

Climate Change – Real Estate Impact

“A man who does not plan long ahead will find trouble at his door.” – Confucius.

Perception becomes reality. Whether alarmist or denier, believer or skeptic, those responsible for making decisions in response to the perceived threat of climate change have taken the side of caution over indecision and preparedness over hesitation.¹ At its core, climate change is a real estate issue. While potential responses implicate other fields of expertise, and potential solutions or stopgaps might be found in the insurance industry, the energy sector, or even nanotechnology, climate change will have a direct impact on real estate.

This paper will address some of the means by which property owners, developers, governmental authorities, and others intend to tackle the perceived effect of climate change. The recent increased severity of fires, floods, mudslides, and rising stormwaters have forced a reckoning. Through new zoning codes, building requirements, infrastructure changes, and other policy tools, the industry has begun to address the issue of climate change from a holistic and increasingly cooperative perspective.

At some level, the real estate industry, and those who have analyzed risk in the industry, have come to a collective agreement that unrestricted development into areas identified as being at-risk is unsustainable. Whether there is a coming apocalypse in the next decade or a slow decline in financially developable areas over the next hundred years, the industry as a whole has decisively chosen to meet the risk head-on. Rather than hoping and waiting, industry professionals have begun to assess the risks as they may occur and address the problems now, rather than wait for today's hindrances to become insurmountable.

Water, Water Everywhere (And It's Not the Type You Want to Drink)

“Whiskey's for drinkin'. Water's for fightin'.” – Attributed to Mark Twain

The Mississippi River has held a fascination in American public lore since its discovery in 1541 by the Spanish explorer Hernando de Soto, a river that he initially named the “Rio de Espiritu Santo” (the River of the Holy Spirit). As noted by Mark Twain in his work *Eruption*, “The Mississippi River will always have its own way; no engineering skill can persuade it to do otherwise ...” That observation is borne out by a recent study noting that both the frequency and magnitude of floods on the Mississippi have increased in the past 150 years.² Many of these floods were correlated with the increased occurrence of global weather patterns linked to the El Niño–Southern Oscillation in the Pacific Ocean and the Atlantic Multidecadal Oscillation, both of which influenced when and how much rain entered the storm linked to the flooding.³ As a result of the increased severity of the floods, the Army Corps of Engineers has undertaken measures to protect land along the Mississippi. Unfortunately, many of the improvements that protect developments and farmland along the Mississippi from the smaller floods only increase the harmful impact of more severe flooding.⁴

“We fired our guns and the British kept a-comin' / There wasn't nigh as many as there was a while ago / We fired once more and they begin to runnin' / On down the Mississippi to the Gulf of Mexico” – Johnny Horton, *The Battle of New Orleans*

According to a geographically disparate group of 85 mayors of cities along the Mississippi River, protecting their citizens and economies from billions of dollars' worth of climate-related impacts will take “major changes” in the near term.⁵ In their November 2018 meeting, mayors belonging to the Mississippi River Cities & Towns Initiative (MRTCI) noted that “infrastructure, manufacturing, agriculture, and vulnerability are all implicated in [the National Climate Assessment Report] with



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effects alarming to even mayors that have been dealing with these impacts for a number of years already.”⁶ In particular, Minneapolis Mayor Jacob Frey made the following statement, “To better protect the Mississippi River — a major force for economic justice and a key source for drinking water — we need to partner with communities, neighboring jurisdictions, and states by following the data and taking meaningful steps to curb climate change.”⁷ In the absence of congressional leadership, cities and states that are connected by a shared waterway may need to work together to address the perceived threat of climate change.

The most visible response to flood-related events is the change in the official FEMA flood zone maps. Many of these new flood zone designations have caught both commercial and residential property owners off guard. For the residential homeowner, the cost of increased insurance can run into the tens of thousands of dollars. In addition to the increased insurance costs, any renovation or reconstruction to homes may not be possible without raising these homes onto stilts or other elevated contraptions, costing tens of thousands of dollars more. In effect, some homes will be rendered unsellable, worth less than the cost of existing mortgage due to their presence in an officially designated flood zone. This could lead to further abandonment of property (particularly those that are damaged and where there does not exist sufficient insurance to rebuild), contributing to neighborhood blight and decreasing property values. Moreover, flood insurance does not, generally speaking, cover a total loss but instead is effectively capped, magnifying the consequences described above.⁸

For decades flood maps changed incrementally or not at all. With the increase in severe storms and weather events, what were once hundred year flood plains are now identified as annual flood plains. This change, coming after decades of relative inactivity by FEMA and its predecessor agencies, makes it increasingly difficult to predict whether properties on or near the edge of water breaks may have their designation changed, resulting in a considerable loss of value. This paper impact, results in a real financial loss, either due to increased engineering costs for future development, increased insurance risks, or possible additional capital costs to developed sites to address future concern over future weather events.

Fighting flood map designations is expensive.⁹ As FEMA has moved to update its decades-old flood maps, many experts have cheered the effort. Made using the latest in mapping technology, such as laser beams (LiDar) and computer modeling, the updated maps are intended to account for climate change and will lessen the blow of devastating storms by compelling homeowners to reduce their risk.¹⁰ But critics of those experts caution that the maps, which are used to determine flood insurance premiums, are tough to challenge and in some cases are ensnaring homeowners located outside of what could reasonably be considered a flood zone.¹¹

Zoning and Infrastructure

“All politics is local.” – Tip O’Neill

The effects of climate change place the country’s infrastructure at risk. By way of example, New York City’s subway system’s pumps are designed to handle 1.5 inches of rain per day and 39 mile per hour winds.¹² These pumps, some built as early as 1914, were no match for Superstorm Sandy and will be no match for the severe storms of the future. Built to run on electrical power, a storm severe enough to overwhelm the pumps would almost certainly disable the city’s electrical grid. Waterlogged tunnels and a lack of electricity will shut down New York City’s subways, the beating heart of America’s largest city and its financial capital. New York is not alone — six of the 10 largest mass transit authorities organized by ridership are located along the Atlantic seaboard.¹³ Even today, nearly seven years after Superstorm Sandy, New York is still trying to recover from its effects.¹⁴ A recent Columbia University study found that a hundred year storm in New York City that flooded all 14 subway tunnels would take 21 days to clear, *assuming the electrical grid retained power*.

New York is only one example of the cataclysmic effects of climate change. Miami’s flooding problems have created concerns for public health issues (e.g., fecal matter flowing through the streets during increased flooding events, contaminated drinking water, washed out streets, and flooded homes).¹⁵ While some engineering solutions, such as pumps, are already in place, Miami

politicians increasingly see its future as a city of floating homes and buildings on stilts.¹⁶ The city of Miami is looking into permitting new construction on only the highest elevations within the city. In addition, the city of Miami is considering the implementation of zoning changes that effectively discourage construction in certain high risk areas and encourage construction in areas less likely to be flood-prone.¹⁷ Miami also considers the criticality and vulnerability of the infrastructure in its disaster planning. In the event of a natural disaster, water and sewer plants are prioritized over parks. That flexibility comes at the cost of heightened requirements for critical infrastructure or infrastructure with the potential to cause significant harm to the surrounding community if not sufficiently protected. If the city wants to build something like a nuclear plant, extra protection is required.¹⁸

As noted by Toby Sells of *Memphis Flyer*, the National Climate Assessment report noted that an extreme weather vulnerability assessment conducted by the Tennessee Department of Transportation found that the urban areas of Memphis and Nashville had the most at-risk transportation infrastructure in the state.¹⁹ The report found that increasing precipitation and extreme weather events will likely impact roads, freight rail, and passenger rail, especially in Memphis, resulting in cascading effects across the region.²⁰ Infrastructure must continue to exist, so many cities have had to choose between roads or rail. As noted below with the city of Portland, Ore., given this choice, there is a push towards transit as opposed to roads when determining the focus of infrastructure management. As opposed to roads, mass transit addresses both mitigation and adaptive conditions at the same time. By way of example, raising roads provides an adaptive response to climate change (e.g., the roads are less likely to flood) but fails to address a possible underlying cause of climate change (e.g., greenhouse emissions). Mass transit on the other hand addresses both adaptive responses (e.g., raised rails flood less often) and mitigation issues (e.g., the reduction of greenhouse gases due to fewer vehicles on the road).

The city of Portland, Ore., in light of federal inaction on climate change, has looked to the city's most powerful weapon to combat climate change — the city zoning code.²¹ Similar to the Mississippi River cities and states, the city of Portland intends to harness local leadership, in tandem with Seattle, San Francisco, and Vancouver to create a “green wall” on the West Coast of North America and be “part of responsible climate action.”²² Some of these measures include not only climate mitigation techniques (e.g., reductions of fossil fuel usage), but adaptive techniques such as supporting smart growth to encourage more walking, transit, and bicycling, all of which require infrastructure that is easier to maintain than traditional highways.²³ From a development perspective this means more emphasis on and more permissive zoning for transit oriented developments (sometimes referred to as TODs). TODs have already gained renown through their inclusion in the LEED certification process and as potential aids in mitigating the effect of climate change, but as more cities take on the Portland model and view the combination of mitigation and adaptive solutions to climate change as being one and the same, development in TODs may lead to increased support in city zoning hearings and increased inclusion in municipal zoning codes.

Zoning can additionally affect architectural and engineering designs (e.g., floating homes, homes on stilts, developments of seawalls, etc.). There is a movement towards densification, particularly in cities, to areas that are less prone to flooding, allowing developers more free reign on density in such areas (commonly called “upzoning”).²⁴ In an upzoned city, development pressures would shift from the historically high value, and increasingly threatened, coastal waterfront to inland areas that are naturally buttressed against the effects of climate change.²⁵ Historically, by focusing on form-based parameters such as setbacks, height, build-to lines, lot coverage and so forth — zoning codes have played a significant role in shaping our urban environments. It is likely that in the future, planners will increasingly recalibrate these same factors to meet climatic and performative objectives related to orientation, exposure, and the interaction between buildings and the public realm.²⁶

To ameliorate the cost of densification, but at the same time discourage the single family model, many cities are incentivizing low-rise structures, constructed in environmentally friendly timber that is significantly less carbon-intensive than concrete-and-glass towers. These low-rise developments are generally well suited to adapting and diversifying low-density, single-use zones where existing transit and infrastructure are often underutilized.

Fires and Mudslides

“And if you see my reflection in the snow covered hills / Well maybe the landslide will bring you down.” – Stevie Nicks

Unlike issues pertaining to water and windstorm, usually seen as affecting commercial properties, fires and mudslides are often considered a residential concern. The nexus between increased fires and mudslides and climate change is fairly straight forward. Effectively, higher temperatures result in earlier snowmelt, allowing for forested areas to dry out more quickly and for a longer period of time, thereby creating more tinder for a potential fire.²⁸ An annual increase in temperature of one degree Celsius may increase the risk of fire by as much as 600 percent.²⁹ The burnt out areas in turn heighten erosion and, when combined with extreme rain and weather events, create more of a favorable condition for mudslides to occur.

One of the simplest resolutions by municipalities to address the fire issue is a moratorium on building in certain at risk areas.³⁰ Certainly the insurance companies are pricing out areas in which the risk of fire is no longer manageable from an underwriting perspective. In Deschutes County, Ore., the county commissioners have created zoning changes requiring certain fire resistant, low density construction on the west side of Bend, Ore., as a means to create a buffer for one of Oregon’s fastest growing cities.³¹ The number of homes that are permitted to be built will be similarly reduced. Note the opposite reaction towards climate change related threats — in fire prone areas cities have moved toward de-densification, while in flood prone areas cities have moved toward densification.

Some advocates have gone so far as to lobby for the creation of landslide zones — areas that are zoned as undevelopable due to the potential risk of landslides and mudslides.³³ These zones have two purposes in states like California: (i) mitigating the risk of landslides that are caused by earthquakes (a non-climate change issue) whereby shifting land causes the crumbling of up-elevation structures and (ii) mitigating the risk of erosion (due to fires) and mudslides (due to rain), both of which are climate change issues, whereby parched land loses its natural growth thereby making it more susceptible to the infliction of damage to down-elevation structures.

This is not only an issue for California. In relatively impoverished parts of the country, including parts of Appalachia, there is a tendency to develop properties along unstable hills that are prone to mudslides.³⁴ The potential for collateral damage, resulting from the houses sliding off the hill and into the houses below, may result in expensive and widespread damage. Developers in areas prone to landslides may need to assess both the risk of the structures they develop as well as the risk that uphill properties may cause to their property below.

The Best Laid Plans of Mice and Men

“The single raindrop never feels responsible for the flood.” – Attributed to Douglas Adams

In a recent Urban Land Institute Global Study titled “Climate Change and Real Estate Investment”³⁵ the authors posited that there are essentially two parts to the climate change risk management discussion — mitigation and adaptation. Climate mitigation measures focus on tackling the causes of climate change. These measures are meant to reduce, prevent, or cause the capture of carbon dioxide, widely believed to be the greenhouse gas causing climate change. Examples of mitigation include switching from fossil fuels to renewable energies, improving energy efficiencies of equipment and buildings, changing practices or behavior to reduce energy use, and protecting national carbon sinks like forests and oceans or creating new sinks by planting trees.³⁶ While important, the mitigation piece falls more squarely in the environmental science and, at some level, the political world. Certainly programs such as LEED certification (an important topic in and of itself) and related sustainable development models follow this mitigation trend, however, it is the adaption piece that impacts much of decision making as to new development projects and the efficacy of existing development.

“Always plan ahead. It wasn’t raining when Noah built the ark.” – Richard Cushing

Climate adaptation measures focus on tackling the actual or expected impacts of climate change (as opposed to mitigation that attempts to prevent them from occurring in the first place, reversing their events, or mitigating their impact).³⁷ These adaptations would include adjustments to natural or human systems such as elevating building or roads to avoid flooding from sea-level rise and increasingly violent coastal storms, employing new, low-water technologies in areas anticipating drought, adjusting agricultural growing seasons and crop varieties to match changes in temperature and precipitation, and installing cool roofs or cooling centers to address heat risk in cities. Adaptation means money.

For purposes of this paper, we will not focus on the discussion of insurance that is certainly a major cost. Insurance, has at times been characterized as a dimmer switch — whether a property is insurable is not a simple yes or no questions. Typically, the answer is more a question of cost than availability. However, with the recent bankruptcy of PG&E, due to, among other matters, wildfire claims in California, the answer by the insurance companies may not be “How much?” but instead a thunderous “No!” With the bankruptcy of a major utility resulting from a perceived climate change related event, will the Gulf states and Florida be treated any differently?

The costs to adapt to climate change can be prohibitive for future development. Following are several examples:

- The National Climate Assessment stated that the annual cost of adapting urban storm water systems to more frequent and severe storms is projected to exceed \$500 million for the Midwest by the end of the century.³⁸
- Under Mayor Bloomberg and now Mayor De Blasio, New York City has set aside nearly \$20 billion to defend against the threat of climate change. That amount, which by the administrations’ own admissions will not address all of the costs that may be incurred by climate change, works out to a staggering \$2,500 per capita or \$10,000 for a family of four.³⁹ This pales in comparison to the recent Urban Land Institute report that suggests the unfunded climate adaptation cost in New York City is \$145 billion or around \$16,953.00 per capita.⁴⁰ By contrast, Chicago has an unfunded climate adaptation cost of \$90.5 billion or around \$33,953.00 per capita.⁴¹ As can be seen from the above example, the fixed costs of climate change adaptation do not necessarily scale to the size of the city. Despite a lower overall cost to hedge against climate change, the vastly greater population in New York allows for the costs to be allocated over a larger population. Smaller and poorer cities unfortunately cannot address these issues with lower costs to bring them in line with per capita realities.
- The costs to fix the New York City subway system post Superstorm Sandy was estimated at \$5 billion.⁴² That cost only addressed fixing the problem. Adaptation related measures that would decrease future costs and downtime in the event of another Sandy-like event would require sums far in excess of those amounts. There is also a question of the unaccounted for loss of productivity costs during any such construction and repairs. By way of example, the South Ferry stop in New York City was closed for nearly six months after Superstorm Sandy. For some commuters, that meant an additional half mile walk to transit. Assuming a normal pace, that results in 20 additional minutes per day, per commute, likely resulting in millions in lost productivity.
- The city of Miami has allocated \$100 million for stormwater drainage improvements with another \$400 million planned in the next several years.⁴³

What is interesting about each of the above examples is that they all put a dollar amount on fixing the problem. Assuming no mitigation techniques are implemented, the above seems to suggest that we as a society could find a Keynesian method, that is we could spend our way out of the harmful effects of climate change. That of course is a bit simplistic. Ultimately, these costs will need to be paid by someone or something because, at its very basic level, these costs are reimbursed effectively as simply taxes.

Let’s say for example, New York City finds the holy grail of climate change adaptation and is able to prevent any type of sea water incursion (lower Manhattan will be submerged if sea levels rise more than eight feet).⁴⁴ That solution will require that someone, meaning the taxpayer, will need to pay for those costs. Whether the funds are raised by bond issuance, real estate taxes, wage taxes, or otherwise, those costs must be paid. Any city, even New York City, is only as strong as their tax

base. Could there be a time when the cost to own property in a city is so cost prohibitive that it does not make sense? Taxes are, in most leases, passed through as a cost to the tenant. Tenants understand those costs are unpredictable but both landlords and tenants have a general understanding as to where those taxes are headed. Businesses might be willing to pay the premium to be in Miami and New York City, but what about neighboring towns such as Bayonne, N.J., or Jupiter, Fla.? Memphis might be able to handle increased costs due to being effectively a capital of the Mississippi River, but could smaller towns survive with their correspondingly smaller tax bases?

Costs of capital improvements are another major issue. In a standard lease, tenants do not pay for capital improvements at properties as an operating expense pass-through. However, as there is increasingly a shortfall between insurance proceeds and repair costs, will landlords need to pass through those costs to tenants? Will tenants be willing to pay? Will such costs simply be in the form of higher rents in locations where flood insurance and wind insurance is unavailable or cost prohibitive? Will this shortfall simply lead to higher rents creating a disincentive for businesses to move into areas affected by higher rents and operating expense pass-throughs due to the presence of the property in flood zones? These are questions and issues that need to be addressed and priced into deals and, ultimately, may affect the desirability of areas to develop real estate and locate businesses.

Conclusion

The above addresses only some of the issues involving real estate in the much larger discussion about climate change. Mitigating solutions such as renewable energy, insurance related issues, and construction concerns are only a few of the additional areas that must be considered when developing or investing in properties that may be impacted by climate change. Flood, wind, stormwater management, fires, and mudslides all affect real estate holdings. Whether the solutions are federal, state, local, or all three are unclear. Certainly many municipalities are using zoning codes to address the issue, but many of the resolutions will come from private industry as well, possibly in the form of capital reserves, increased rents (due to increased construction costs), redirection of development dollars to less climate change prone areas, or other resolutions. What we do know is that the real estate industry, and those associated with the real estate industry, have made the determination, regardless of individual beliefs as to the scope of climate change, that climate change is an issue that will affect the real estate industry for the foreseeable future.

¹ "Get your facts first, then you can distort them as you please." – Mark Twain. Few writers in American literature have so distilled the American ethos as has Mark Twain. Throughout the next few pages, several of Twain's observations from over a century and a half ago will be used to shed some light on today's environmental quandaries.

² Toby Sells, *Memphis Flyer*, November 27, 2018. The Mississippi River Corridor has already sustained over \$200 billion in disaster impacts since 2005, according to the MRTCI, with six of the 10 Mississippi River states incurring more than \$10 billion in losses for each state.

³ See *Nature International Journal of Science*, April 4, 2018. The article notes that a new study suggests that the frequency of floods is, in part, due to the increase in construction of structures erected to control the river. Some hydrologists, however, have suggested that the river needs a more naturalistic management to mimic the wander of dynamic waterway of a century ago. With millions now living and farming in the historic floodplain, this becomes more difficult as it may lead to displacement. What the various viewpoints do agree on is that there is an increase in cataclysmic incidents and that the development of the waterway is partially to blame. As will be discussed later in this paper, much of the means to combat this issue may come in the form of zoning and/or the remapping of the flood plains that, like taxes, create the power to destroy, or at least the power to manage, development.

⁴ *Id.*

⁵ Toby Sells, *Memphis Flyer*, November 27, 2018. Interestingly, changes in the Mississippi have been a source of comment and conjecture since the days of Mark Twain. With his typical wit, Twain wrote the following observation about the Mississippi, "In the space of one hundred and seventy-six years the Lower Mississippi has shortened itself two hundred and forty-two miles. That is an average of a trifle over one mile and a third per year. Therefore, any calm person, who is not blind or idiotic, can see that in the Old Oolitic Silurian Period, just a million years ago next November, the Lower Mississippi River was upwards of one million three hundred thousand miles long, and stuck out over the Gulf of Mexico like a fishing-rod. And by the same token any person can see that seven hundred and forty-two years from now the Lower Mississippi will be only a mile and three-quarters long, and Cairo and New Orleans will have joined their streets together, and be plodding comfortably along under a single mayor and a mutual board of aldermen. There is something fascinating about science. One gets such wholesale returns of conjecture out of such a trifling investment of fact."

⁶ *Id.*

⁷ *Id.*

⁸ "Congress has said they wanted the flood insurance program to be self-sustaining," said Bob Faunce, a city planner in Lincoln County, Maine, upon

promulgation of the new flood maps that took effect in 2015. "Eventually they [FEMA] want premiums to cover losses, and that's not been the case. So on that basis, rates will go up to cover the true risks involved." FEMA's National Flood Insurance Program, which is \$24 billion in debt, is eliminating some subsidies that kept premiums below market rates.

⁹ See Miranda Leitsinger, *NBC News*, February 14, 2014. Homeowners on Dry Hollow Road in rural Pennsylvania had only 45 days to obtain flood insurance after the new maps were finalized costing several hundred dollars a year per home in an already cash strapped portion of the state. The cost to actually fight FEMA, taking into account engineering costs, could rise to over \$5,000.00 per household.

¹⁰ *Id.* FEMA's map overhaul covers America's populated 1.1 million miles bordering rivers, lakes, coasts, and other flooding sources. So far the agency has surveyed nearly half of its target area, mapping about 3,800 communities. Some 8.6 million homes, or 6.5 percent of the nation's housing stock, are in flood zones, according to FEMA.

¹¹ *Id.*

¹² See Allison McCann, *Buzzfeed*, October 30, 2012. Nearly 13 million gallons of water are pumped out of the New York City subway system on a dry day. See *Urban Land Institute Global Study*, Climate Change and Real Estate Investment, Winter 2018.

¹³ APTA 2017 Fact Book, <https://www.apta.com/resources/statistics/Documents/FactBook/2017-APTA-Fact-Book.pdf> pg. 33

¹⁴ See Emma G. Fitzsimmons, Full Shutdown of L Train Is Halted by Cuomo, *The New York Times*, January 3, 2019.

<https://www.nytimes.com/2019/01/03/nyregion/l-train-shutdown.html>

¹⁵ See Kevin Loira, *Business Insider*, April 12, 2018.

¹⁶ *Id.*

¹⁷ *Id.* Tiffany Trozler, director of the Florida International University Sea Level Solution Center stated "We can continue to build not accounting for what we expect in the future or we can work with cities and private investors and developers to change the way that we develop."

¹⁸ *Id.*

¹⁹ See Toby Sells, *Memphis Flyer*, November 27, 2018.

²⁰ *Id.*

²¹ See Natasha Balwit, *Citylab*, *Portland's Answer to Climate Denial? Local Action*, December 7, 2016. Quoting Portland, Ore. Mayor Charlie Hales, "Cities can declare things, and that's nice and helpful, but when you put it into your zoning code, that's the ultimate authority of local government. Frankly it's an authority that is very difficult for the federal government, or anyone else, to trample on. ... [It's] the law of the land, and that's local control as it should be."

²² *Id.*

²³ *Id.*

²⁴ See Janna Levitt, *Azure*, "Why Zoning is Key to Combatting Climate Change," February 19, 2019

²⁵ *Id.* Upzoning has meant that some of the city's less affluent neighborhoods are now experiencing displacement and what has been called "climate gentrification."

²⁶ *Id.*

²⁷ *Id.*

²⁸ See Center for Climate and Energy Solutions White Paper, c2es.org.

²⁹ *Id.*

³⁰ *Id.*

³¹ See Emily Cureton, *OPB*, *OPB.org*, "Could Zoning Change Shield Bend from Wildfire?" January 19, 2019.

³² *Id.*

³³ See David R. Montgomery, *Guardians of Democracy*, January 19, 2018.

³⁴ *Id.* It should be noted as well that "earth movement," which would encompass both earthquakes and landslides are many times not covered by insurance without obtaining a separate endorsement.

³⁵ See *Urban Land Institute Global Study*, "Climate Change and Real Estate Investment," Winter 2018.

³⁶ *Id.*

³⁷ *Id.*

³⁸ See Bettendorf, Iowa Mayor Bob Gallagher, *Memphis Flyer*, November 27, 2018. Mayor Gallagher went on further to state: "More important to my state of Iowa, the assessment says projected changes in precipitation, coupled with rising extreme temperatures before mid-century, will reduce Midwest agricultural productivity to levels of the 1980s without major technological advances."

³⁹ This number assumes approximately 8,000,000 inhabitants in New York City. Though the average salary in New York City is above the national average, and depending on the source, is approximately \$70,000 per worker, this means the average worker would be paying an additional tax equal 3.5 percent of their salary to mitigate, but not eliminate, adverse climate change issues. To put this in perspective, New York City's pension shortfall as of the end of the 2016 fiscal year was approximately \$65,000,000. See May Williams Walsh and Karl Russell, *The New York Times*, June 20, 2017. Though there are some accounting questions regarding the pension resolution number, New York City has effectively stated as a goal that they must close that gap that they believe will take 15 to 40 years, depending on whom you ask. Despite being three times the initial climate change cost estimate, the time period to close the pension gap is long enough that there is at least some semblance of phasing in the costs. The urgency of climate change has created a more immediate need for capital funds (e.g., you can partially fund pension but a sea wall is either built or it is not). Maybe New York City can manage these higher taxes due to climate change infrastructure costs, but can Memphis? Coastal New Jersey? The Outer Banks? When will the costs exceed the ability for people to pay what is effectively a municipal tax to address climate

change costs?

⁴⁰ See *Urban Land Institute Global Study*, "Climate Change and Real Estate Investment," Winter 2018.

⁴¹ *Id.*

⁴² See Joel Rose, *National Public Radio*, December 6, 2012.

⁴³ See Robert Meyer, Risk Management Decision Process Center, Wharton, University of Pennsylvania, 2014.

⁴⁴ See *Urban Land Institute Global Study*, "Climate Change and Real Estate Investment," Winter 2018.