Stormwater infrastructure is designed to handle specific sized storm events. The original design capacity is based on the best available precipitation data or reference standards, which may result in undersized infrastructure for existing or future storm events. In addition, additional runoff generated from increased urbanization or land use change can overwhelm the original design capacity. Utilization of regional infrastructure capacity can be limited due to local infrastructure constraints. Overwhelmed capacity of combined sewer systems can lead to basement backups as well as sewage overflows into water bodies.

Inadequate maintenance and replacement: Lack of normal maintenance of both grey and green infrastructure, including waterways, can reduce the capacity of our existing drainage systems and lead to flooding. This is largely due to a combination of factors, including the underground nature of much of the grey infrastructure, competing priorities, and a lack of understanding of the importance of maintaining these systems. Some communities do not maintain accurate information about stormwater infrastructure location and condition, which hinders preventative maintenance. Many communities lack an asset management program with a preventative maintenance schedule for stormwater infrastructure, a long term plan for replacement, or a dedicated revenue source for implementation.

In addition, stormwater infrastructure is owned by both public and private owners with varying capacity to handle maintenance and replacement. On private property, many landowners lack an understanding of how to maintain proper drainage. Without a solid understanding of how rainwater moves through the landscape, structures or fill may be placed in locations that impede the flow of runoff.[10] In addition, when property owners fail to perform routine maintenance, from cleaning out gutters to maintaining vegetated green infrastructure, they are not only increasing localized flood risk on their property, but may also contribute to drainage issues on neighboring properties as well. This can be particularly true of detention basins and other stormwater infrastructure that is under the control of Homeowner's Associations.

Drivers that perpetuate flooding

Lack of adequate information: Disclosures of previous flooding are required during points of sale or lease, but existing property owners have a financial incentive to suppress this information given the potential impact to the value of the property. In addition, real estate agents may not be educated on their role to inform buyers and sellers in the process. This leaves new tenants or owners unaware of the potential risk of future flooding events and potentially distorts the market for these locations. Additionally, data on previous private insurance and National Flood Insurance Program (NFIP) payments are protected and cannot be used by buyers to make a more informed purchase.

Subsidized flood insurance: NFIP was established to help provide affordable flood insurance, help communities repair damaged homes and businesses, and promote floodplain management. However, this program has been recognized by some as perpetuating

[10] Federal Emergency Management Agency. 2005. Reducing Damage from Localized Flooding: A Guide for Communities. Chapter 4. P. 4-18. See https://www.fema.gov/media-library/assets/documents/1012

development and redevelopment in flood-prone areas despite floodplain regulations.[11,12] The Biggert-Waters Flood Insurance Act of 2012 was designed to reduce the number of discounted or subsidized insurance premiums through a number of reforms, including increasing rates until full-risk rates[13] are reached, phasing out grandfathered policy rates, and creating a reserve fund.[14] However, the rapid rate increases led to the passage of the Homeowners Flood Insurance Affordability Act of 2014, which reinstated many of the subsidized aspects of the program. A recent GAO report found that current NFIP premiums do not reflect the full risk of loss and may not be communicating the risk of flooding.[15]

Community capacity constraints: Local governments are at the front line of flood prevention and post-flood activities that work to reduce future risk. Such activities include administering and enforcing floodplain management regulations, conducting damage inspections after flooding events, and tracking the cumulative improvements made to structures. However, technical and financial constraints can prevent communities from carrying out activities that reduce flooding exposure in the future. In addition, if residents are not filing flood insurance claims after a flood, this can reduce community's ability to obtain mitigation funds that can help with capital improvement costs.

[11] Hayat, Becky and Robert Moore. 2015. Addressing affordability and long-term resiliency through the National Flood Insurance Program. Environmental Law Reporter. 45 ELR 10338

[12] Jarvis, Brooke. April 18, 2017. *When Rising Seas Transform Risk into Certainty.* New York Times. April 18, 2017. https://www.nytimes.com/2017/04/18/magazine/when-rising-seas-transform-risk-into-certainty.html?_r=0

[13] Full-risk rates are those rates that generate premiums that are sufficient to pay for the anticipated losses and expenses.

[14] United States Government Accountability Office Report to Congressional Addressees, *"Flood Insurance: Comprehensive Reform Could Improve Solvency and Enhance Resilience,"* April 2017, GAO-17-425.

[15] United States Government Accountability Office Report to Congressional Addressees, *"Flood Insurance: Comprehensive Reform Could Improve Solvency and Enhance Resilience,"* April 2017, GAO-17-425.

Existing flooding impacts and extent

Flooding impacts the region in a variety of ways, from damage to homes and businesses to larger scale issues of habitat and water quality degradation. It often results in damages that are difficult to quantify. CMAP staff reviewed existing data and literature to understand the types of impacts and their extent for both urban and riverine flooding. To better understand the location and costs of flooding damages within the Chicago region, CMAP evaluated NFIP policies, claims, and payments, FEMA disaster relief Individual Assistance (IA) grants, and Small Business Administration (SBA) loans from 2003 to 2015[16] by zip code.[17] CMAP also explored several focus areas where flooding impacts are less widely known or documented that are particularly relevant to core CMAP functions: buildings, neighborhoods, and vulnerable populations, water resources, parks and open space, and transportation network.

Flooding damages documented by federal assistance programs

CMAP evaluated NFIP policies, claims, and payments, FEMA disaster relief Individual Assistance (IA) grants, and Small Business Administration (SBA) loans from 2003 to 2015[18] by zip code.[19] To understand the results, it is helpful to have a better understanding of the different features of these three programs. Created in 1968, the NFIP was designed to supplement private insurance policies, such as renters and homeowners insurance, that do not typically cover losses from flooding. Today, NFIP policies are mandatory for all newly constructed or renovated structures with federally-backed mortgages located within the 100-year floodplain, and are available on a voluntary basis for renters and property owners located in communities that have adopted FEMA-approved floodplain management regulations.[20] In order to file an NFIP claim, the property owner must have a policy and the damages were caused by flooding.[21] NFIP policies have been purchased in almost every applicable Chicago area community.

Following a presidentially declared disaster, local residents, business, and governments are eligible for federal relief programs through FEMA's Individual Assistance (IA) grant programs. Presidentially declared disasters are reserved for events of such severity and magnitude that the state or local governments cannot effectively respond.[22] The disasters are declared by county and are not limited to floodplain locations. The region experienced five presidentially declared disasters related to flooding between 2003 and 2015.[23] The FEMA IA grant program consists

[16] This exact time period of the proceeding analysis is from October 1, 2003 to February 26, 2015. This time period was chosen based on the available data from all three datasets.
[17] Zipcode geography was the smallest analysis unit available across all three datasets.
[18] This exact time period of the proceeding analysis is from October 1, 2003 to February 26, 2015. This time period was chosen based on the available data from all three datasets.
[19] Zipcode geography was the smallest analysis unit available across all three datasets.
[20] Almost all communities with floodplains in the Chicago Region are covered by NFIP, see www.fema.gov/cis/IL.pdf
[21] If a sewer backup occurs in the basement that can be attributed to flooding, it is covered.
[22] FEMA Disaster Declaration Process. See www.fema.gov/disaster-declaration-process
[23] For purposes of this report, CMAP included only those disasters that identified flooding: August 20 - 31, 2007 (DR-1729), June 1 - July 22, 2008 (DR-1771), September 13-October 5, 2008 (DR-1800), July 19-August 7, 2010 (DR-1935), April 16-May 5, 2013 (DR-4116).

primarily of one-time grants to residents and businesses for immediate relief and structural repairs and are available to all residents regardless of income.

If a resident or homeowner experiences damages in excess of what their NFIP insurance or IA grant will cover, they may be eligible for a low-interest, long-term disaster loan through the Small Business Administration. These loans are intended to be a last resort, and are only eligible for demonstrated needs that are not covered by other relief programs. Access to SBA loans are granted following a presidentially declared disaster or additional disasters identified by the state. The region has experienced four such disasters between 2003 and 2015.[24]

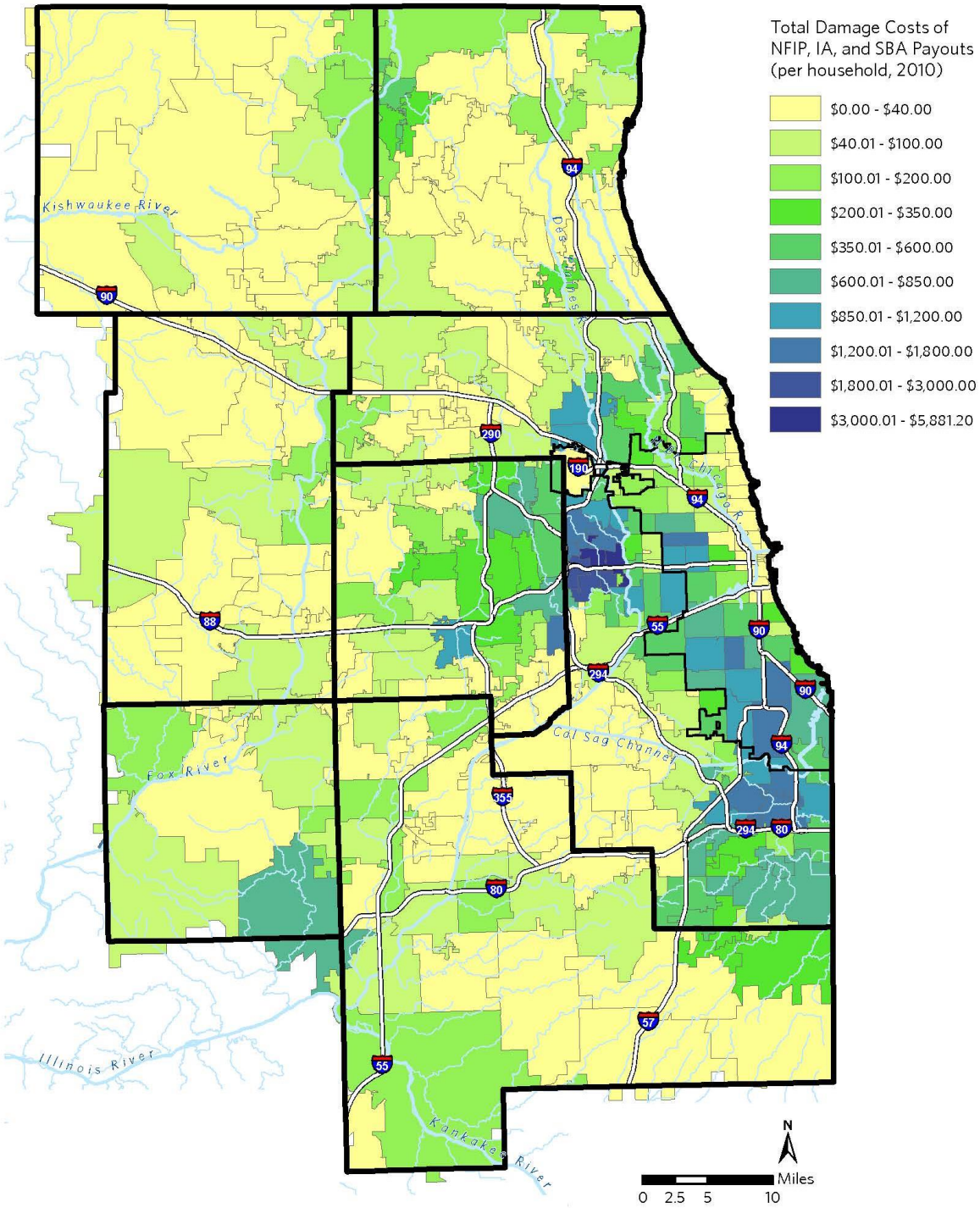
Additional grant assistance, through FEMA Public Assistance and Hazard Mitigation programs, are also available for emergency preparation, service provision, and recovery work performed by government agencies and non-profit organizations. However, this data was not included in this analysis at this time.

Total damages as documented by federal assistance programs

Combined, NFIP, IA, and SBA programs provided the Chicago region with $907 million in flood relief between 2003 and 2015. Figure 1 highlights the total damage payments associated with NFIP, IA, and SBA payments by zip code normalized by 2010 households during this time period. The majority of payouts come from FEMA IA grants (65 percent), followed distantly by NFIP claims (18 percent) (Figure 2).

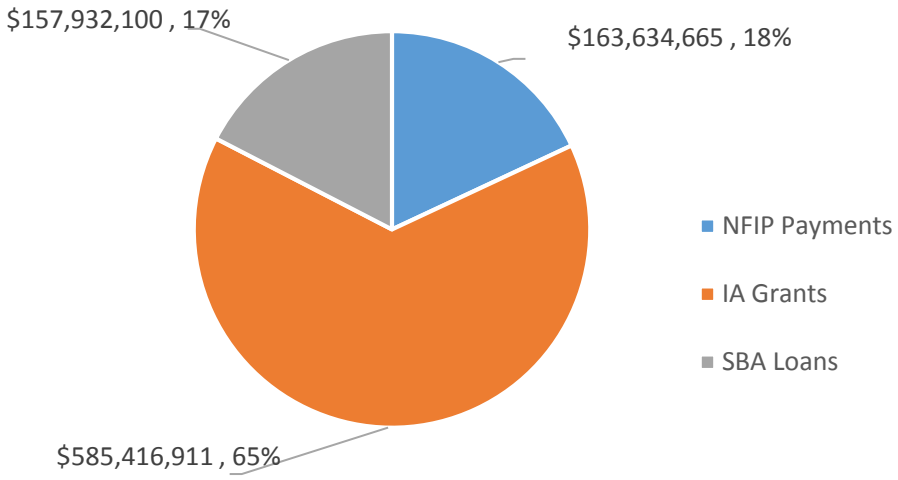
[24] For purposes of this report, CMAP reviewed SBA loans associated with the five presidentially declared disasters and four additional disasters recognized by the SBA program: March 17-April 20,2008 (IL-00014), July 27-28, 2011 (IL-00032), April 4, 2008 (IN-00022), June 18-19, 2009 (WI-00019).

Figure 1. Total flooding damage payments associated with NFIP, IA, and SBA programs per 2010 household by zip code in the Chicago region from 2003 to 2015.



Chicago Metropolitan Agency for Planning, 2017.

Figure 2. Total flooding damage payments by federal program - NFIP, IA, and SBA - in the Chicago region from 2003 to 2015.

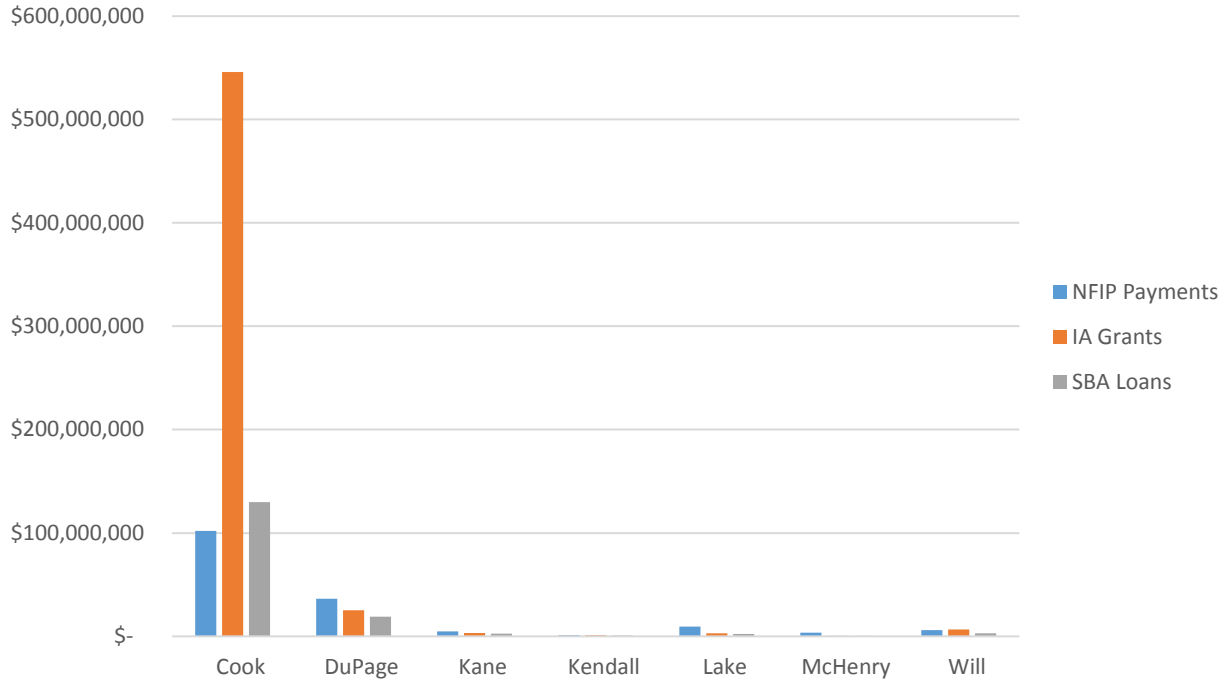


Source: 2017 Federal Emergency Management Agency.

Spatial distribution of payouts vary by federal program

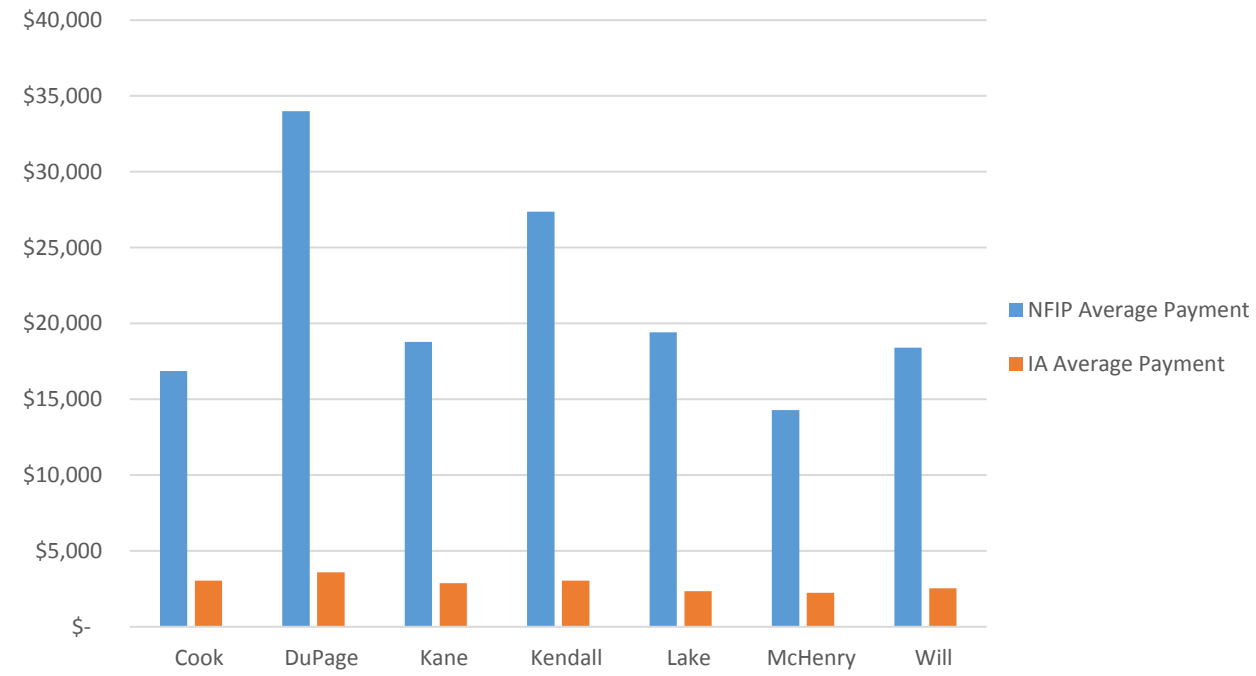
The spatial distribution of total damages paid from 2003 to 2015 were compared across the different federal programs by county and zip code. The majority of damage payments occurred in Cook County (62 percent), followed by DuPage County (22 percent) (Figure 3). During this time period, NFIP paid 8,491 claims, totaling $164 million with an average of $19,272 per claim (Figure 4). Areas with the largest payments by zip code went to communities along the Des Plaines River in northwest Cook County and Salt Creek and the DuPage River in DuPage County (Figure 5).

Figure 3. Total flooding damage payments associated with NFIP, IA, and SBA programs by county from 2003 to 2015.



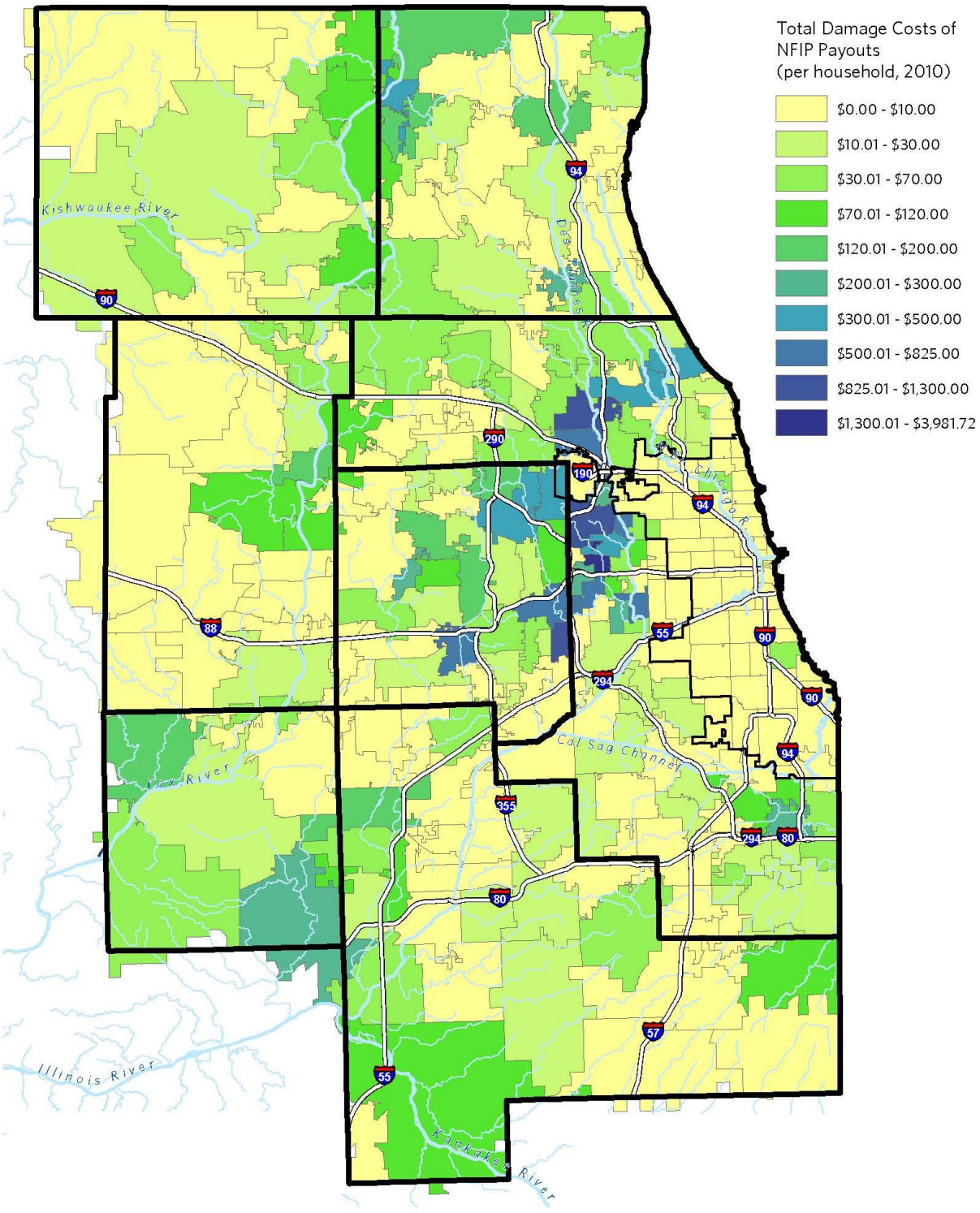
Source: 2017 Federal Emergency Management Agency.

Figure 4. Average payment per NFIP claim and IA grant by county from 2003 to 2015.



Source: 2017 Federal Emergency Management Agency.

Figure 5. NFIP claim payments per 2010 household by zip code in the Chicago region, from 2003 to 2015.



Chicago Metropolitan Agency for Planning, 2017.

In the Chicago region, 63 percent of paid NFIP claims were located within the 100-year floodplain. Paid claims in the floodplain accounted for 72 percent or $115 million of the total payments from NFIP (Table 1). The average payment for claims in the 100-year floodplain was slightly higher than payments made outside of this area. Approximately 37 percent of paid NFIP claims and 28 percent of all NFIP payments are generated by policyholders who are not required to purchase NFIP flood insurance.

Table 1. NFIP claims and payments in relation to the 100-year and 500-year floodplain, in the Chicago region from 2003 to 2015.[a]

	Filed Claims	Claims with Payment	Average Payment	Total NFIP Payouts
100-year floodplain	6,250	5,261	$ 21,984	$ 115,659,786
500-year floodplain[b]	1,273	1,005	$ 12,806	$ 12,869,589
Outside floodplain	2,816	2,101	$ 15,169	$ 31,869,155
Total	10,339	8,367	$ 19,170.38	$ 160,398,530

[a] Does not include claims/payments for addresses that could not be matched using geo-coding.
[b] The percentage of claims filed for locations within the 500-year floodplain does not include the area also identified in the 100-year floodplain.
Source: 2017 Federal Emergency Management Agency.

Federal disaster relief grants through the Individual Assistance program to residents and businesses totaled $585 million, making it the largest program providing flood payments in the Chicago region. IA grants are available to residents after a presidentially declared disaster, which is declared by county (Table 2). Between 2003 and 2015, IA payments were heavily concentrated in Cook County (93 percent) (Figure 3). The IA grant program paid 192,220 claims, with an average of $3,046 per claim (Figure 4). A quick comparison between IA and NFIP payments shows different distributions – with IA damages concentrated in southeastern and western Cook County (Figure 6).

Table 2. Presidentially declared disasters eligible for IA grants by county.

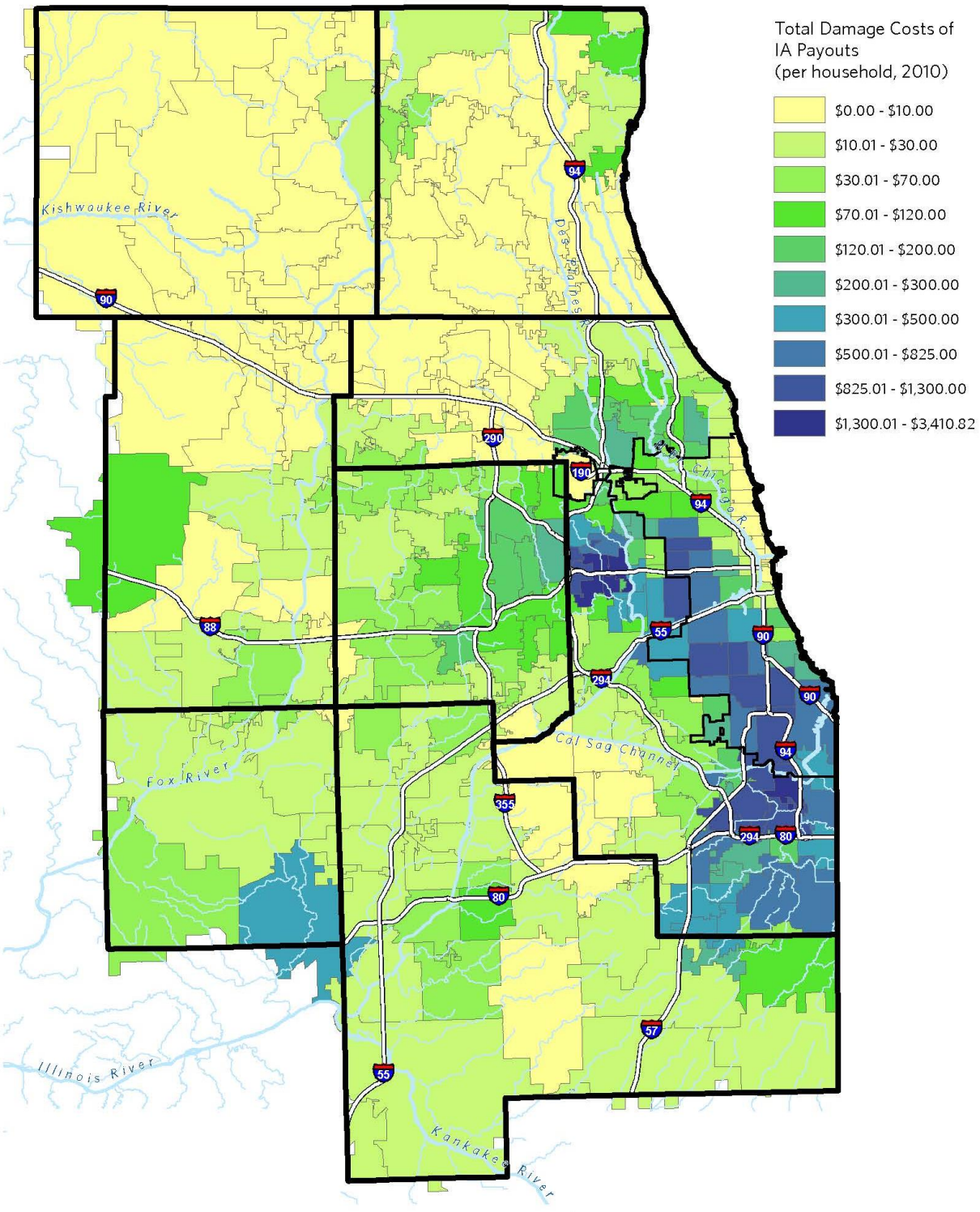
Disaster Period	County
August 20 - 31, 2007 (DR-1729)	Kane, Lake, and Will
June 1 - July 22, 2008 (DR-1771)	Lake
September 13-October 5, 2008 (DR-1800)	Cook, DuPage, Kane, and Will
July 19-August 7, 2010 (DR-1935)	Cook, DuPage
April 16-May 5, 2013 (DR-4116)	Cook, DuPage, Kane, Kendall, Lake, McHenry, and Will

Source: 2017 Federal Emergency Management Agency.

The Small Business Administration provided the region with $157 million in low-interest disaster loans between 2003 and 2015 (Figure 7).[25] Approximately 87 percent of this total, or $137 million, were made to individuals. The remaining $21 million went to local businesses. Similar to the IA program, SBA loans were heavily concentrated in Cook County (82 percent) (Figure 3). An average loan amount was not available at this time.

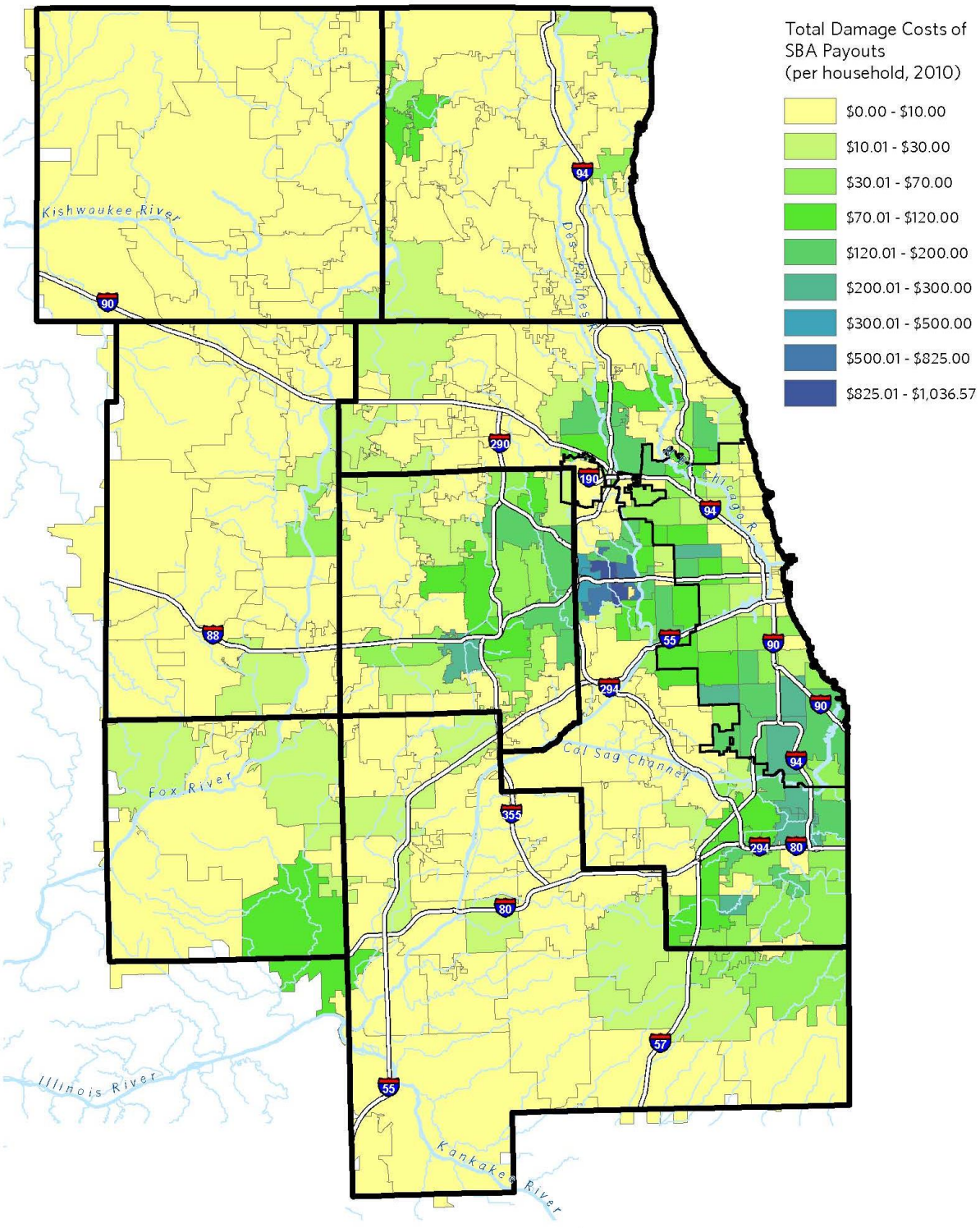
[25] SBA Disaster Loans are intended to supplement public and private relief programs. Interest rates, repayment periods, and other terms are determined by need, availability or credit, and amount of non-SBA relief received.

Figure 6. IA grant payments per 2010 household by zip code in the Chicago region, from 2003 to 2015.



Chicago Metropolitan Agency for Planning, 2017.

Figure 7. SBA disaster loans per 2010 household by zip code in the Chicago region, from 2003 to 2015.



Chicago Metropolitan Agency for Planning, 2017.

Flooding and socioeconomic factors

Given the impacts flooding can have on the built environment, as well as how flooding does not affect all communities equally, CMAP has begun to explore the relationship between documented flooding damages and other community characteristics. The exploration here will rely heavily on work underway in other ON TO 2050 strategy papers, including the Inclusive Growth strategy paper, which is exploring strategies to help achieve a more inclusive regional economy.[26]

In order to facilitate the development of strategies to promote inclusive regional growth, CMAP is identifying census tracts in the region with concentrations of both low-income families and minorities or limited speakers of English. Together, these tracts are termed "excluded communities" and will serve as the basis for beginning to analyze the ways various planning topics, including flooding losses, unfold in the identified areas. Vulnerability to flooding appears to be greater in individuals already facing social vulnerability due to socioeconomic, demographic, and health factors.[27] CMAP's current metric for identifying excluded communities was compared with the above documented flooding damages (Figure 8). Many of the zip codes with the highest amount of damages correspond with the census tracts identified, particularly southeastern and western Cook County and portions of DuPage County.

In the coming months, CMAP will be identifying areas in the region that have experienced disinvestment, or a persistent lack of private and civic investment after the long-term flight of businesses and/or residents. Disinvested areas may have higher building and lot vacancies, low tax bases with high tax rates, aging or poorly maintain physical infrastructure, and their residents may experience higher rates of poverty and unemployment. How flooding contributes to disinvestment through infrastructure and property damages and increased maintenance costs will be further explored.

Data limitations and barriers

While the damages documented through the NFIP, FEMA IA grant program, and SBA loan program help provide an understanding of the cost and extent of flooding, it is not comprehensive of the damages experienced in the region. There are a variety of limitations and barriers to consider, including the lack of private insurance data, economic barriers in obtaining insurance, flooding associated with smaller storm events, and underutilization of available resources. In addition, this analysis focused on property level damage and did not include disaster relief and hazard mitigation programs for local governments.

Lack of private insurance data

CMAP was unable to obtain the private insurance claims data on basement/foundation flooding for this analysis. Reviewing data for six counties in the Chicago region, the Illinois Department of Natural Resources (IDNR) found that private insurance claims accounted for almost $1.09 billion or 60 percent of payouts when evaluating NFIP, IA, and private insurance payments

[26] More information on the Inclusive Growth strategy paper can be found here: www.cmap.illinois.gov/onto2050/strategy-papers/inclusive-growth

[27] Lowe, Dianne, Kristie L. Ebi, and Bertil Forsberg. "Factors Increasing Vulnerability to Heath Effects before, during, and after Floods," International Journal of Public Health, 2013. 10, 7015-7067; doi:10.3390/ijerph10127015.

between 2007 and 2014.[28] The spatial distribution of private insurance payments in the Chicago region was not included in the IDNR report. This is a substantial amount of documented damages that is missing from CMAP's analysis.

In 2014, the Center for Neighborhood Technology reviewed the cost and prevalence of flooding within Cook County by zip code between 2007 and 2011.[29] CNT found that 28 percent of payments came from private insurance.[30] While these two studies used different time periods and geographies, the difference in private insurance amounts could be partially attributed to different rates of securing private insurance within the Chicago region.

Economic barriers in obtaining insurance

Economic factors are likely influencing participation in the NFIP program and private insurance. IDNR found that the average household income for NFIP claims was $61,626, while the average household income of households who filed private insurance claims was $76,913.[31] The Chicago region's median household income is $62,903.[32] Given that over a third of NFIP claims are for locations where participation in the program is not mandated, additional households may similarly benefit from voluntarily joining the program but do not because of economic constraints. In addition, mandatory participation in NFIP is operationalized via mortgages. Once a mortgage is paid off, households may choose to exit the program due to cost concerns. Nationwide, 25 percent of property owners in high-risk areas with a mortgage did not have flood insurance, and another 25 percent did not have a loan and also had not purchased insurance coverage.[33]

Flooding associated with smaller storm events

Flooding is known to result in property damage under a range of different sized storms. For example, some neighborhoods experience basement backups during 2 to 5-year storm events. However, access to FEMA disaster relief grants and SBA loans is reserved for significantly larger storm events. For example, the last presidentially-declared disaster occurred in April 2013, when 5.5 inches of rain fell over two days. Without a presidentially-declared disaster, flooding damages occurring at households without NFIP or private insurance will not be documented.

Underutilization of available resources

Damages due to flooding are not typically covered by homeowners or commercial insurance policies, yet policyholders commonly misunderstand this. In addition, many people may not be aware of NFIP or the federal relief programs that could help them recover from a flooding

[28] State of Illinois Department of Natural Resources. 2015. Report for the Urban Flooding Awareness Act. Prevalence and Cost, p.8. See www.dnr.illinois.gov/WaterResources/Documents/Final_UFAA_Report.pdf.
[29] Center for Neighborhood Technology. 2014. The Prevalence and Cost of Urban Flooding: A case study of Cook County, IL.
[30] The private insurance percentage cited here excludes the PA and SBA data also provided by CNT's analysis for Cook County for easier comparison with the percentages cited in IDNR's Urban Flooding Awareness Act report.
[31] State of Illinois Department of Natural Resources. 2015. Report for the Urban Flooding Awareness Act. Appendix D: Prevalence and Cost, p. D-10. See www.dnr.illinois.gov/WaterResources/Documents/Final_UFAA_Report.pdf.
[32] U.S. Census. 2014 American Community Survey five-year estimates.
[33] Rand Corporation. 2006. The National Flood Insurance Program's Market Penetration Rate: Estimates and Policy Implications. http://www.rand.org/content/dam/rand/pubs/technical_reports/2006/RAND_TR300.pdf

event. Even with NFIP or private insurance, damages from small or repeated events may not be claimed for a variety of reasons, including concerns that premiums will increase or that their policy will be cancelled.[34]

Other flooding impacts

Flooding impacts our communities and neighborhoods in a number of different ways that are not captured by federal assistance programs. CMAP explored how several key assets are impacted by flooding – buildings, neighborhoods, and vulnerable populations, water resources, parks and open space, and transportation network.

Impacts to buildings, neighborhoods, and vulnerable populations

Property damages from reoccurring flooding can contribute to larger scale disinvestment that is not fully captured in insurance claim or disaster relief data. Flooded areas can become less desirable places to live and work which may stymie redevelopment and increase disinvestment in the area. Socioeconomic conditions such as age, income, and ethnicity also play a key role in determining the degree to which an individual or a community will be affected by a flood event.

Decreased property values. Areas that flood show signs of deterioration, including worn building facades, streets, and sidewalks, and flooding also contributes to the devaluation of property. CNT found that wet basements can decrease property values by 10 to 25 percent and are cited as a primary reason for not purchasing a home.[35] According to FEMA, nearly 40 percent of small businesses never reopen following a flooding disaster.[36] These vacant storefronts can decrease property values and vibrancy in downtowns and other commercial areas.

Increased maintenance and repair costs. Reoccurring flooding also increases maintenance and repair costs for households, businesses, and local governments. Property owners with underwater mortgages are even less likely to perform adequate maintenance or repair, as they have no equity to borrow against. Low income residents may struggle to afford private insurance and for those who can afford flood insurance, filing repeated flooding claims often leads to rate and deductible increases. To combat the effects of reoccurring flooding on public assets, local governments face high repair and maintenance costs of transportation and sewer infrastructure in flooded areas, which may result in lower service performance.

Increased foreclosures, vacancies, and disinvestment. The compounded costs of reoccurring flooding may cause property owners to walk away from their properties or slip into foreclosure. A study of communities in Atlanta found a relationship between the decline of neighborhood incomes with increased risks of flooding and foreclosure. Neighborhoods with the most risk of foreclosures and flooding were lower income with a larger minority population and a lower

[34] An NFIP flood insurance policy cannot be cancelled or non-renewed due to too many claims.
[35] Center for Neighborhood Technology. 2014. The Prevalence and Cost of Urban Flooding: A Case Study of Cook County, IL. See www.cnt.org/sites/default/files/publications/CNT_PrevalenceAndCostOfUrbanFlooding2014.pdf
[36] Federal Emergency Management Association. "Make Your Business Resilient," 2016. https://www.fema.gov/es/media-library/assets/images/116921

homeownership rate.[37] In these areas, managing vacant flood-damaged or foreclosed homes while stabilizing the property values of the remaining residences is a challenge.

Declines in health and quality of life. Residents impacted by flooding could experience a range of health and quality of life issues. Vulnerability to flooding impacts appears to be greater in individuals already facing social vulnerability due to socio-economic, demographic, and health factors.[38] Flooding can increase exposure to mold and mildew, contributing to allergies, asthma, and respiratory infections, which can disproportionately impact children, the elderly, and immune-comprised individuals. Flood waters could introduce gasoline, pesticides, and other chemicals into dwelling units and result in long-term health problems. The elderly and residents with disabilities or illnesses are most vulnerable to acute, disruptive flooding, particularly when power outages and transportation disruptions interrupt daily needs and medical treatment.

Flooding also causes stress as residents cope with the clean-up and repair costs, lost personal belongings, and the potential for future flood events.[39] Renters insurance does not cover flood damage, and most landlords purchase structure-only policies, leaving tenants' possessions unprotected. Residents may be unaware of home maintenance strategies that could reduce their exposure. In addition, some populations, particularly immigrant and minority communities, may lack knowledge of public assistance programs and emergency response procedures.

Impacts to water resources

CMAP is exploring current issues and policy recommendations related to water supply, water quality, and wastewater planning in a related ON TO 2050 water strategy paper. Stormwater management and flooding in particular have clear connections and impacts to other water resources, which are outlined in this section.

Delivers pollutants. Stormwater runoff carries non-point source pollutants, which in general can impair water quality and habitat in streams and rivers. Stormwater runoff can also carry pollutants into shallow groundwater sources via infiltration, which can impact the quality of the groundwater for use as water supply, either directly by contaminating individual wells, or indirectly by increasing treatment costs in municipal and other collective supply systems. Polluted groundwater can also impair ecosystems that rely on clean and functional groundwater hydrology to sustain organisms and habitats. For example, runoff of chlorides applied to control snow and ice can infiltrate into groundwater tables and impair the use of the

[37] Carpenter, Ann, "*Under Water in More Ways Than One: Assessing the Impact of Historic Flooding and Foreclosures on Atlanta's Vulnerable Communities,"* Federal Reserve Bank of Atlanta. Volume 21, Number 1. Accessed on 12 March 2017: https://www.frbatlanta.org/-/media/documents/community-development/publications/partners-in-community-economic-development/2011/01/assessing-impact-historic-flooding-foreclosures-atlantas-vulnerable-communities.pdf

[38] Lowe, Dianne, Kristie L. Ebi, and Bertil Forsberg. "Factors Increasing Vulnerability to Heath Effects before, during, and after Floods," International Journal of Public Health, 2013. 10, 7015-7067; doi:10.3390/ijerph10127015.

[39] The Center for Neighborhood Technology conducted an online survey of flooding victims and found that 84 percent reported suffering stress from the event and 13 percent reported ill health as a result of the flooding. Center for Neighborhood Technology. 2014. The Prevalence and Cost of Urban Flooding: A case study of Cook County, IL.

water for drinking and other uses. Chlorides also impair water quality for organisms that are not adapted to more saline conditions.

Alters hydrology and reduces infiltration. By capturing and moving rainwater quickly away from the landscape, traditional stormwater management systems can significantly reduce infiltration and recharge of rainwater into groundwater systems and modify the movement of groundwater that supports groundwater-fed ecosystems. Stormwater management systems also modify the hydrology of surface water systems to the extent that stream and riparian habitat are impaired by the "flashy" increase and decrease in water levels, as well as the velocity with which "managed" stormwater flows through stream channels, causing damage including erosion of stream beds and banks and sedimentation of stream and riparian habitat.

Overwhelms capacity of storm and wastewater infrastructure. In combined sewer systems, excessive stormwater runoff volumes can cause overflows of combined sewage and stormwater into receiving rivers, thereby impairing aquatic habitat and potentially increasing downstream drinking water treatment costs, particularly on the Fox and Kankakee Rivers. Stormwater entering either a combined sewer system or through inflow and infiltration of a separate sewer system increases the demand on wastewater treatment facilities as it works to treat both sewage and stormwater. Wastewater treatment is expensive and energy intensive, and such investments are wasted if used to treat stormwater, which should not go through this treatment to begin with. In addition, rising floodwaters can impair infrastructure and facilities used to convey and treat water, such as wastewater and water supply treatment facilities and distribution systems.

Affects Lake Michigan withdrawals. The Chicago region's use of Lake Michigan water is governed by a U.S. Supreme Court Consent Decree, which establishes a limit to the Illinois diversion of Lake Michigan water to the Illinois River. Over half of the allocation is typically used for public drinking water supplies, while a significant portion (27.7 percent) of the diversion is attributed to the stormwater runoff that occurs within the Great Lakes basin.[40] Instead of returning to the Lake Michigan watershed, the stormwater runoff is diverted by sewer systems that redirect this amount to the Illinois River. This portion of the diversion contributes to the limit in the public drinking water withdrawals that can be made within the allocation. Increasing precipitation due to climate change could further impact the portion of the allocation used for public drinking water supplies.

Impacts to parks and open space

The region's green infrastructure network provides a range of ecosystem services, including an estimated $4.2 billion in flood control annually.[41] Maintaining biodiverse ecosystems can help the region mitigate and prepare for climate change, but open space areas will faceincreasing flood events or pressures to handle stormwater runoff to the potential detriment of other habitat goals. CMAP interviewed several land managers from Forest Preserve Districts and municipal

[40] CMAP. 2010. Water 2050: Northeastern Illinois Regional Water Supply/Demand Plan. See www.cmap.illinois.gov/livability/water/supply-planning/water-2050

[41] CMAP. 2015. Green Infrastructure Vision 2.3: Ecosystem Service Valuation. See https://datahub.cmap.illinois.gov/dataset/green-infrastructure-vision-2-3-ecosystem-valuation

public works to better understand the impacts of flooding to our natural areas.[42] Given habitat and connectivity goals, many of the region's conservation and recreation open spaces are located along streams and rivers and contain wetlands. Land managers expect these areas to flood and seek to harness this natural process for native habitats. However, the magnitude and frequency of flooding is greater than pre-settlement conditions and presents several challenges to open space managers who are working to maintain native habitats and recreational amenities:

Exacerbates invasive species and increases restoration demands. Flood waters can impact native plant habitats in a number of ways. Flood waters are composed of the stormwater runoff from our streets and neighborhoods, which picks up pollutants and the seeds of invasive species on its way to the stream or river. The lower water quality can damage native species and allow more tolerant, invasive plants to take over. This can increase habitat restoration demands on land managers as they work to maintain native habitats.

Increased erosion and sedimentation. Flood waters can also increase erosion and lead to downstream sedimentation. Land managers discussed the slow impacts of erosion over time as well as the more catastrophic events that happen less frequently. In a natural landscape, wetlands would naturally silt up and water would move onto the next area over time. But land managers often do not have this flexibility given their limited land holdings. This requires dredging out of wetland areas and replanting in order to maintain natural habitats. Some land managers described the erosion impacts of extreme winter conditions – particularly freezing events followed by substantial rains – that cause massive shifts in the landscape and requiring them to redo native plantings. Some discussed how there is less funding available for erosion management and that most maintenance activities are focused on vegetative management.

Reduces recreation opportunities. Flooding within parks and open space can also result in the closure of specific trails or picnic areas. While these closures are temporary, they do impact use of trails and open spaces. Many of the more active amenities of our parks and open spaces were designed in recognition of the floodplain and largely remain intact after floodwaters recede. However, some land managers have relocated campgrounds and other facilities to reduce the continual maintenance costs associated with repairs after floods. In addition, as land managers update trails or other structures, they are often redesigning these facilities to accommodate today's stormwater runoff volumes and flows. Water quality impacts from combined sewer overflows can also lead to the closure of beaches.

Stormwater impacts on adjacent properties. Open space land managers are often engaged in figuring out potential stormwater management solutions for adjacent private property. Either in advance of a development proposal, where a municipality is seeking their input on the stormwater strategies, or post-development where the original design or lack of maintenance has led to flooding. Many of these situations represent an opportunity to improve or restore hydrologic functions and meet habitat restoration goals. However, some land managers are seeing an increase in staff time and resources dedicated to solving nearby drainage issues.

[42] CMAP conducted several phone interviews with the Kane County Forest Preserve District, Will County Forest Preserve District, Cook County Forest Preserve District, Village of Riverside, and Village of South Holland.

Impacts to transportation

Flooding impacts the region's transportation network in two main ways – declines in performance and increased infrastructure maintenance and repair.

Declines in performance

Rain and flooding can impact the performance of the transportation network in a variety of ways. Weather related delays and corresponding traffic disruptions can occur on our streets, highways, and rail lines. Street drainage systems may become overloaded, resulting in street flooding and possible street closures and rerouting. This can impact personal travel as well as truck and bus traffic and can lead to more incidents and decreases in safety. Similarly, rail systems can be impacted as flooding occurs in tunnels and effects other vulnerable facilities. In April 2013, expressways and rail lines in the Chicago region were closed due to flooding. Road and transit closures can cause a cascade of indirect impacts, including declines in economic productivity and emergency service provision. Some neighborhoods' transportation networks can be significantly impacted by road flooding, particularly at railroad viaducts; leading to emergency response and job access concerns. Active forms of transportation, such as bicycling and walking, likely decline during storm events and may result in more reliance on transit or the automobile.

CMAP recently released a Highway Operations strategy paper as part of the ON TO 2050 planning process.[43] FHWA Office of Operations estimates that inclement weather causes 15 percent of congestion, increasing the number of crashes and delays and reducing road capacity. Increasing precipitation due to climate changes could result in increased congestion related to rainfall events.

Increased infrastructure maintenance and repair

Flooding often results in damage to transportation infrastructure. This can come in the form of catastrophic events, like when riverine flooding washes out bridges and culverts, as well as more subtle changes that shorten the life expectancy of infrastructure. Standing water can weaken the road base, while high soil moisture levels can lead to structural declines in roads, bridges, and tunnels. These impacts can lead to more frequent repair or replacement of components of the system, also contributing to declines in performance. Areas that are already experiencing flooding will likely face more frequent and severe problems as climate change brings more frequent and intense storms. In addition, changes in precipitation can lead to increased costs for transportation projects as drainage systems are designed to accommodate more stormwater.

[43] CMAP. 2017. ON TO 2050 Highway Operations Strategy Paper. See www.cmap.illinois.gov/onto2050/strategy-papers/highway-operations

Next steps

In the coming month, CMAP will summarize the region's current strategies to flood mitigation and prevention to gain a better understanding of the policy gaps and barriers to addressing these issues effectively. CMAP will identify a couple priority barriers to explore further, which could include the changing precipitation and static design standards, real/perceived barriers to redevelopment, community capacity constraints, and water quality and supply regulations, among others.