



HOUSTON RESILIENT

How Houston has met — and will meet — the challenges posed by Hurricane Harvey

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HOUSTON: RESILIENT REGION

This is the first section of a three-part report on how Houston has met — and will meet — the challenges posed by Hurricane Harvey. Part One defines the city and region’s trajectory, and its fundamental resilience. The second part addresses Houston’s urban form, and how the right planning choices can provide some solutions to the problems of flooding. The third part lays out specific suggestions for balancing growth with environmental sustainability.

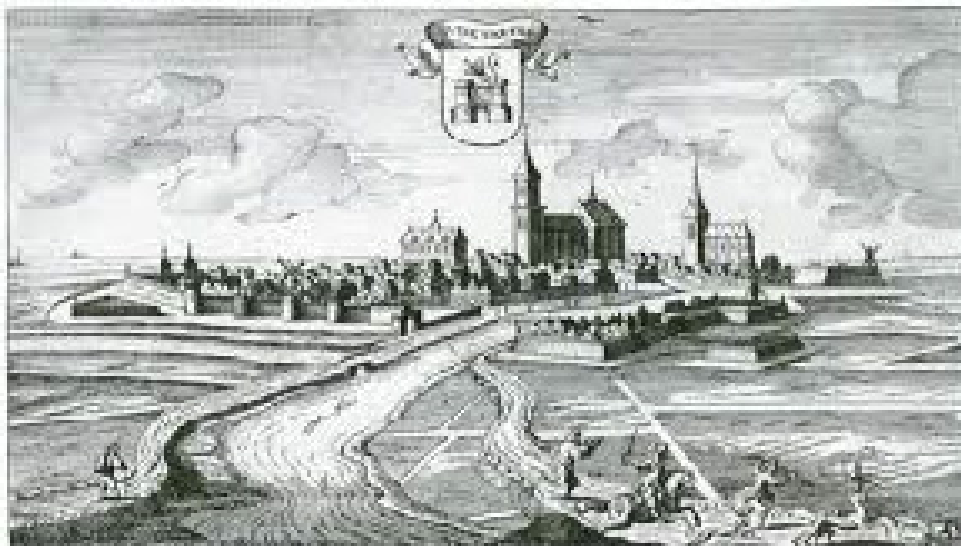
As leaders and policy makers address post-Harvey issues, we present the steps they can take to make Houston more resilient, while still allowing it to retain its character as a region of opportunity. We demonstrate how actions that raise housing costs will make the Houston region less competitive with other parts of Texas, and with the nation as a whole.

PART ONE: A REGION AT AN INFLECTION POINT

Throughout history, cities have flourished to the extent that they have been able to meet the challenges of urban expansion and nature. Houston represents a stunning case in point. Located far from the natural harbor, the city was forged, in large part, by the 1914 decision to build a ship channel that connects this bayou city with the Gulf, fifty miles away.¹

Houston has grown almost in spite of its location and the forces of nature. From the beginning, the city fought against the dangers of floods and isolation, with soil that was particularly poor at absorbing moisture. Long before Harvey, Houston was devastated by hurricanes, including one that destroyed Galveston in 1900. A 1935 flood caused much more severe damage, proportionally, than Harvey did, on a then much smaller Houston.²

Downtown Houston floods, 1935



To overcome its natural disadvantages and accommodate growth; state, regional and local authorities developed an elaborate system of major thoroughfares and freeways for transportation, widened bayous, and created reservoirs and detention systems for flood control. As a result of Harvey, they are now contemplating an expansion of Houston's drainage infrastructure.

Some voices, citing climate change, expect hurricane-related issues to worsen in the years ahead. This has led to recommendations by some in academia and particularly from outside the region to shift away from the growth paradigm that has defined Houston. Long one of the most vibrant urban regions in North America has come under increased attacks.

Among these voices there have been calls to mimic what could be characterized as a 'Smart Growth' strategy. This approach would depend on severely limiting development, particularly in the periphery, and impose strict regulations on housing, including in poorer, older, heavily minority areas. Houston has long had in place deed restrictions to maintain the integrity of residential neighborhoods as well as significant development guidelines for commercial projects. This has allowed the city to respond both to community needs and the marketplace. Although there appears to be little support for a broader smart growth strategy among most business and political leaders, its proponents are likely to continue calling for such policies, which have routinely led to higher housing prices, as can be seen in 'models' such as Portland, the San Francisco Bay Area, and Seattle.

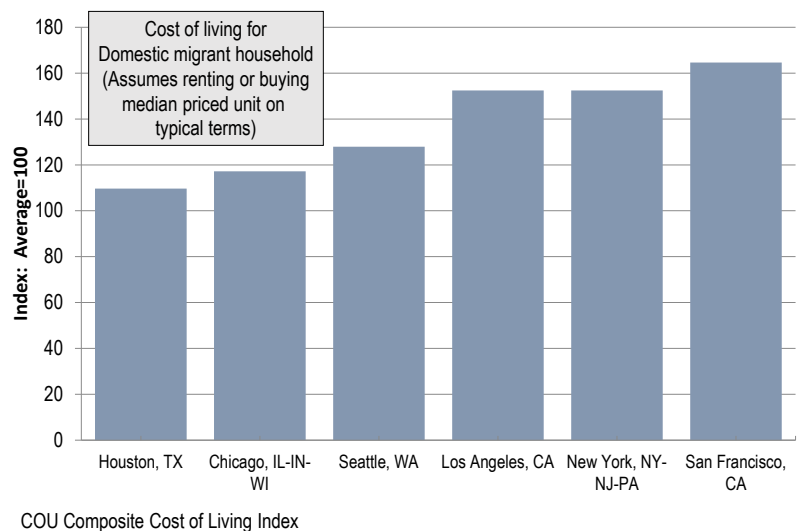
Tightening regulations is appropriate where necessary for flood control, but the real solutions lie in infrastructure investments, improved conveyance and in using suburban development as an efficient, cost effective means to detain and store water. It is critical to consider the economic and social consequences that dramatic new regulations would impose on the region and its residents.

This is particularly germane to concerns about higher housing costs; lower prices have long been one of the region's great competitive advantages. "This is not a hospitable place. Nature is a problem," suggests Meyers Research geographer Scott Davis. "Houston is about an idea. It is known as opportunity—a place that is affordable."³

HARVEY AND HOUSTON'S TRAJECTORY

The current debate about the post-Harvey future represents a direct challenge to the Houston "idea" that has attracted millions to the region from the rest of the country, and from abroad. It has made Houston among the nation's best "bargains," measured by costs and incomes, ranking well ahead of rivals such as San Francisco, New York, Los Angeles, Seattle and Chicago.⁴

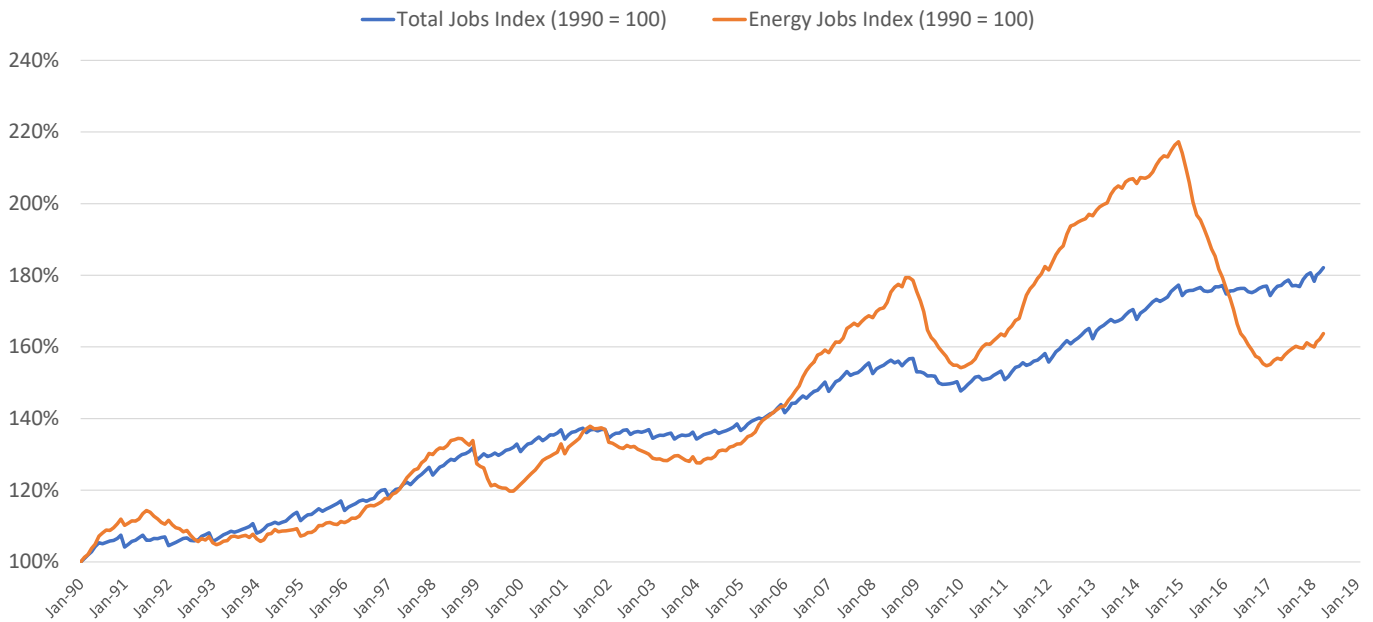
Cost of Living Index for Movers: 2016
HOUSTON COMPARED TO OTHER METROPOLITAN AREAS



Today’s conundrum is how to reconcile serious environmental challenges with continued economic growth and reasonable housing prices. “For Houston, the lasting effect of Harvey will be the realization that after decades of rapid economic development its reservoir operations and infrastructure may be inadequate,” notes Dr. Robert Gilmer, director of the Institute for Regional Forecasting in the University of Houston’s Bauer College of Business. “Storm-related infrastructure is about keeping the economy resilient.”⁵

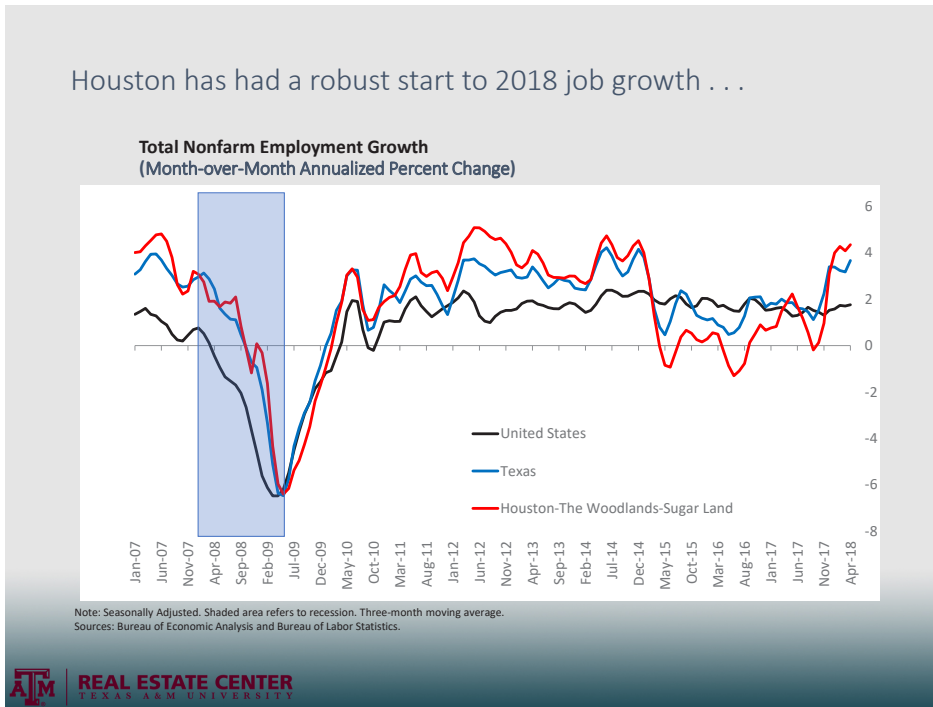
Gilmer and others note that the almost biblical downpours around Harvey came just as Houston’s economy and demographics were suffering their weakest performance in decades. The region was already reeling from the collapse of oil prices that began in 2014. The energy industry, still the leading engine of the region’s economy, laid off 86,000 people after December 2016, and now, however, at least 10,000 jobs have been recovered. Overall job growth, which had been buoyant for a decade, turned briefly negative, although more recently it has gone positive.⁶ Houston, once consistently in the Forbes top ten in job creation among the nation’s major metro areas, fell in 2017 to a mediocre thirty-third out of seventy-one large metros.⁷

Houston Employment Index, Total Jobs vs. Energy Jobs

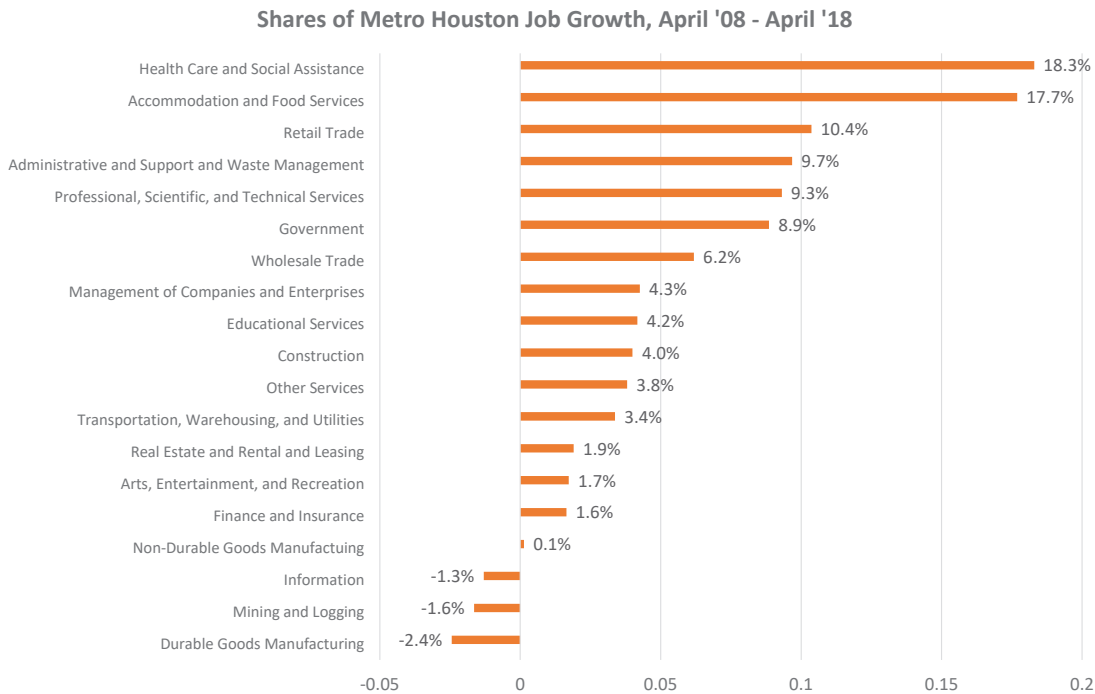


Source: Greater Houston Partnership calculations based on Texas Workforce Commission data

The confluence of energy industry decline and Hurricane Harvey suggests to some that the region's era as a beacon of growth and opportunity has come to an end.⁸ Yet this year it sloughed off the worst effects of Harvey and was once again on a growth track even as construction related jobs from the storm ebbed. In 2018, Houston seems to have recovered much of its momentum.



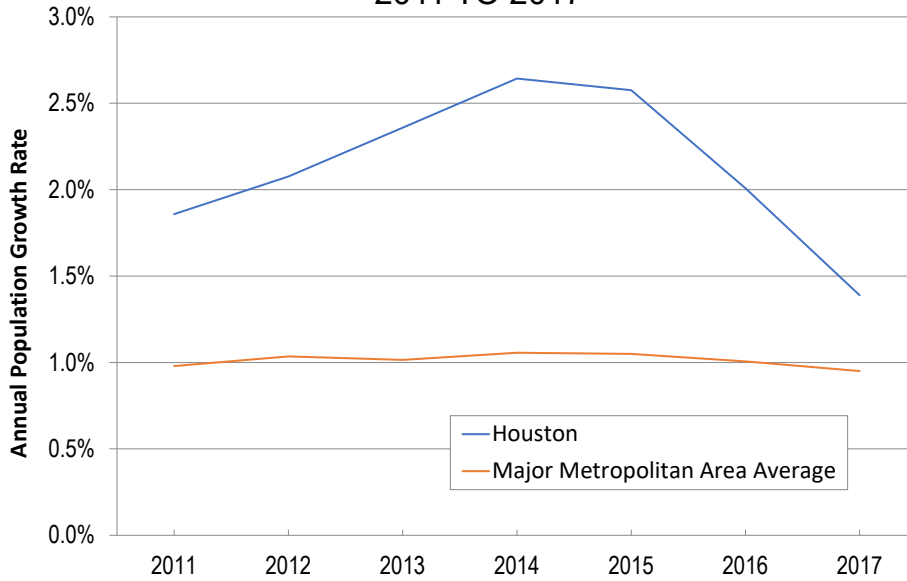
Significantly, the region has already begun to experience job growth across a broad spectrum of industries. Even as energy was struggling, other sectors—including health, and professional, technical and business services—were recovering nicely. Within a year of the storm the city had managed to recover its growth trajectory.



Source: Greater Houston Partnership calculations based on Texas Workforce Commission data

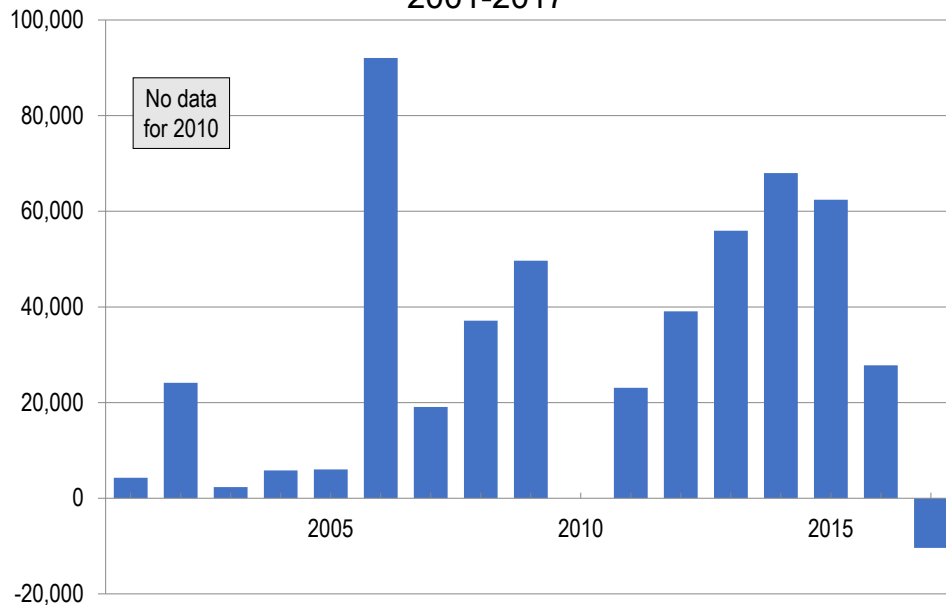
At the same time, steady population growth has continued, although its pace has slowed. Houston, due to its fast-natural growth rate (births minus deaths) and international immigration, has retained a faster growth rate than the major metropolitan regional average.

Houston Metropolitan Area Growth 2011 TO 2017



Derived from Census Bureau data

Net Domestic Migration: Houston MSA 2001-2017



Derived from Census Bureau data

The area has not experienced a massive economic or demographic decline, but in an already weakened environment Harvey has presented Houston with an existential challenge. An unprecedented four feet of rain in four days—one year’s worth of rain and the greatest rainfall event in recorded US history—overflowed the banks of every channel in Harris County, flooded nearly 100,000 homes (7% of the housing stock), and created an estimated \$81.5 billion in damage, the nation’s second-largest natural disaster after Hurricane Katrina.⁹

Harvey Damage 2017



THE REAL EFFECTS OF HARVEY

Understanding what happened—and what did not—during Hurricane Harvey is essential to crafting an appropriate response to flooding. To many pundits, including writers from *ProPublica* and the *Texas Tribune*, blame for the disaster lay largely in Houston’s lack of zoning, and in a regulatory climate designed to spur growth.¹⁰ Days after the storm hit, Ana Campoy and David Yanofsky of digital news outlet *Quartz* opined, “Houston’s flooding shows what happens when you ignore science and let developers run rampant.”¹¹ Further afield, the *Guardian* climate columnist George Monbiot even portrayed the event as a kind of payback for being the world capital of planet-destroying climate change.¹²

Although not widely shared, some local media and academics predictably followed the themes of the national media. Some saw the floods as proof that Houston’s pro-development model was fatally flawed, particularly in terms of suburban development. An article by a *Houston Chronicle* columnist specifically blamed municipal utility districts and suburban developers for the severity of the flooding.¹³

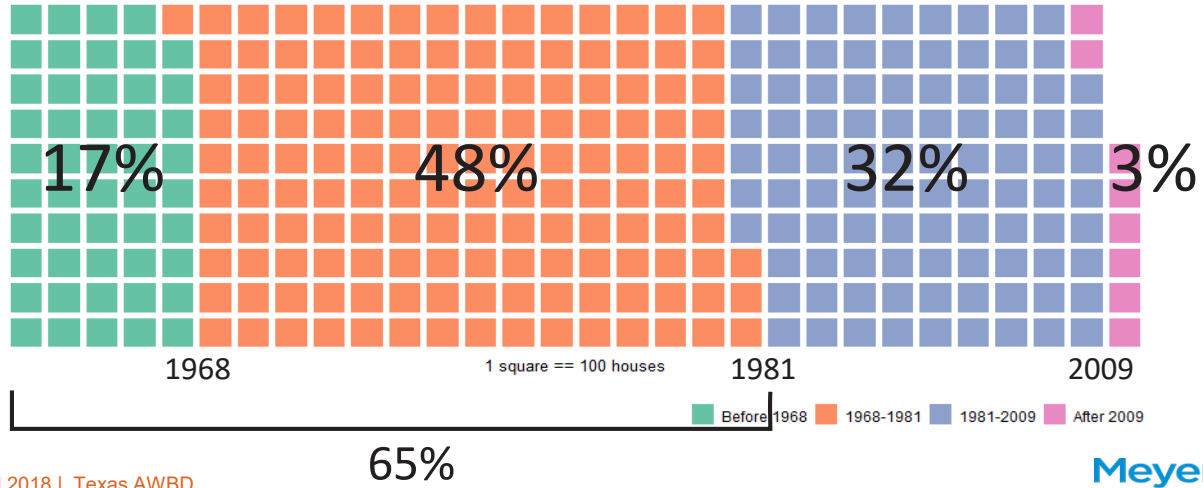
Contrary to what has been suggested in the media, particularly nationally, the worst impacts of Harvey were felt not in new suburban development, but primarily in older areas. Indeed, regions with newer construction seem to have weathered the storm far better than older, denser areas closer to the traditional core.

Survey Results: Flooding by Subdivision Plat Date

An accurate rendering of the date (and rules in place) of development is the date of the first subdivision plat filed within the utility district. Not all plats have dates readily available, and there are more than 22,000 subdivisions in Harris County alone.

The chart below shows the extent of flooding in our survey by the subdivision plat date, categorized by the state of floodplain regulation. The National Flood Insurance Program (NFIP) was not created until 1968; about 17% of houses which flooded are located in districts platted before the NFIP. More than 48% of houses which flooded are in districts with plats between 1968-1981; 1981 is the year that Flood Insurance Rate Maps (FIRM) were first available for Harris County. Prior to 1981 there were no FIRMs available for the area, and prior to 1984 Harris County did not require onsite stormwater detention. This was truly a watershed moment in development regulation. Another 32% were in districts platted between 1981-2009, when revised FIRMs and new regulations based on them were issued after the Tropical Storm Allison Project. Only 3% homes of the 37,211+ that flooded were in districts platted after 2009. The bottom-line is that as we learn more about flooding and implement stricter regulation, home flooding is reduced.

Flooding by Subdivision Plat Date



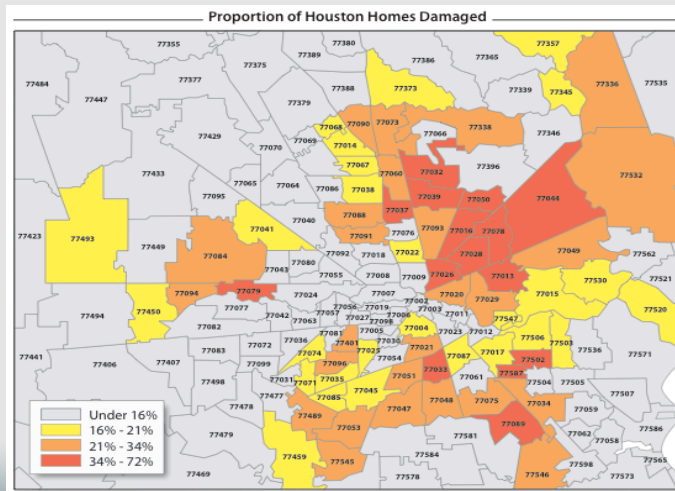
April 2018 | Texas AWBD
Impact of Harvey on Houston MUDs



As the figure above suggests, the highest proportion of damaged homes were generally older, smaller, and less expensive than the rest of Houston. Most of these homes were not in suburban, many of which have been meticulously planned and widely acknowledged as national models, but closer to the historic heart of Houston.¹⁴

Vulnerable Regions Facing New Regulation:

The highest proportion of housing damage occurred northeast of downtown in economically disadvantaged neighborhoods.



Source: Sources: Federal Emergency Management Agency and U.S. Census Bureau and Real Estate Center at Texas A&M University



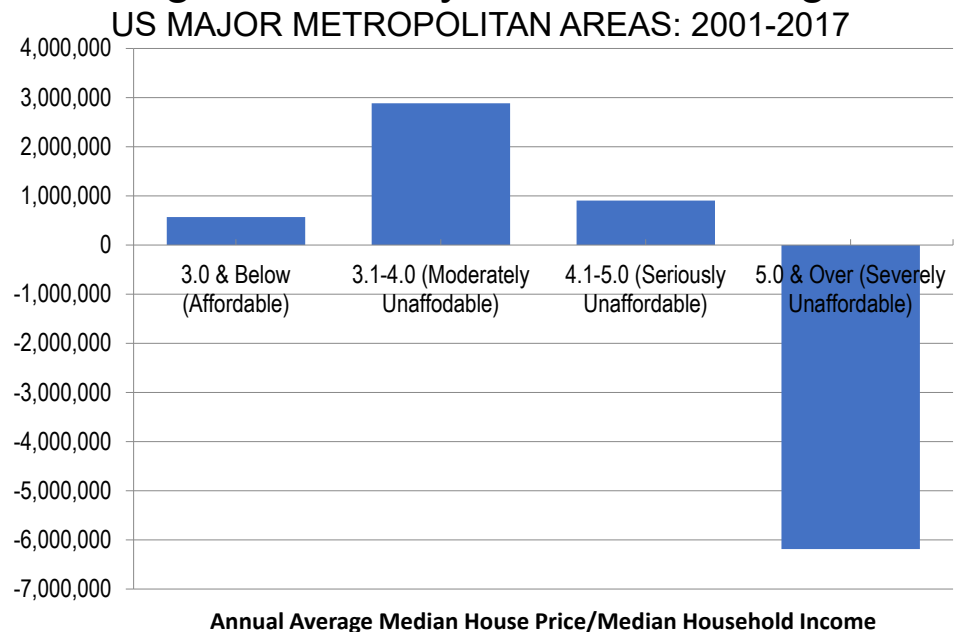
Residents of the most damaged areas—compared to those in less damaged places—generally have lower incomes, with a higher percentage below the poverty level. The hardest-hit areas also include a significant minority population that is younger and has a lower education level. Those who live in these areas are the most threatened by regulatory changes, which many are ill-equipped to cope with.

Rather than suburban dysfunction, according to Meyers Research, patterns suggest the many advantages of the kinds of detention policies imposed in 2009 after Hurricane Allison. Less than 3% of the houses that were identified as flooded after Harvey were built after 2009; these newer homes complied with the drainage and detention regulations adopted after Allison.¹⁵ According to Harris County’s engineering staff, of the 75,000 homes built after the 2009 regulations, only 467 flooded; a remarkable 99.4% did not.¹⁶

Perhaps the biggest surprise was the superior performance of areas controlled by the very Municipal Utility Districts (MUDs), lambasted as contributors to the city’s supposedly flood-inducing sprawl.¹⁷ Overall, Meyers found that fewer than 8% of houses in Houston MUDs experienced flooding, even though MUDs are largely concentrated in areas that were developed before the adoption of modern water detention regulations, and before FEMA released flood plain maps of the region. The Municipal Utility District is a uniquely Texan institution that allows developers to build out infrastructure for their projects and are ultimately reimbursed by the sale of bonds that are backed by property taxes. These jurisdictions also have no pension and health care obligations that are burdening so many municipalities.¹⁸

As we consider these patterns, it is important to keep in mind the need to avoid major policy changes, notably for the City of Houston, that would increase unnecessarily the cost of future housing by tens of thousands of dollars, and, ironically, accelerate the shift to the periphery.¹⁹ Part Two of our series discusses proposals that could ultimately undermine the very affordability that has made Houston and other reasonably priced cities so attractive for millennials, immigrants and minorities.

Housing Affordability & Domestic Migration



Derived from Census Bureau data, *Demographia* & Harvard Joint Housing Center

RESILIENCY OR RETREAT?

After a disaster of this scale, a thorough review of options for the future is necessary. Few observers would deny the pressing need for strong water detention requirements, such as those that worked well on the periphery and around the Texas Medical Center, an area which was well-prepared.²⁰ Policies that designate appropriate elevation levels also make perfect sense and should be implemented.

Doing nothing is not an option here. The key issue is the direction that ‘fixes’ should take. Some leading academic and media sources see an imperative to restrict the market-friendly, flexible, ‘Houston Model’ in the very peripheral areas that have enjoyed the most growth and allowed for consistently good levels of affordability.²¹ These proposals suggest that such areas might someday be subject to flooding, and thus should not be built on.²² This is akin to suggesting that California ban development across much of its land mass due to the potential of earthquake damage.

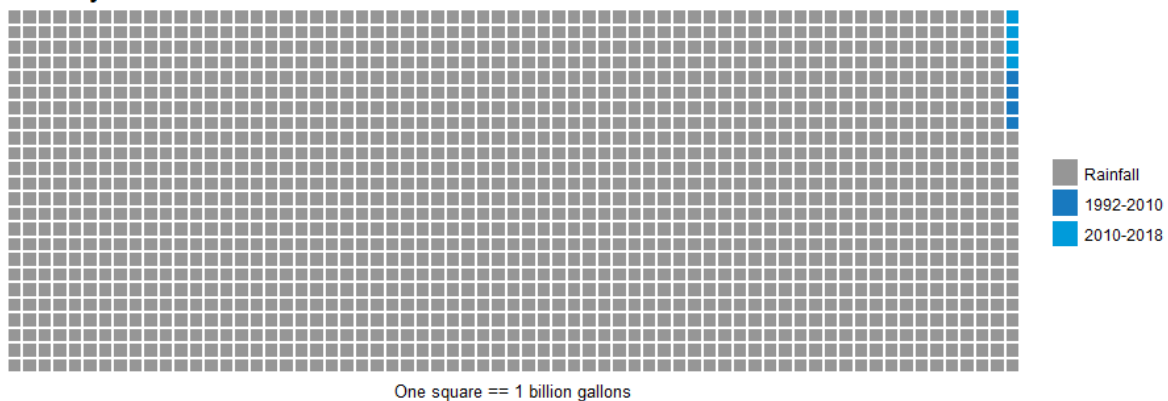
Skepticism towards engineering solutions remains high, in part because rebuilding might also encourage ‘sprawl’—suburbanization—that has defined the region’s growth over the past half century.²³ Concern over suburbanization is so great that the *Houston Chronicle* opined that steps such as creation of a third reservoir might be inadvisable, since it might enable new peripheral development.²⁴ This reflects a common national perspective shared by other, more consistently progressive outlets. *Mother Jones* defined the issue this way: Build tunnels, or plan a careful retreat? Not surprisingly, it suggested that retreat is inevitable and preferable.²⁵

Harvey’s Rains Overwhelmed Even an Undeveloped Katy Prairie

John S. Jacob, in his study, *Houston Area Freshwater Wetland Loss, 1992 – 2010* (Texas A&M University System), suggests that the native wetlands in the Katy Prairie could have absorbed much of the floodwaters that overwhelmed west Houston. It states that west Houston wetlands loss “...in the study area is equivalent to at least 12,000 acre-feet, or nearly 4 billion gallons, of storm water detention.” The study period ended in 2010 so there are no figures available for development over the last decade. Areas west of Houston have seen significant development but during this period wetlands and floodplain development have significantly changed; without a replication of the original study it is difficult to say how much water storage capacity could have changed.

Using the calculations shown on the following page, Harvey dumped 1.6 trillion gallons of rainfall on Harris County alone during its four days in the Houston area. The graph below shows the total amount of rainfall from Harvey, the 4 billion gallons potentially stored as defined by the Jacobs study, and an additional 4 billion gallons, assuming the wetlands loss defined in the study doubled from 2010-2017.

Harvey Rainfall



Harvey produced hundreds of billions of more gallons of rainfall than could have been absorbed by these “lost wetlands” – under even the most conservative analysis.

Critical to the retreat scenario is the notion that if the flood plains and the Katy Prairie had been left in their natural state much of the flooding would have been avoided. Yet a serious analysis of the run-off, done by Meyers Research, showed that the area's natural soils, with their poor suitability for retention, would have barely impacted flooding on the scale of Harvey, even if they had been maintained.²⁶ If there had not been any recent development in the Katy Prairie wetlands, for example, it still would have absorbed only 4 billion gallons out of the 1.6 trillion gallons that fell on Harris County, a savings of a mere 0.25%.²⁷ Notes Charles Marohn of media organization *Strong Towns*, "Anyone suggesting that more wetlands or more pervious surfaces would have done anything to mitigate what has just happened is lacking a proper sense of scale."²⁸

Finally, it is critical to note that Houston is far more environmentally sensitive than often portrayed media. The city of Houston has more acres of parkland and greenspace than any other large city in America and ranks third behind San Diego and Dallas in park acreage per capita.²⁹ Unfortunately, the clay soil sheds water instead of absorbing it.³⁰ Houston has a long history of significant flooding that goes back to its founding in the early 1800s, well before any significant development or suburbanization.³¹

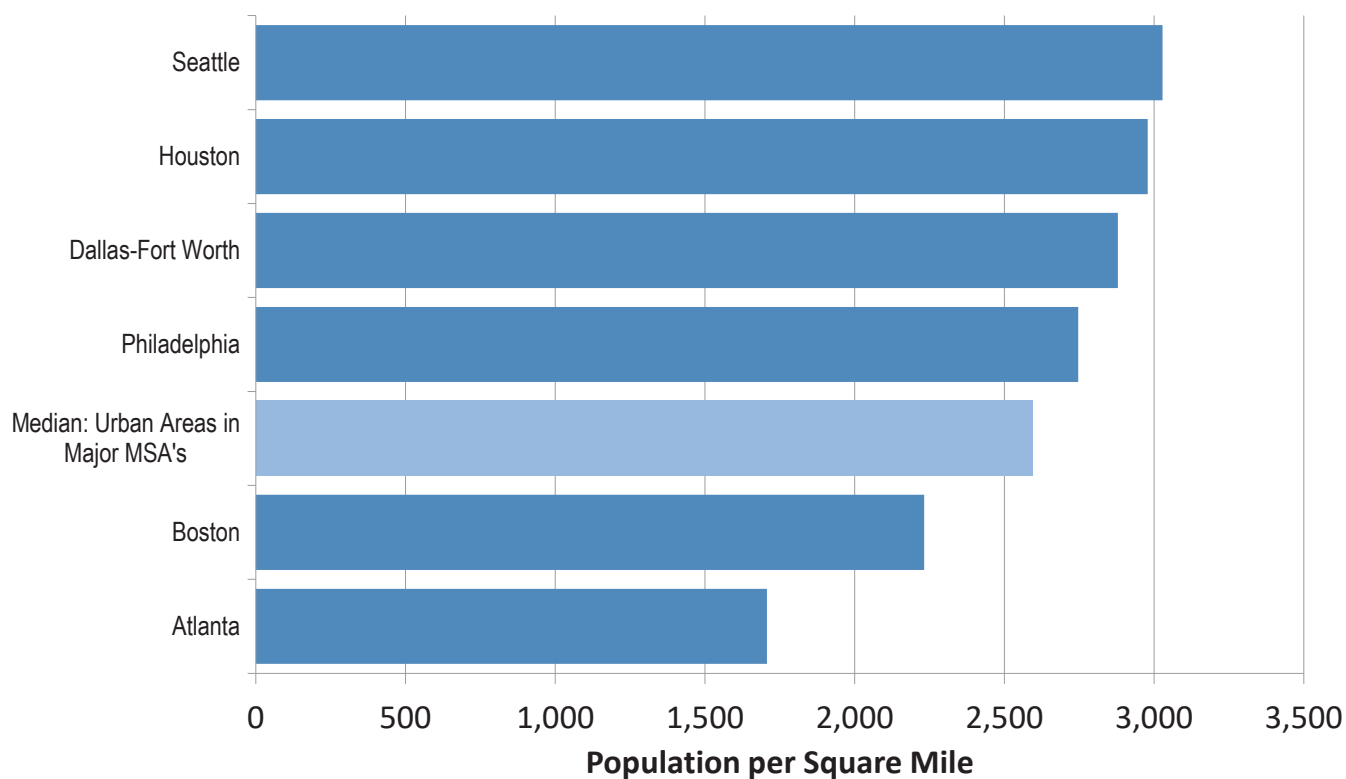
SMART GROWTH FOR HOUSTON

The calls for a so called 'Smart Growth' strategy, now largely restricted to some media and some academics, would embrace urban containment policies that largely preclude new low-cost housing subdivisions on the urban fringe. This approach has been associated with northeastern and west coast metropolitan areas. Unfortunately, this would also undermine the basis for the area's growth and prosperity. Unlike Seattle, Portland or the San Francisco Bay Area, for example, Houston does not generally draw people to move there for its natural beauty, mild weather or beaches. It is a city built on the concept of opportunity, growth and expanding frontiers: the essence of 'the Houston idea.'

This is not the first time a Smart Growth approach has been suggested for Houston. The idea was also raised during the energy bust of the 1980s.³² This theme has since been reinforced by such vocal groups such as Houston Tomorrow which, along with a number of local urban analysts, continue to emphasize density as a core value.³³ After the Harvey disaster, some, including from the Rice Design Alliance, called for the creation of a "thick" city: denser, and with an enhanced role for traditional transit.³⁴ This approach echoes the views of many outside critics and media outlets, who blamed the extent of flooding on unchecked growth, lack of zoning, unplanned growth and the paving over of the saw grass prairie.³⁵

Yet the solutions offered by these voices seem dubious, given that metro Houston's urban density is already greater than the median urban density of the 53 major metropolitan areas (those with more than 1,000,000 population). That group includes dense urban areas with far larger urban cores than Houston's, such as Boston and Philadelphia.³⁶

Houston Urban Area Density Compared 2010 (LATEST DATA)



Derived from Census Bureau data

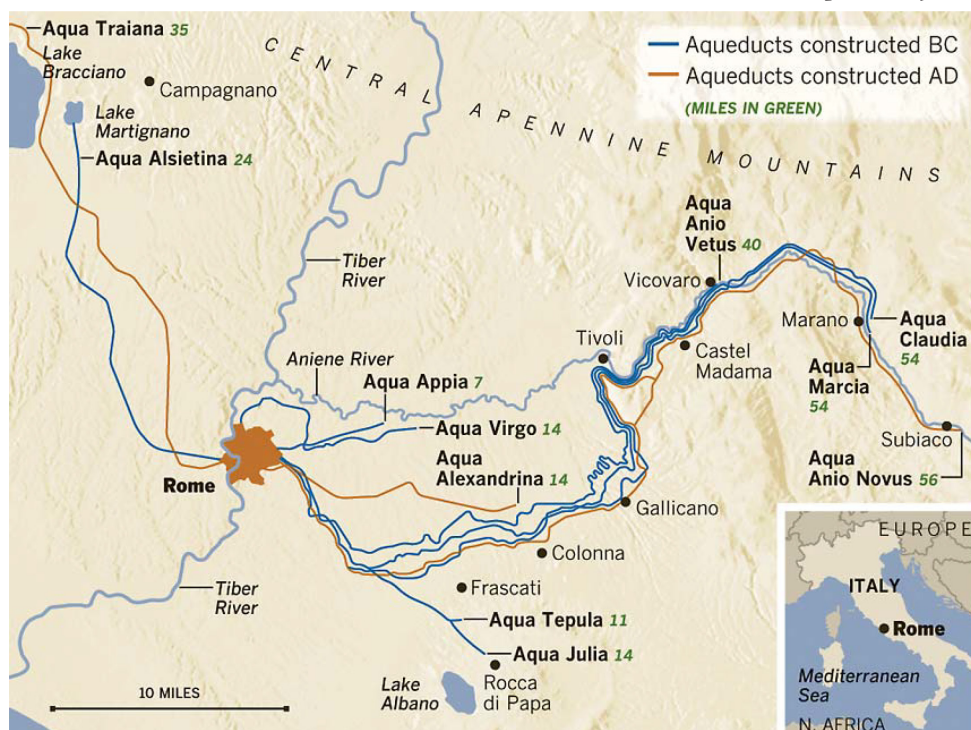
Another pinnacle of Smart Growth policy is public transit. But Houston, despite massive investments, has seen its ridership decline, and it is actually continuing to fall, as is occurring all across the country.³⁷ Finally, it seems dubious, as Mayor Turner and others have pointed out, that Houston's lack of zoning exacerbated the flooding.³⁸ Indeed, City Lab's Nolan Gray suggests that "Houston's flexible approach to urban development" could help shape the metro area post-Harvey, a notion we will develop in ensuing articles in this series.³⁹

LEARNING FROM THE PAST

"Subjected to everything from earthquakes to smart bombs, cities are among humankind's most durable artifacts," suggest Thomas Campanella and Lawrence Vale in their introduction to *The Resilient City*.⁴⁰ Making great cities does not come easily, yet these places tend to be resilient, as we can see from the recovery of, for example, London and Berlin after World War II, Hiroshima and Nagasaki after atomic blasts and, more recently, New York's resurgence after the 2001 mass terrorist attack.

Throughout history, many regions, like Houston today, have learned to respond to the barriers of nature. The Romans built aqueducts to bring water from the high mountains and cities in the Middle East would have been impossible to inhabit without considerable engineering of water systems.⁴¹

Roman Aqueduct System



A relevant model for Houston can be seen in the Netherlands, a low-lying region. For hundreds of years, its planners managed to push back against the sea. In the process, they created one of the world's great metropolises. Historian Jonathan Israel traces the rise of the Netherlands, particularly following a massive flood in the 16th century, to its period of extensive infrastructure building, and its decline to a later period of less ambitious construction.⁴²

Like Houston's suburban expansion, the Netherlands' infrastructure development opened up new land and opportunities for local residents. It also initiated liberal laws about tenancy and allowed for the expansion of ownership and enterprise, much as Houston's expansion accomplished over the past half century. The new lands constituted "the geographic roots of republican liberty," notes historian Simon Schama.⁴³ In contrast, failing to commit to infrastructure has caused the decline of numerous cities, as occurred in ancient Mesoamerica, the Indus Valley, and Cambodia.⁴⁴

Early Dutch Dam and Dyke System



A more recent example is New Orleans, a city, notes geographer Rich Campanella, that was constructed in a place “... anathema to human settlement.”⁴⁵ The dangers of flooding were widely appreciated, but as hundreds of millions of dollars were spent on convention centers, stadia and other entertainment-oriented projects, New Orleans’ leadership neglected the levees and the entire flood plain, and did little to prepare for disaster.⁴⁶

This is one reason why 836 died from Hurricane Katrina compared to 82 total deaths from Harvey, despite less rain from Katrina. The New Orleans region, one-fifth the size of Houston, continues to struggle due to the lack of social, economic, and political resiliency that made Katrina the kind of catastrophe that Harvey did not become.⁴⁷ “Floods are ‘acts of God,’” suggests Campanella, “but flood losses are largely acts of man.”⁴⁸

Katrina: A Natural and Man-made Disaster



BUILDING A STRATEGY THAT PUSHES HOUSTON AHEAD

In contrast to the Katrina experience, Harvey represented what the UK-based *The Spectator* called “a lesson for the world.”⁴⁹ Particularly notable in addressing the immediate results were volunteers, who helped their unfortunate neighbors survive the disaster.⁵⁰

Helping out: The Houston Way



In contrast to New Orleans at the time of Katrina, Houston’s government responded admirably with essential service providers, including the police and fire departments. Flood control, although clearly not up to the standards required by such a huge weather event, has been much improved. Tropical storm Allison in 2001 led to a significant upgrading of Houston’s infrastructure. This minimized the damage done by Harvey, particularly in the newer parts of the region, and allowed for a remarkably quick recovery.⁵¹ If Houston wants to retain its growth model, these efforts will need to be redoubled.

It is our conviction that, even as we address environmental issues, Houston does not have to embrace retrenchment and slow growth. Houston has proven its resiliency over the years in the face of both natural disasters and economic ones.

The next two parts of this report show how, rather than restricting growth, the region can successfully adopt growth-friendly approaches. Houston can continue its forward trajectory in a sustainable way for the environment, and for the people who call this area home.

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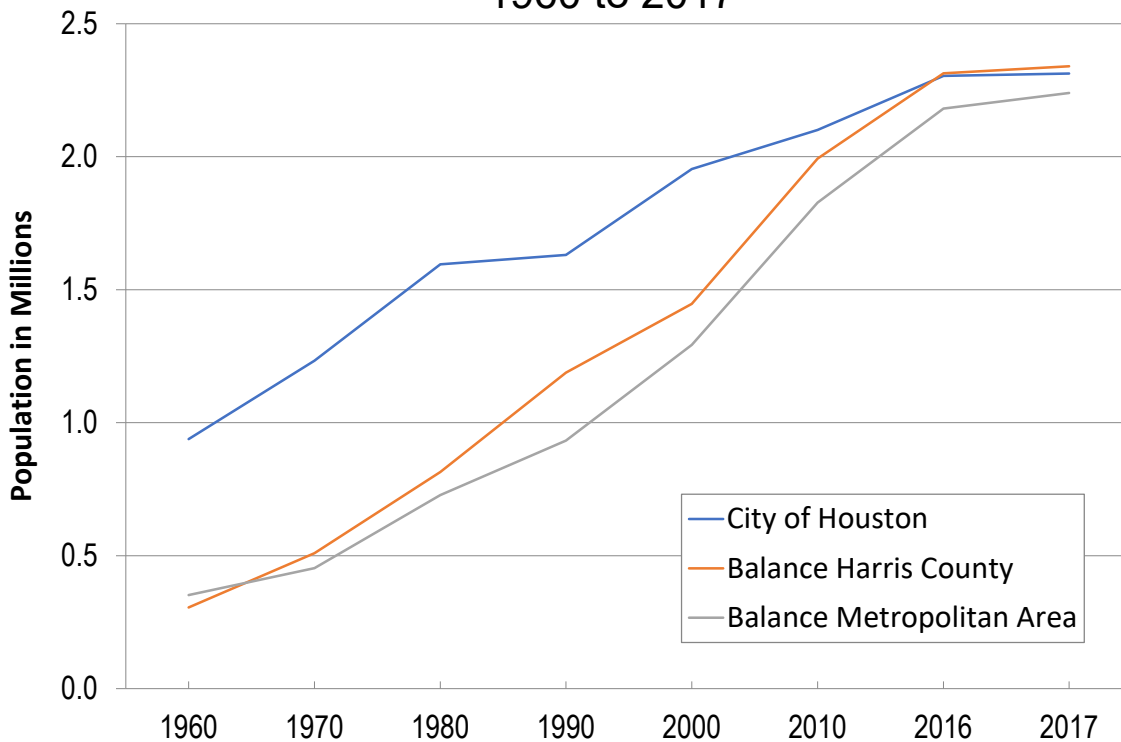
HOUSTON: RESILIENT REGION

HOUSTON RESILIENT PART TWO: CITY AND SUBURB

The first part of this series explored the notion that Hurricane Harvey offered proof that Houston needs to renounce its pro-market approach to development. To do so, the theory goes, the Houston region should curb the development pattern that has paced its growth for the past half-century, and instead embrace a traditional, dense city model.

Some of the newly suggested regulation will impact minority and poorer neighborhoods at a severe disadvantage and will impose disproportionate impact on small, starter homes as well as older existing structures. These changes will threaten Houston's economic and social health. What has been so remarkable about Houston's growth has been its protean nature: the city has intensified close to its core, and at the same time grown outwards at a rapid rate. Curbing this spatial expansion would stifle future economic growth by increasing home prices across the entire region, particularly in the urban core.

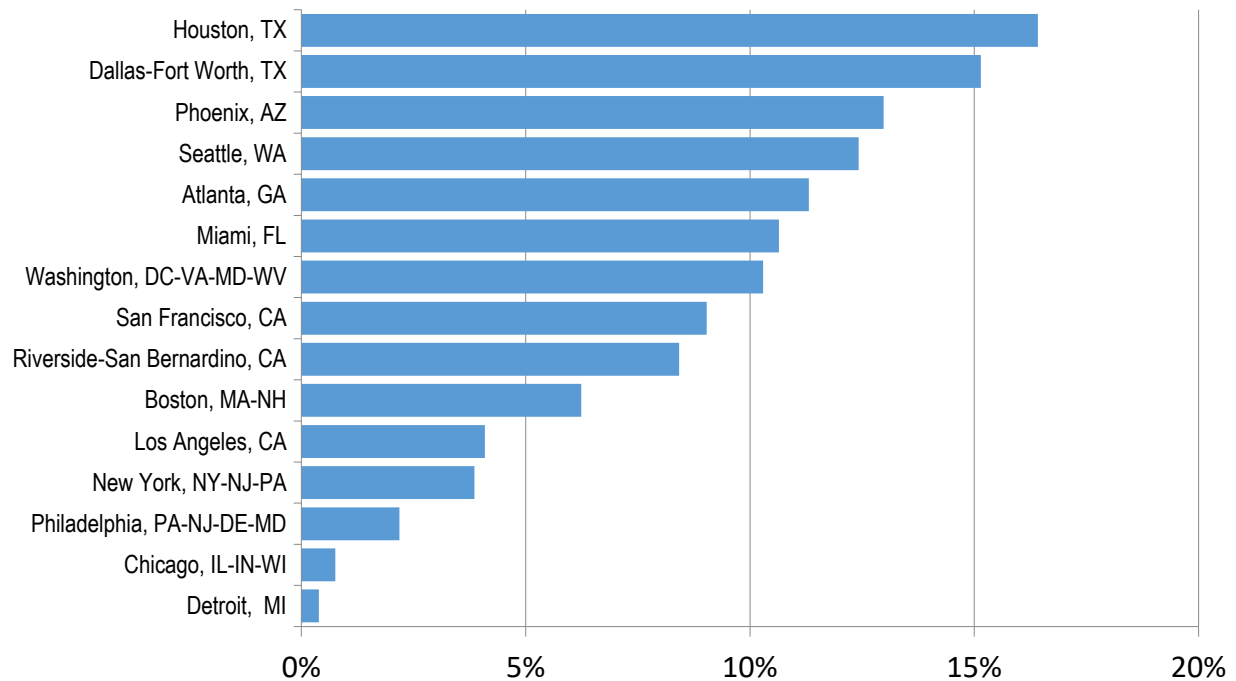
Houston Metropolitan Area Population 1960 to 2017



Derived from Census Bureau data

Population Growth Rate: Metropolitan Areas

15 LARGEST METROPOLITAN AREAS: 2010-2017



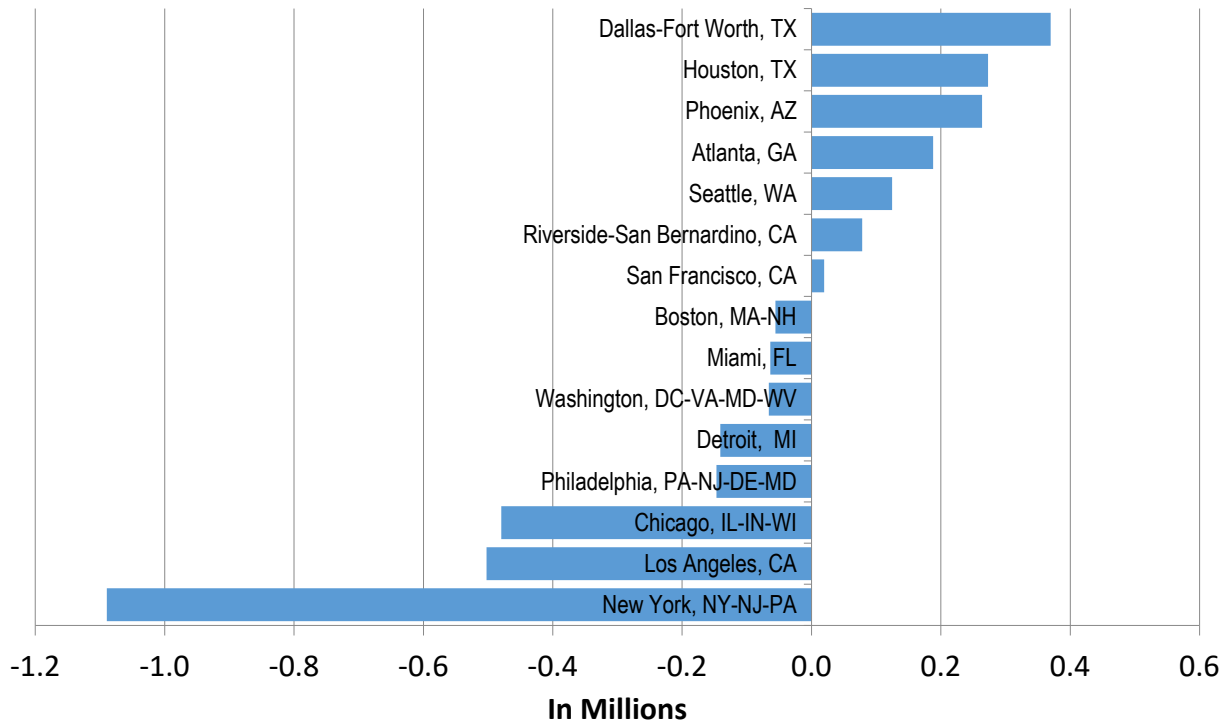
Derived from Census Bureau 2018

Figure 3

With 6.9 million residents, Houston has grown into the nation's fifth largest metropolitan area, in large part due to its affordable housing. As housing prices in some regions have risen, sometimes precipitously, more affordable areas — notably those enjoying sustained economic growth — have enjoyed the most rapid expansion. Since the 2010 Census, Houston has grown the fastest of the largest 15 metros.

Much of this has been driven by domestic migration, which in turn has a strong dependence on housing prices and employment possibilities. Houston has trailed only Dallas-Fort Worth in its rate of net migration among the major regions since 2010. The big losers were New York, Los Angeles and Chicago.

Net Domestic Migration: Metropolitan Areas 15 LARGEST METROPOLITAN AREAS: 2010-2017



Derived from Census Bureau 2018

Figure 4

Historically, Houston’s inner ring has been responsive to market forces, but new regulations by the city could put minority and poorer neighborhoods at a severe disadvantage. These new regulations would have, as we will demonstrate, disproportionate impact on small, starter homes as well as older existing structures.

All this could further accelerate the already profound shift of growth to the region’s outer fringes. This is also the norm nationally, and is likely to continue in the future.¹ Harris County communities outside the City of Houston, as well as the metropolitan area beyond Harris County, are both growing faster than the City of Houston. In 2017, Harris County outside the City of Houston exceeded the population of the city for the first time.

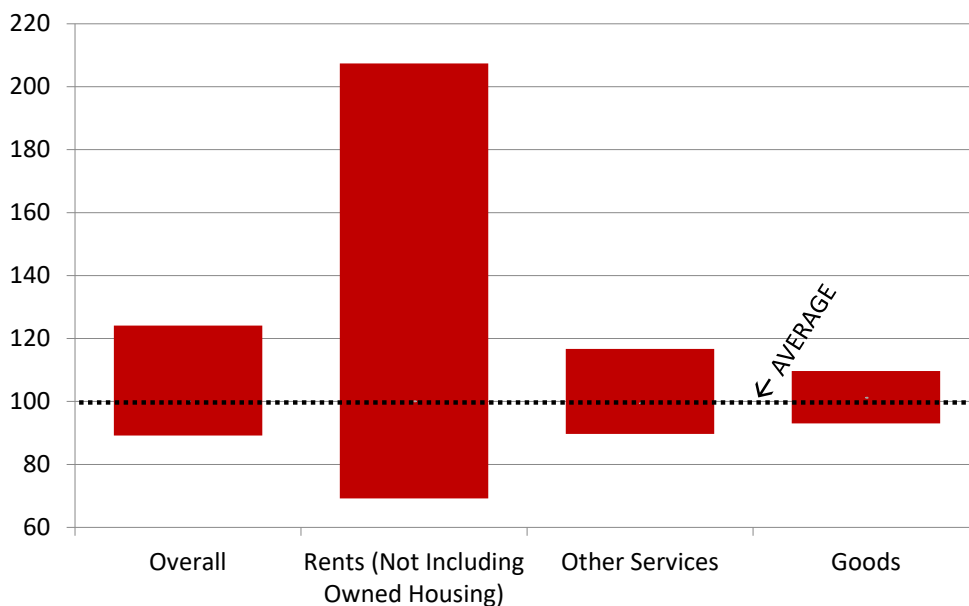
The growing predominance of outer rings can be seen in Houston’s housing stock. From 1960 to 1979, most new houses for owner-occupants in the metropolitan area were built in the city of Houston. In ensuing decades, far more houses and an increased proportion of multifamily units were located outside of Houston and, most dramatically, in the metropolitan area outside of Harris County.²

HOUSING AFFORDABILITY: HOUSTON'S GREAT ACHIEVEMENT AND FUTURE ADVANTAGE

Housing affordability drives the cost of living in high-cost metropolitan areas and increasingly shapes the migration of people and businesses. We measure affordability by price-to-income ratios that are typical, including by “median multiple” (median house price divided by median household income). Rental affordability is most frequently evaluated using ratios of gross rent to income. These metrics are used to measure ‘middle-income’ housing affordability.

Housing dwarfs the other components of the cost of living, even though goods and services include all other categories of spending, such as food, clothing, and transportation. In high-cost markets, 85% of the higher cost of living for new domestic migrant households is the result of higher housing costs.³

Range: U.S. Cost of Living Index: 2015 53 MAJOR METROPOLITAN AREAS



Derived from US Department of Commerce Data

Figure 7

This enormous price divergence that has emerged between regions with high housing costs and places with lower costs is a relatively recent phenomena. During the great housing boom that followed World War II, most regions allowed for development on what was then the urban fringe, where land costs tend to be lower.⁴ There was little difference in housing values across the country. Virtually all major markets were “lightly regulated.”⁵ This pattern permitted the development of the housing subdivisions that expanded US home ownership from 43.6% before World War II to 65.2% in 1981.⁶

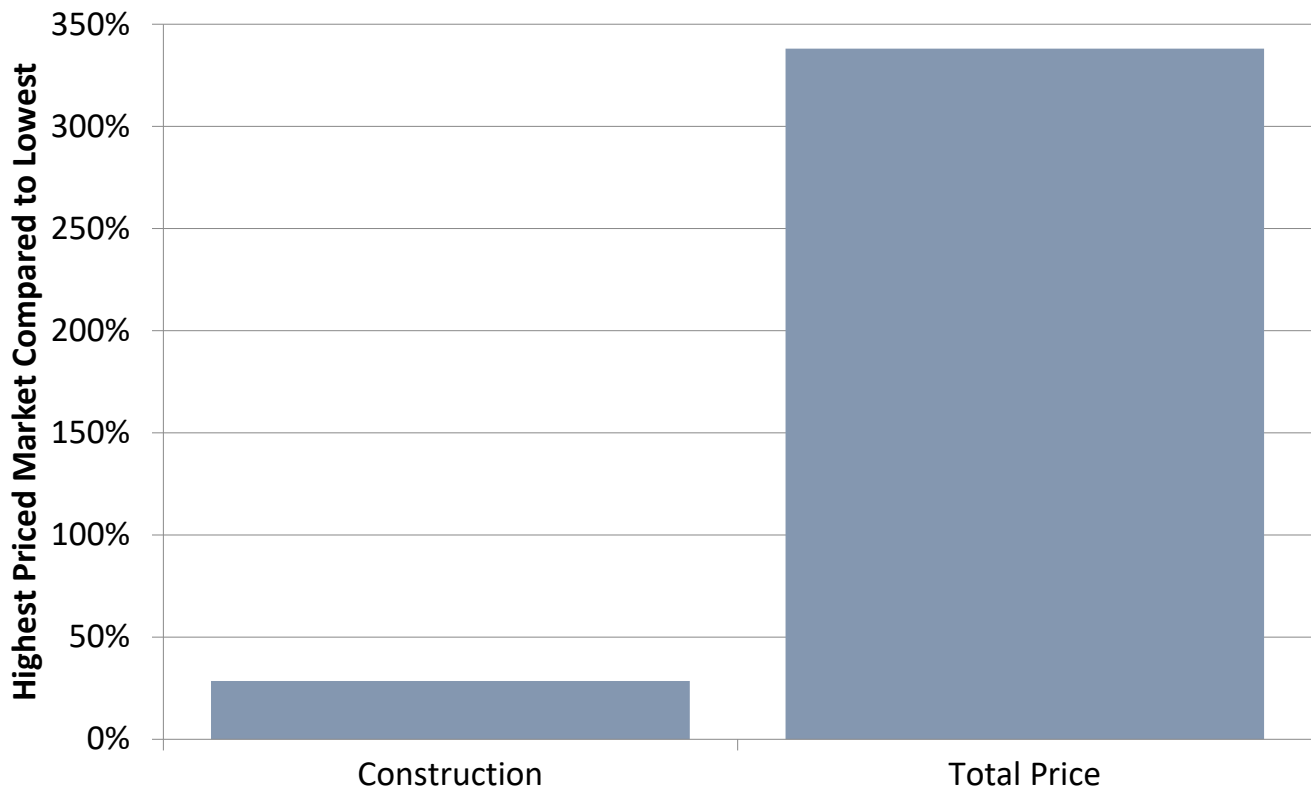
During this period, new houses virtually everywhere were sold at production costs that included competitive profit margins, according to economists Edward Glaeser of Harvard University and Joseph Gyourko of the University of Pennsylvania. The maintenance of a competitive land market was key to keeping new house prices affordable for middle-income households.

The growing separation between regions is, in large part, the result of new regulations. Urban growth boundaries that enforce urban containment are associated with rises in land prices, as are impact fees for developers. And fees are ultimately included in home prices.⁷

Construction costs have hardly played a role in this inter-metropolitan difference in housing. Construction pricing between the least and most costly cities varied by 28% in 2015, according to Glaeser and Gyourko.⁸

Construction Costs & House Prices

MAXIMUM RANGE MAJOR METROPOLITAN AREAS: 2015



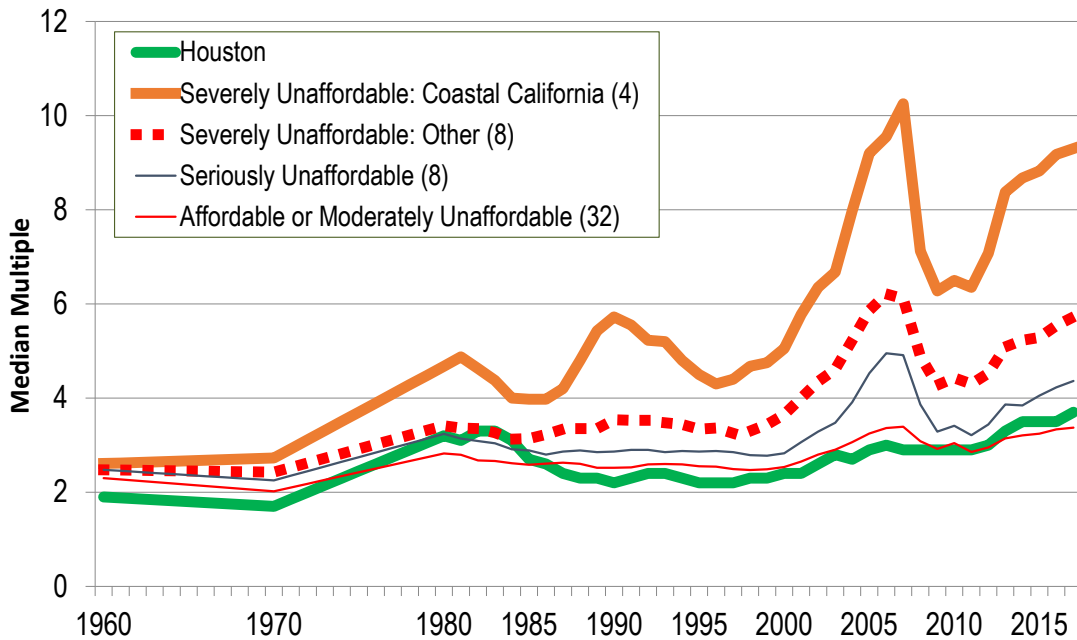
Sources: Glaeser & Gyourko 2018, *Demographia Survey 2016*

Figure 8

The purpose of urban containment is to limit urban expansion (“urban sprawl”), intensify urbanization, and to preserve open space, agricultural land, and environmentally sensitive areas that are not currently suitable for urban development.⁹ Houston has long been criticized for not adopting these policies, and some have linked its approach to the severity of the region’s flooding problems. As a recent Grist article said, “Houston is already the sprawliest, floodiest city in America.”¹⁰ Although the flooding issue needs to be addressed, Houston’s future should be decided with an understanding of the impact these policies have had on housing affordability, first in coastal California, and then, for example, in Seattle, Portland, Denver, Miami, New York and Boston. In virtually all studied cases, urban containment — in contrast to other land use regulations — is associated with severely unaffordable housing markets.

Middle-Income Housing Affordability

HOUSTON & OTHER MAJOR MARKETS: 1960-2017

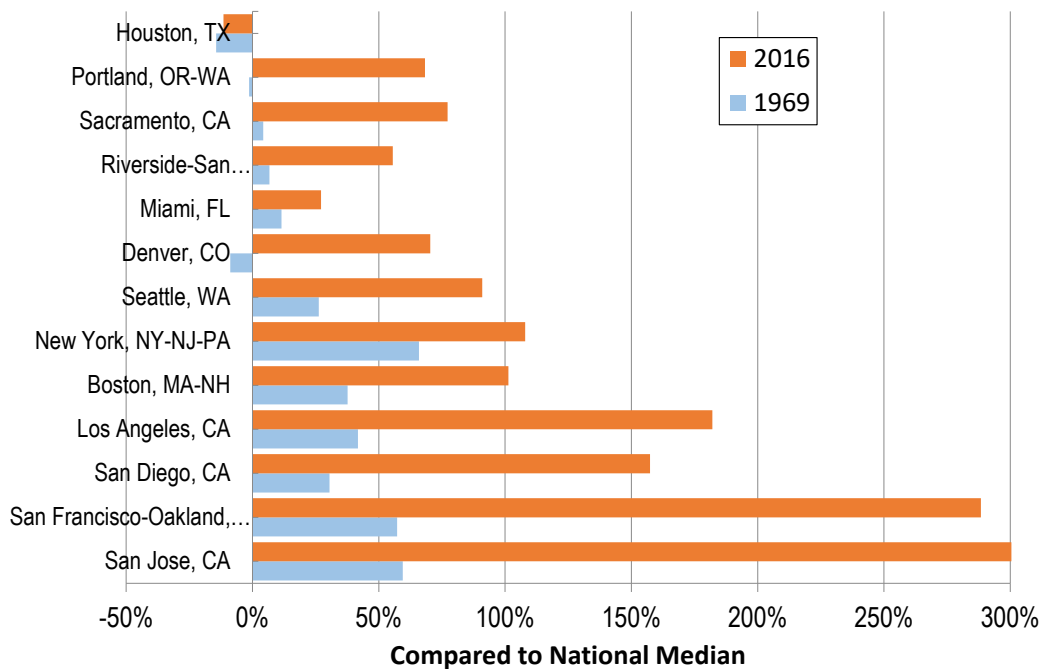


Derived from Census Bureau, Harvard University and Demographia.

The gap in housing prices between Houston and more expensive areas has been growing. It represents a huge advantage, and a boon to the prosperity of its residents of all classes. Houston's prices have moved up far less than those in many of the regions it most competes with for employers and talent.

Median House Price: 1969 & 2016

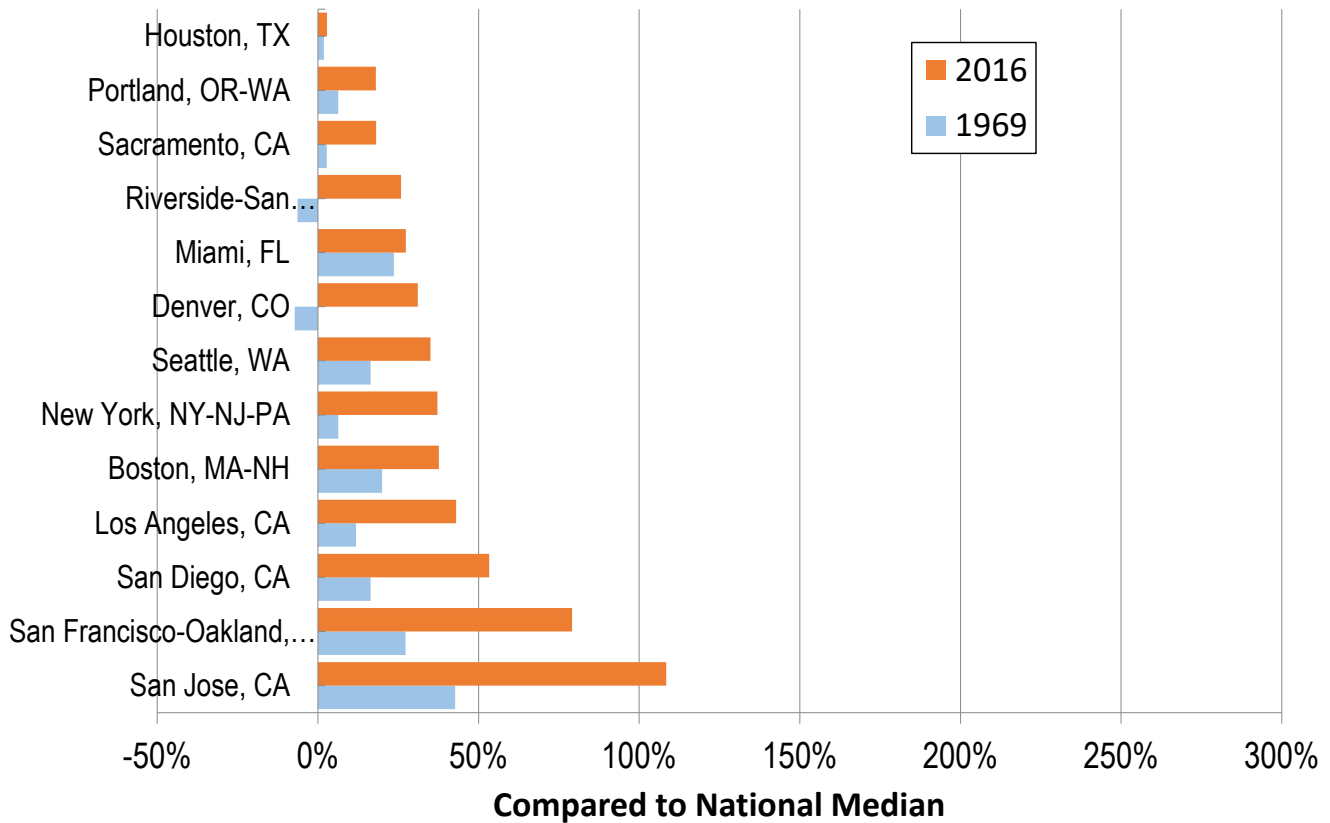
HOUSTON & SEVERELY UNAFFORDABLE MSA'S



Derived from Census Bureau data

The lower land prices also positively impact renters. Markets with higher house prices tend to have higher rents. Thus, regulations that are associated with higher house prices, and especially urban containment regulations, are likely to be associated with higher rents.¹¹

Median Gross Rent: 1969 & 2016 HOUSTON & SEVERELY UNAFFORDABLE MSA'S



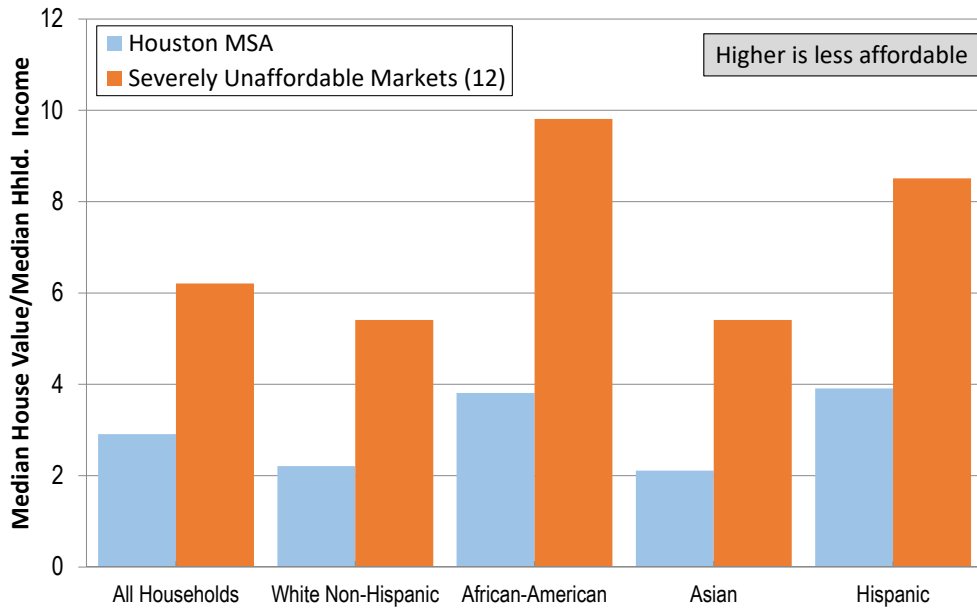
Derived from Census Bureau data

THE SOCIAL BENEFITS OF HOUSING AFFORDABILITY

With their pre-occupation with ‘urban sprawl,’ professional urban planners often make the mistake of overlooking the creation of urban forms as a means to a more important end, not as an end in itself. As the renowned urbanist Jane Jacobs said, “If planning helps people, they ought to be better off as a result, not worse off.”¹² Economists Paul Cheshire, Max Nathan and Henry G. Overman of the London School of Economics put it: “People, rather than places,” should be the focus of urban policy.¹³

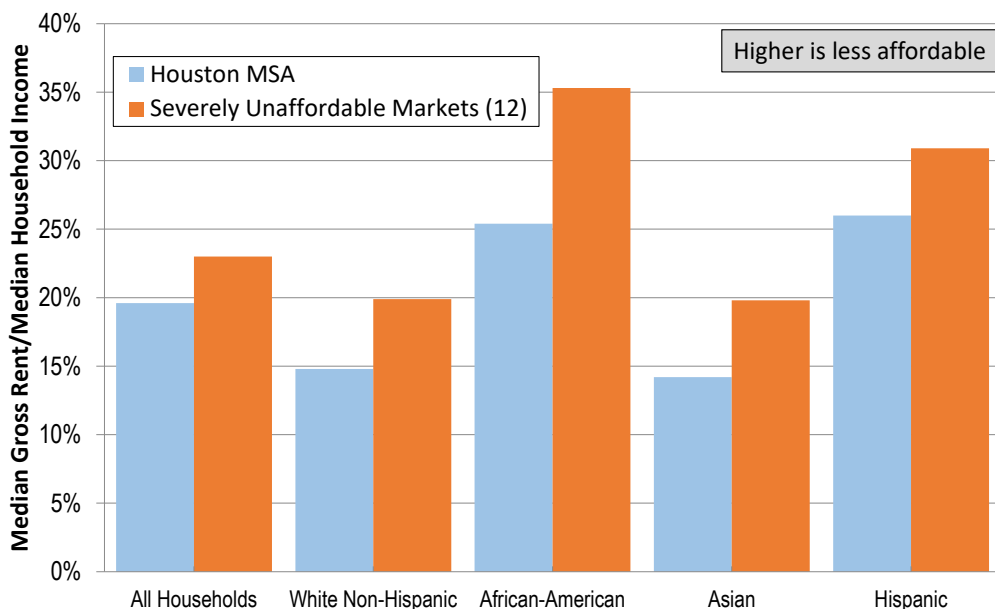
Houston's housing policy has followed this precept, maintaining lower prices even amidst rapid population and income growth. The opposite rule has prevailed in the severely unaffordable markets. There, housing costs rise relative to incomes, which is the principal factor in driving the overall cost of living higher. But higher incomes in these areas generally do not make up for the higher housing costs. Among the 15 largest metropolitan areas, Houston ranks first in housing affordability (tied with Detroit).

Houston & Severely Unaffordable Markets 2016: HOUSING AFFORDABILITY



Derived from American Community Survey, 2016

Houston v. Severely Unaffordable Markets 2016: RENTAL AFFORDABILITY



Derived from American Community Survey, 2016

In those same metropolitan areas, rents also increase relative to incomes, but substantially less than the costs of privately owned housing. Houston is fifth in rental affordability (median gross rent divided by median household income) at 19.6%; it is more affordable than the national average of 20.4%.

This has a particular impact on minorities, who historically have had low incomes. Houston offers the most affordable US rents for African-Americans, with rent taking 25.4% of income. This is more affordable than the national average of 30.5%, and considerably more affordable than highly regulated markets like San Francisco (45.3%), Miami (37.2%) and Los Angeles (37.0%).

Among Hispanics, Houston's rental affordability ranks fifth among the top 15 metropolitan areas, with rent taking 26.1% of income. This is slightly above the national average of 25.6%. The five least affordable rental markets are highly regulated Boston, New York, Miami and Los Angeles, as well as mostly-regulated Philadelphia.

Houston's planning regime has done much for the people of the region. Adjusted for costs, Houstonians in a range of ethnicities enjoy higher real incomes than their counterparts in more expensive markets, in some cases by a wide margin.

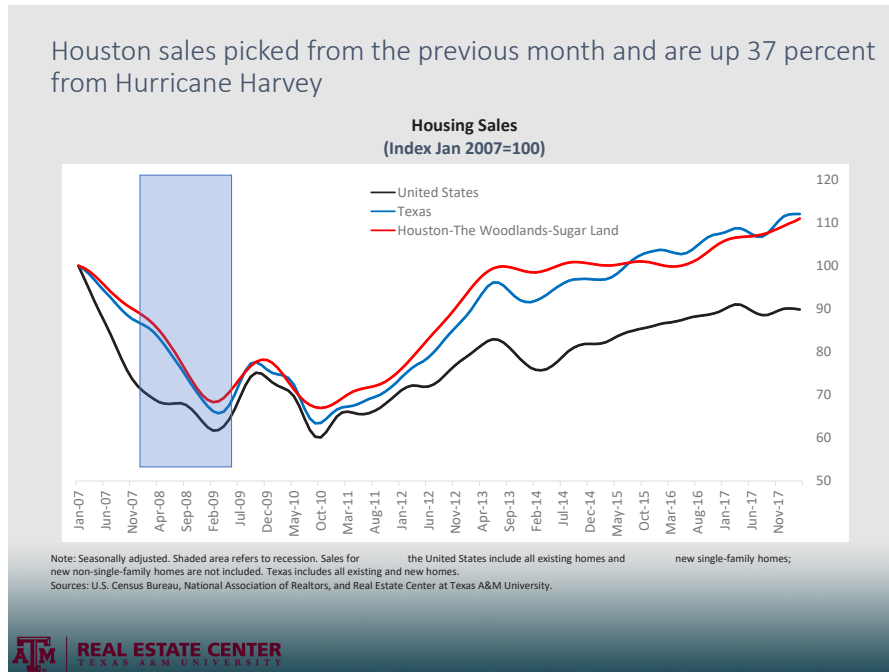
Notably, Houston has greatly out-performed urban containment (sometimes called 'Smart Growth') areas in the rates for owner-occupied housing.¹⁴ Home ownership is a critical aspect of upward mobility into the middle class. Lower prices have been particularly beneficial for minorities— often immigrants — who will play an increasingly dominant role in Texas and in the country overall. The region ranks first in housing ownership affordability for African-Americans and second for Asians; it is tied for Latinos with Atlanta and Dallas-Fort Worth.

In most cases, the areas that embrace urban containment have done far worse. Minority homeownership is much higher in Houston and more liberally regulated markets than in the urban containment paragons of San Francisco, Los Angeles, New York, Seattle and Boston.

It is critical to note the role of suburbs in this positive trend. Minorities — Asians, Latinos and African-Americans — tend to have higher incomes in the Houston suburbs than in the city. Suburbs may represent a regressive urban form to many planners and some in the media, but to minorities they represent the primary avenue of opportunity.

REGULATORY THREATS TO THE HOUSTON MODEL

After something of a lull, Houston home sales are again robust. Sales are rising well above the national average, and have achieved parity with those in the rest of Texas.



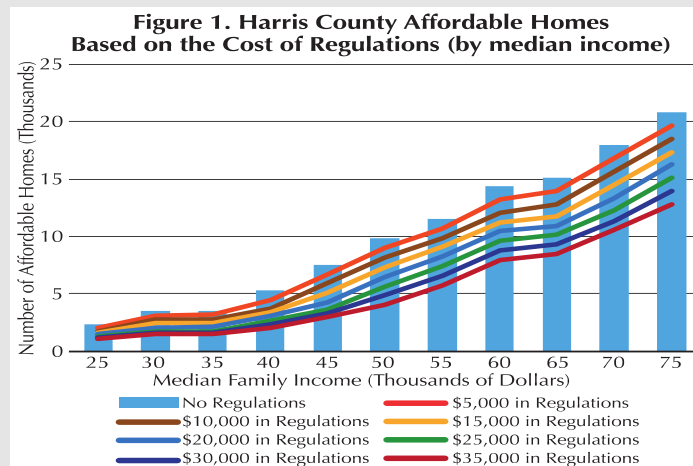
As we suggested above, this recovery could be threatened by new regulations imposed in the City of Houston. In response to Hurricane Harvey, the City of Houston recently passed regulations for new-home construction. Currently, new homes in the 100-year floodplain — the area that theoretically would flood approximately one year out of every 100 — are required to be built one foot above the floodplain. Under the new rules, new construction on that floodplain would need to be elevated two feet. That requirement has been expanded to include new homes in the

500-year floodplain as well. Existing homes that are enlarged will also need to comply.

The new building regulation will impact the amount, location, and type of residential development, and can lead to higher construction costs and time delays that restrict the ease of building houses, making homes less affordable.

Potential Impacts of New Policies:

The new regulation decreases affordability since the increased building cost is passed on to the consumer.



Notes: The graph computes the number of homes that are affordable to each income distribution based on varying costs of regulations. The home price affordable to each income distribution was calculated from a price-to-income multiplier derived from 2016 data from the Home Mortgage Disclosure Act and U.S. Census Bureau. Based on 2016 Real Estate Center sales price data for both new and existing homes, the number of homes affordable to each income distribution was computed. While owners of pre-existing homes are not required to elevate their home, using the pool of new and existing homes provides a more representative share of the market. As the cost of regulations increases, the number of homes affordable to each income distribution decreases.
 Sources: Home Mortgage Disclosure Act, American Community Survey, U.S. Census Bureau, author's calculations

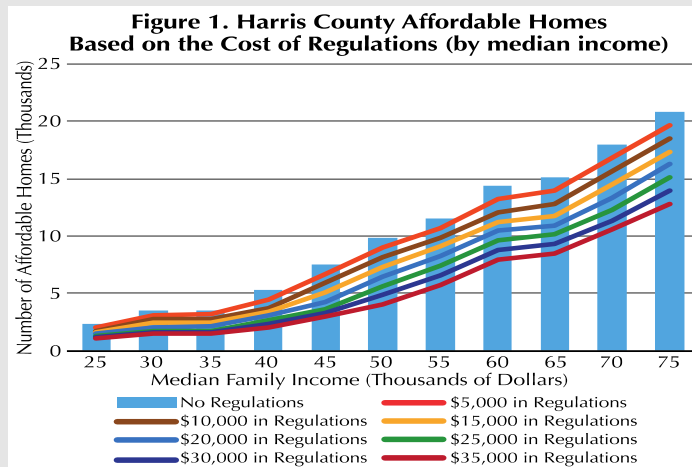
The biggest impact will be on less-expensive starter homes to be built on smaller lots. Under the new regulation, homes will need to be built on an elevated concrete slab. Builders estimate the cost to build on elevated concrete, versus building on a standard post on grade, at \$25,000 to \$35,000. Every additional foot the home is raised adds an additional \$10,000 to the slab cost. So, a new house that would have sold for \$185,000, but now needs to be elevated two feet — even if the builder passes that price to the homebuyer at cost — just became a \$205,000 home.¹⁵

In cases where an owner plans to expand, and thereby be subject to the new rules, elevating their existing home would be much more expensive than building a new one, because the engineering and work required to successfully lift a home is intensive and difficult. To lift an existing one-story, 2,060 square foot perfectly rectangular house five feet (which might not even put it a full two feet above the 500-year floodplain), for example, would cost approximately \$171,000. Costs for elevating larger and more technically complex houses are in the \$250,000 to \$300,000 range.¹⁶

These regulations are being implemented at a time when Houston and Texas prices are on a definite upswing. Affordability is eroding throughout the state’s metro areas, and may be particularly vulnerable to potential regulatory over-reach.

Potential Impacts of New Policies:

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Sources: Home Mortgage Disclosure Act, American Community Survey, U.S. Census Bureau, author’s calculations



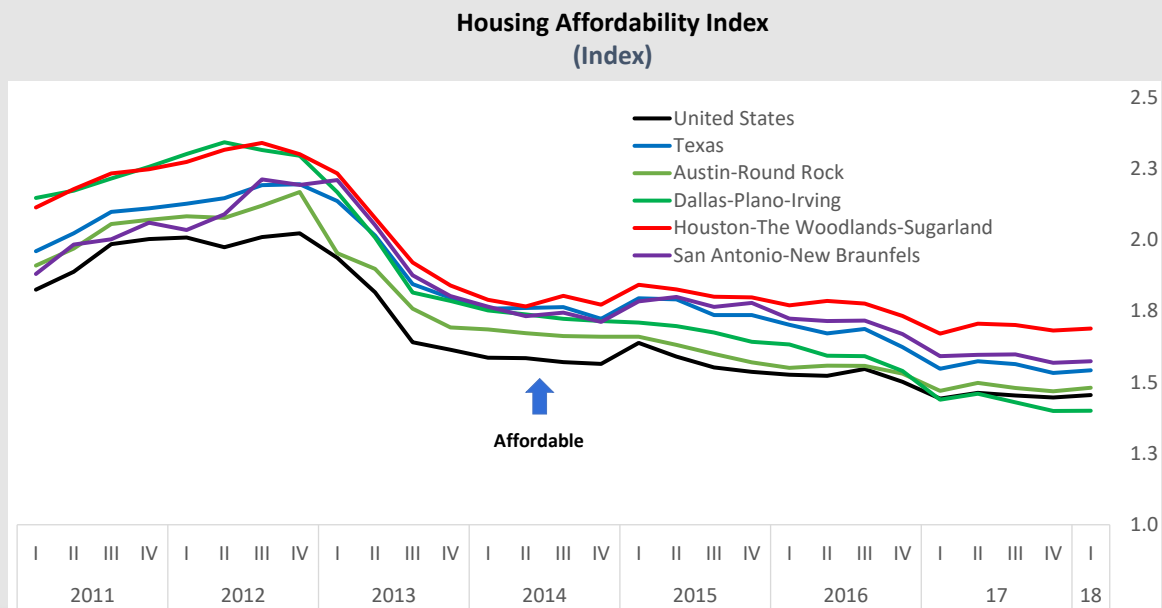
VULNERABLE REGIONS FACING NEW REGULATION

Regions with the highest proportion of damaged homes were generally older, smaller, and less expensive than the rest of Houston. There were some exceptions, like the region surrounded by Greens Bayou, Sheldon Lake, and Lake Houston. This area, which encompasses the 77044 ZIP code, has newer homes with higher selling prices, but the prices are still below the city’s median of \$225,000. Two other ZIP codes hit hard by the storm have bigger homes — 77050 and 77079 — but only 77079 registers higher sale prices.

Residents in the poorer, older areas most hit by the storm also could have an increasingly difficult time financing housing modifications to comply with proposed building codes. Many of those in the places with the most damaged homes (ZIP code 77078) are most vulnerable. In this area of northeast Houston with a median home price of \$78,200 and a median size of 1,371 square feet, if flood insurers were to require residents to elevate their homes, it would cost around \$113,500 to elevate an average home: \$35,500 more than the median price. The cost of elevating would be higher than the value of the home. Factoring in the age of the home and the homeowner's income level, this appears economically unfeasible. How about demolishing the existing home and building a new one? Again, a question of economic feasibility rises based on the income needed to pay for new home construction. One additional headwind would be the cost of temporary living while the new home is under construction. This is also true if the home is to be elevated.

The new regulation decreases affordability. Breaking down sales of existing and new homes in Harris County by regulation compliance cost reveals a significant drop in the number of households that can afford a home. Our exercise, although not perfect because it does not include the complete stock of new homes and is a combination of existing and new homes, does show the impact of passing new costs from the homebuilder to the consumer.

With rapid appreciation, Texas affordability continues to fall relative to the U.S., especially in the major MSAs



Note: Seasonally adjusted.
Sources: Real Estate Center at Texas A&M University.



In some cases, notes former mayoral candidate Bill King, “... the city could spark gentrification of neighborhoods in which many residents have few resources to adapt to new standards.” This is particularly critical within the City of Houston: a 2018 Metrostudy on Houston housing estimates the city’s new regulations could add an additional \$65,000 to the costs of building or reconstructing a house in the city, compared to building in the surrounding, unregulated or less regulated areas.¹⁷ As Greg Travis, Houston District G City Council Rep, put it, “... I think we are passing the buck — the city has been underfunding drainage improvements for decades, and now we want to make everyone elevate. City Hall needs to take responsibility for flooding instead of pushing it onto homeowners.”¹⁸

CAN THE SUBURBS BE PART OF THE SOLUTION?

We believe that Houston can bounce back from Harvey as a model for a sustainable city. The opportunity is enormous.

Houston’s urban form is often seen as damaging to the environment. This thinking is antiquated, particularly if we look on a regional scale. City core and suburbs together need to be addressed as one holistic unit with multiple ‘centers’: a polycentric whole. Suburbs can supply the core with energy generation and tame negative environmental effects in a way that a dense, already-built core cannot achieve on its own.

As we’ve shown, suburbs and suburbanization are not the primary causes of flooding. The percentage of impervious surfaces — that is, surfaces covered by impenetrable materials that prevent rainwater from soaking into the ground — are higher in places where land is used for shopping centers and other commercial or industrial purposes, and lower in residential areas.

Since cities and suburbs are composed of different combinations of those uses, their ability to absorb water varies. Professor Alan M. Berger, co-director of the MIT Norman B. Leventhal Center for Advanced Urbanism, has concluded that the percentage of impervious surfaces in dense urban centers ranges from 60% to 95%.¹⁹ In New York City proper, for example, 72% of the surface is impenetrable.²⁰

The percentage of impenetrable land in purely residential areas can be as low as 10%. Berger suggests that, in contrast to the high range in cities, impervious surfaces cover 10% to 60% of suburban areas. And — more significant in the case of Houston— newly-built suburbs could be designed with minimal impervious surfaces. Rather than see suburbs as the enemy of flood control, it would be an ally. “Urbanization, and especially suburbanization, has been responsible for large amounts of wetland loss including, historically, outright destruction,” notes Celina Balderas Guzmán, a wetlands researcher and PhD student at University of California Berkeley. “[But] while suburban development has been part of the problem, it could also be part of the solution.”²¹

This is not to deny that wetland loss is an issue. Harris county lost 30% of its remaining wetlands between 1992 and 2010. The vast majority of that loss is from residential (52%) and commercial/industrial (12%) development.²² The question is, where do we go from here?

Guzman believes that regions need “a new paradigm for managing stormwater,” and that the best solutions “...will be those that shift away from mono-functional, centralized infrastructure.” Some of this can already be seen in the improved performance of detention ponds in Houston’s lower density areas during Harvey. These initiatives can be expanded into “constructed wetlands” that mimic natural wetlands, using the same physical, biological, and chemical processes to treat water. Besides treating stormwater pollution and detaining floodwaters, constructed wetlands can, among other functions, boost biodiversity and provide urban amenities such as recreation.

Such wetlands need space, and that means that much of the new storm-resistant systems need to be incorporated into suburban areas, she adds.²³ To be most efficient and productive, a constructed wetland must cover multiple acres and have a sizeable watershed. For that reason, “...suburban expansion... provides an opportunity for a fundamental change in our approach to coping with stormwater and, simultaneously, to rethinking urban infrastructure.”

Berger suggests that Houston create a new system of high performance wetlands upstream for every suburb downstream, or within their sub-basin, to make up for the current and past losses. This could be managed through a wetland banking system. Development can continue if more effective absorptive areas are created. These wetlands will need to capture not only last rainfall amounts, but, in addition, absorb and slow down massive amounts of water resulting from new precipitation rates caused by climate change. And if designed properly, they can become recreational corridors with suburban amenities.

Houston already has many communities, such as the Woodlands, that were designed to absorb stormwater through natural means, thus reducing water removal from the aquifer and slowing the ground under Houston from sinking. These developments suffered limited damage during Harvey — about 0.2 percent of the population in the Woodlands needed to be evacuated. Other well-planned communities also performed better than older areas.²⁴

Woodlands may show the way



Ultimately, there is no reason to curb Houston’s urban form, if we consider the possibilities of creating a new ecology in our suburban areas. New developments, particularly on the fringe, provide Houston with an ideal laboratory for creating environmentally — and socially — sustainable models.²⁵ Notes ecologist Sarah Jack Himmers, these models can reflect the specific “native ecology” of their place, as could other locations throughout the environmentally diverse region.²⁶

The future for Houston after Hurricane Harvey depends on which of two approaches it chooses. One would diminish affordability in an effort to curb flooding, and redefine its urban form along more traditional patterns. The other, which we see as more suitable, would retain both its affordability and its polycentric urban form. It would protect residents and the environment through the use of new water management systems and technologies to maintain the dynamism of this dispersed region.

- 1 William H. Frey, "US population disperses to suburbs, exurbs, rural areas, and "middle of the country" metros," Brookings, March 26, 2018, <https://www.brookings.edu/blog/the-avenue/2018/03/26/us-population-disperses-to-suburbs-exurbs-rural-areas-and-middle-of-the-country-metros/>.
- 2 Occupied in 2016, per the American Community Survey.
- 3 Over 1,000,000 population.
- 4 This analysis is largely based on two similar data sources. Historic median house values and median household income data is from the Census Bureau and is available through 2016. Median house price data is from *Demographia* and its sources, through 2017. The Census Bureau data is available for a longer period of time.
- 5 Edward Glaeser and Joseph Gyourko, "The Economic Implications of Housing Supply," *Journal of Economic Perspectives* 32, no. 1 (Winter 2018), <https://pubs.aeaweb.org/doi/pdfplus/10.1257/jep.32.1.3>.
- 6 "Historical Census of Housing Tables," *U.S. Census Bureau, Housing and Household Economic Statistics Division*, October 31, 2011, <https://www.census.gov/hhes/www/housing/census/historic/owner.html>; "Homeownership Rate for the United States," *U.S. Census Bureau*, April 26, 2018, <https://fred.stlouisfed.org/data/RHORUSQ156N.txt>.
- 7 Urban growth boundaries have multiple designs. For example, a virtual urban growth boundary can be established by large lot zoning in peripheral areas, making it uneconomic to build starter housing tracts.
- 8 "The Economic Implications of Housing Supply."
- 9 Arthur C. Nelson and Casey J. Dawkins, *Urban Containment in the United States History, Models and Techniques for Regional and Metropolitan Growth Management* (American Planning Association Planning Advisory Service, (2004), 2.
- 10 Eric Holthaus, "Gigantic water tunnels won't save Houston from the next Harvey," *Grist*, April 10, 2018, <https://grist.org/article/gigantic-water-tunnels-wont-save-houston-from-the-next-harvey/>.
- 11 This however is not a one-to-one relationship. Rents have increased considerably less than house prices since 1970 (below).
- 12 Laura Bliss, "Jane Jacobs, in Her Own Words," *City Lab*, May 4, 2016, <https://www.citylab.com/equity/2016/05/jane-jacobs-quotes-last-interview-100th-birthday/481053/>.
- 13 Wendell Cox, "People rather than places, ends rather than means: LSE economists on urban containment," *New Geography*, December 23, 2015, <http://www.newgeography.com/content/005126-people-rather-places-ends-rather-means-lse-economists-urban-containment>.
- 14 Often the urban containment markets have been characterized as having "smart growth." However, it is the urban containment regulations (above) of smart growth that drive up land prices.
- 15 Lawrence Dean from Metrostudy, and Scott Davis from Meyers Research.
- 16 Ibid.
- 17 Market Update Presentation document in Google drive folder, pg.92+
- 18 Greg Travis, "Why I voted against Houston's new flood regulations," *Houston Chronicle*, May 7, 2018, <https://www.houstonchronicle.com/opinion/outlook/article/Why-I-voted-against-Houston-s-new-flood-12889423.php>.
- 19 Alan M. Berger, interview by Zina Klapper, June 27, 2018; Karen Capiella and Kenneth Brown, "Impervious Cover and Land Use in the Chesapeake Bay Watershed," U.S. EPA Chesapeake Bay Program, January 2001, p. 54; Arnold and C.J. Gibbons, "Impervious surface coverage: the emergence of a key environmental indicator," *Journal of the American Planning Association* 62 (1999): 243–258.
- 20 "LTCP Frequently Asked Questions," NYC Environmental Protection, http://www.nyc.gov/html/dep/pdf/cso_long_term_control_plan/ltcp_faqs_handout.pdf.
- 21 Celina Balderas Guzman, "Suburban Wetlandia," in *Infinite Suburbia* (New York: Princeton Architectural Press, 2017), p. 478 - 491.
- 22 John S. Jacob, Kirana Pandian, Ricardo Lopez, and Heather Biggs, "Houston-Area Freshwater Wetland Loss, 1992-2010," Texas A&M Agril Extension, 2014, <http://tcwp.tamu.edu/files/2015/06/WetlandLossPub.pdf>.
- 23 "Suburban Wetlandia," p. 478 – 491.
- 24 Geneva Vest, "Post-Harvey Houston Can Learn from Suburbs Designed with Nature," *OffCite*, October 6, 2017, <http://offcite.org/post-harvey-houston-can-learn-from-suburbs-designed-with-nature/>.
- 25 Sarah Jack Hanners, "The Cosmopolitan Ecology of Suburbia," in *Infinite Suburbia* (New York: Princeton Architectural Press, 2017), p. 454 – 462.
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HOUSTON: RESILIENT REGION

RESILIENT CITY THREE: BUILDING HOUSTON’S FUTURE

New Orleans now has a housing affordability crisis because it did not adequately consider the problem after Katrina.¹ *Jeff Herbert, Water Institute of the Gulf.*

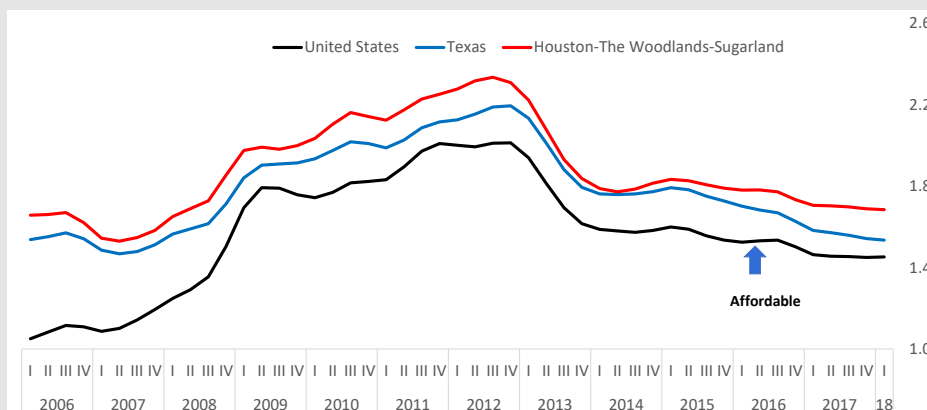
Like other cities after their enormous disasters – Chicago after the Great Fire of 1871, San Francisco after the 1906 Earthquake, New Orleans post-Hurricane Katrina — Houston is at a critical crossroads. How can it recover from the greatest rainfall event in recorded US history without compromising the essential affordability model that has made it great?

And how can it build resilience for the future? Can it take a different path than New Orleans, where, over a decade after Katrina, almost 60% of renters pay in excess of 30% percent of their income on rent?²

If smart growth, especially urban containment policy, hijacks the agenda, Houston’s middle and working classes, including its large number of immigrants, face a dismal future. Home supply will be restricted and made less affordable, and the American Dream will go from great hope to cruel tease.³

With rapid appreciation, Texas affordability continues to fall relative to the U.S.

Housing Affordability Index (Index)



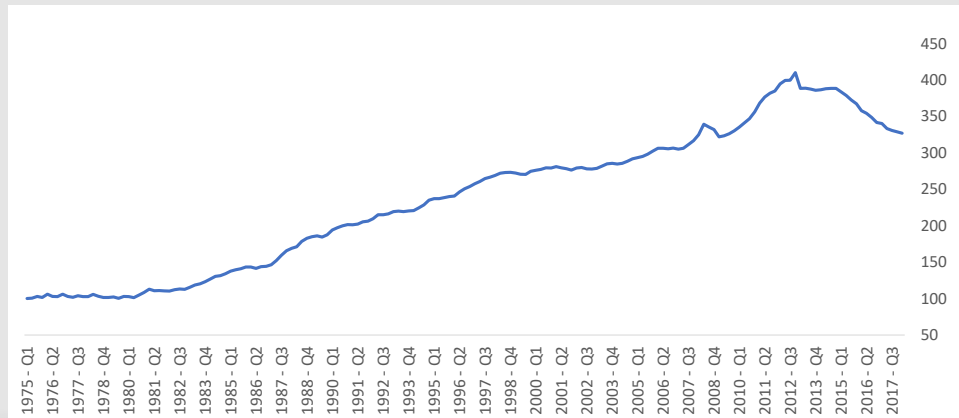
Note: Seasonally adjusted. The Housing Affordability Index (HAI) measures the ability of a household earning the median family income to qualify to purchase the median-priced home. The index is the ratio of median family income to the required income to qualify for a purchase mortgage loan at the current interest rate. A ratio of 1.00 means the median family income is exactly equal to the required income to purchase the median-priced home in the area. Affordability increases as the required qualifying income decreases relative to the median family income.

Sources: Real Estate Center at Texas A&M University.



Since 2012, Texas housing prices have been rising faster than incomes

Ratio Texas Personal Disposable Income Per Capita to House Prices
(Index 1Q1975=100)



Note: Seasonally adjusted.

Sources: Sources: Federal Housing Finance Agency (FHFA), U.S. Bureau of Economic Analysis, and author's calculations.

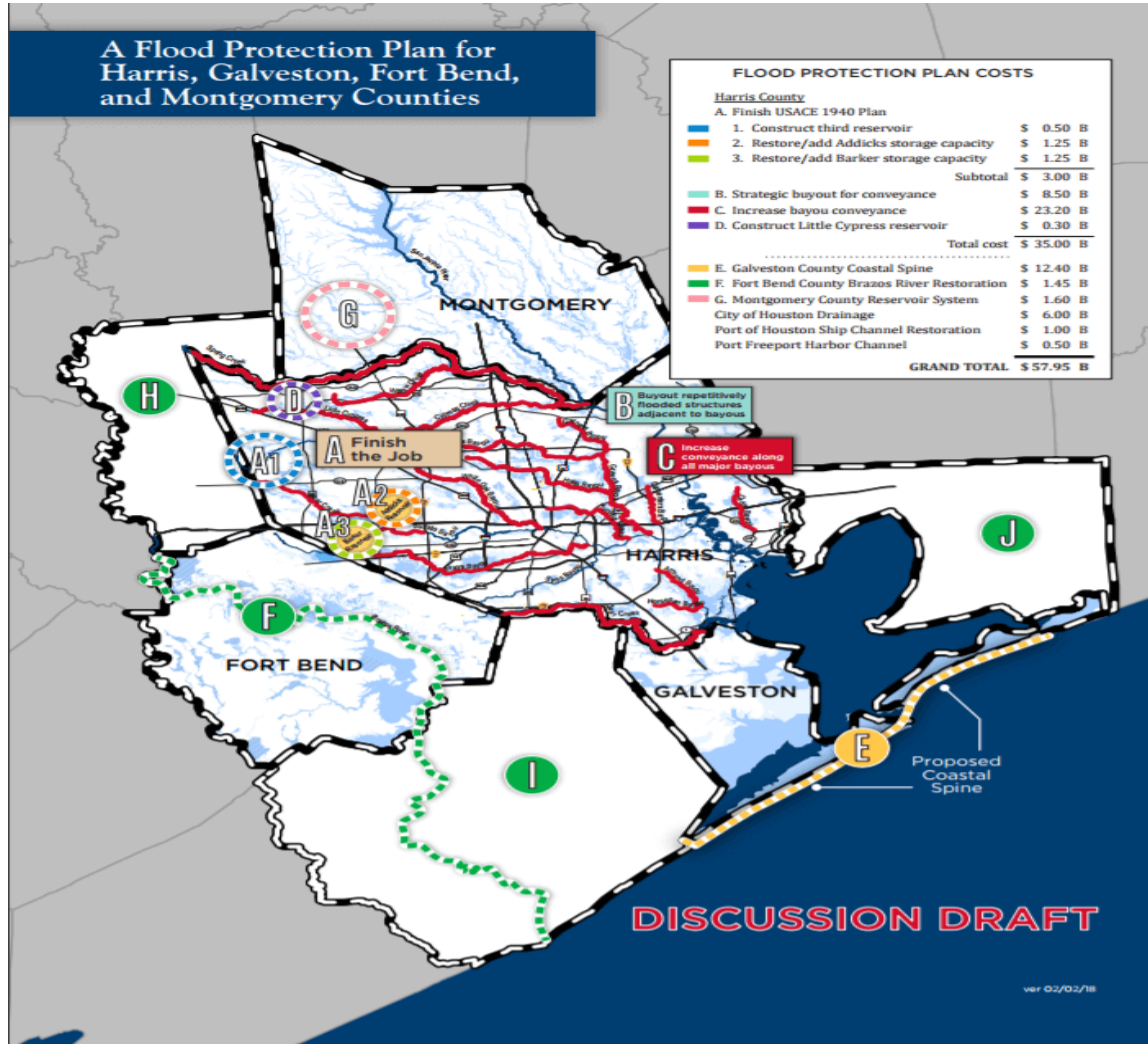


Houston's future must be understood in the context of what is happening to America's cities. As noted by Richard Florida, the originator of the "creative class" theory of urban development, the current trajectory of America's greatest cities has been to reinforce inequality and restrict upward mobility. "As the middle class and its neighborhoods fade," he writes, "our geography is splintering into small areas of affluence and concentrated advantage, and much larger areas of poverty and concentrated disadvantage."⁴

It is critical that our post-Harvey policies do not accelerate this trend in Houston. Development regulations must, of course, be reviewed and tightened based on lessons learned. But some of the risk tolerances being discussed are so low that, if applied to earthquake-prone California, the entire state of 40 million people would have to be evacuated.⁵ Pragmatic realism and strict cost-benefit analysis have to be our guiding philosophy. No city can be designed to withstand a once-in-a-thousand-years disaster unscathed. Houston fared quite well compared to the scale and scope of the event, but resilience can always be improved. This report outlines a framework of potential solutions for consideration.

INFRASTRUCTURE AS PART OF THE SOLUTION

Fortunately, the region is moving towards a growth-friendly but tough approach to resiliency: Harris County Judge Ed Emmett's 15-point resiliency plan (see Exhibit A), and Houston Stronger's plan for \$58 billion in infrastructure projects for water conveyance, storage, and surge defense, including the Ike Dike against potentially catastrophic storm surges up Galveston Bay and into the refineries of the Houston Ship Channel.⁶



Increased water conveyance and storage infrastructure to reduce the size of 100-year flood plains is absolutely critical to an equitable resiliency solution, since the economically disadvantaged cannot afford to elevate their homes as easily the affluent can. For example, recent work to expand Sims Bayou is a great model. Sims Bayou has not had significant flooding since its completion, even during Harvey. To help pay for such infrastructure, Harris County is holding a \$2.5 billion bond election on August 25th. Even though it will increase property taxes by up to 1.4%, the taxpayer value is substantial, since the funds can be leveraged 4-to-1 or more as the local match for federal funds.⁷

REGULATIONS AND RISK

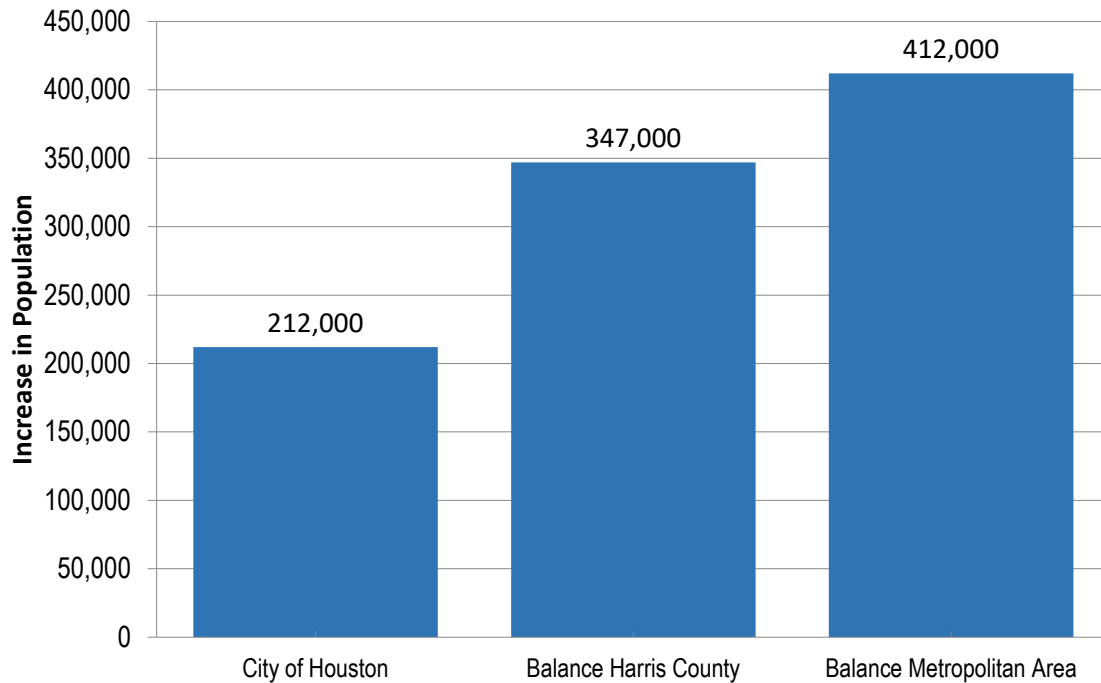
Subsequent to the adoption of strong 2009 regulations, less than 0.6% of homes developed in Harris County have flooded.⁸ Nonetheless, the City of Houston has adopted even more stringent regulations that now require new structures to be elevated two feet above the 500-year flood plain.⁹ This is vast regulatory overkill, given that 70% of homes in the 100-year plain did not flood, and that the city’s current ordinance for building in the 500-year flood plain already had an 80% to 90% success rate.¹⁰

In one case, the new standard would put a house five feet above Harvey’s floodwaters. Regulations should be revised to simply state that new development plans must demonstrate that the structure would not have flooded in previous storms of record. As a 1,000+ year storm, Harvey sets the new standard. Higher than that is excessive.

There are substantial risks to excessive construction standards: notably, the cascading results of higher costs. The new regulations would also undermine existing neighborhoods. New, elevated developments, many of them necessarily dense, would drive more businesses and residents out of central Houston and towards the periphery, much of it outside Harris County.

Rather than see the city as defined by its geographic boundary, we should regard, as did Frank Lloyd Wright, “...the citizen as the city. The city is going wherever he goes.”¹¹ By warring against suburbia, many apostles of urban containment are actually creating the conditions for the very sprawl they disdain, forcing the city to be too expensive, congested and family-unfriendly.

Houston Metropolitan Area Population Change 2010 to 2017



Derived from Census Bureau data

Figure 5

At the same time, we believe that new, cost-effective regulations applied to the periphery could be adjusted to ensure even better water detention and retention ability than these suburban areas had before they were even developed. Alan M. Berger, Professor and Co-Director of the MIT Norman B. Leventhal Center for Advanced Urbanism suggests just such a suburban development pattern: new regulations that go beyond runoff-neutral, and drastically increase water retention. This would help alleviate some of the flooding risk for homeowners in the current suburban areas who are worried that further exurban expansion would harm them with increased runoff. Berger, along with sustainability scholar Celina Balderas Guzman and a multi-disciplinary team at MIT, has just released a report detailing guidelines for urban stormwater management, the result of a two-year study.¹²

Texas should enact a state law that mitigates development with downstream impact. It is especially important that it cover rural counties upstream from Harris County that lack the same stringent development regulations as Houston. We should improve flood risk disclosures, and actively encourage the purchase of flood insurance. And we should consider property tax credits for those with flood insurance.

TRANSIT FOR THE 21ST CENTURY

Images of water-clogged freeways in the aftermath of Hurricane Harvey have led some to suggest that a move away from car usage would be one way to assure resiliency. It has been suggested that there is now a greater need to shift to traditional public transit. Houston's freeway system was seen as having left it "vulnerable to flooding."¹³

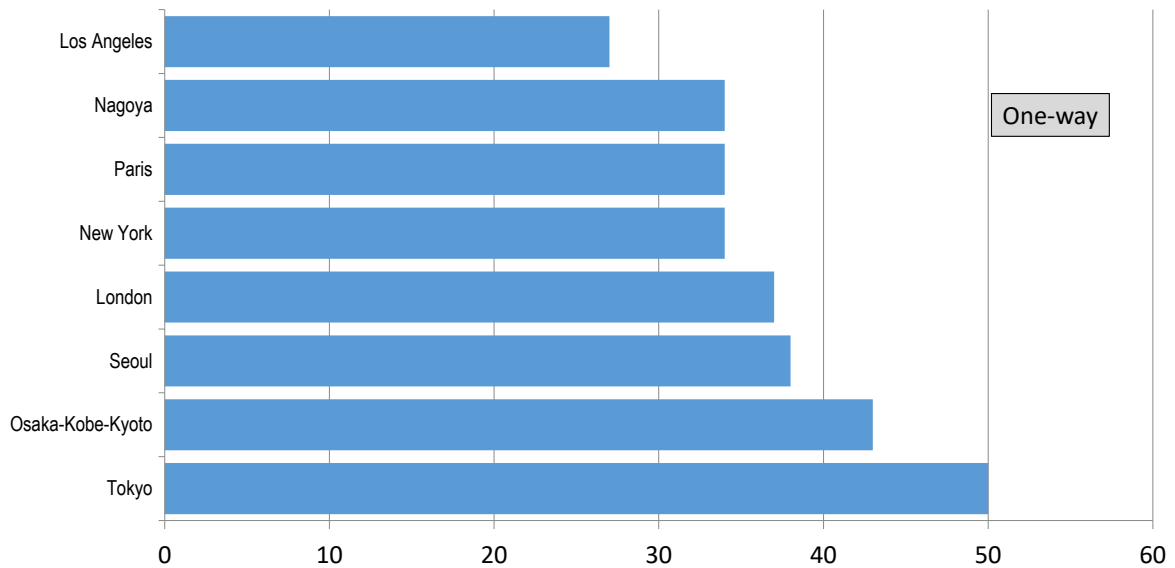
Yet in reality, Houston's freeways actually provided much of the detention needed in the emergency. The transit system did not help and was shut down for virtually all of the storm. Past experiences with flooding in other cities, notably New York during Hurricane Sandy, have proved that traditional transit has not been any more successful than road systems, and perhaps has been even less so, in coping with weather-related emergencies.

There is no doubt of transit's value in its niche markets. This is especially true with respect to the largest, densest downtown areas. For example, the cities with the six largest downtowns in the US are New York, Chicago, Philadelphia, San Francisco, Boston and Washington. Nearly 57% of US work trip destinations on transit are in these six municipalities. This is far higher than their 7% share of jobs. Of course, New York (the municipality) dominates this data, accounting for 36% of overall work trip destinations.

In contrast, in cities like Houston, massive investment in transit systems has been, at best, marginally successful. On average, transit commuting takes twice as long as commuting by car. In Los Angeles, a region renowned for its horrific traffic, transit has experienced significant ridership losses, even as the population has increased. It still has the shortest documented work trip travel time of any of the world's megacities (those with populations of more than 10 million).¹⁴ Travel times in places with robust transit like New York, Hong Kong, Tokyo and Paris are actually longer than those in LA, not to mention Houston.

Work Trip Travel Times: World Megacities

AVAILABLE DATA AT 2010



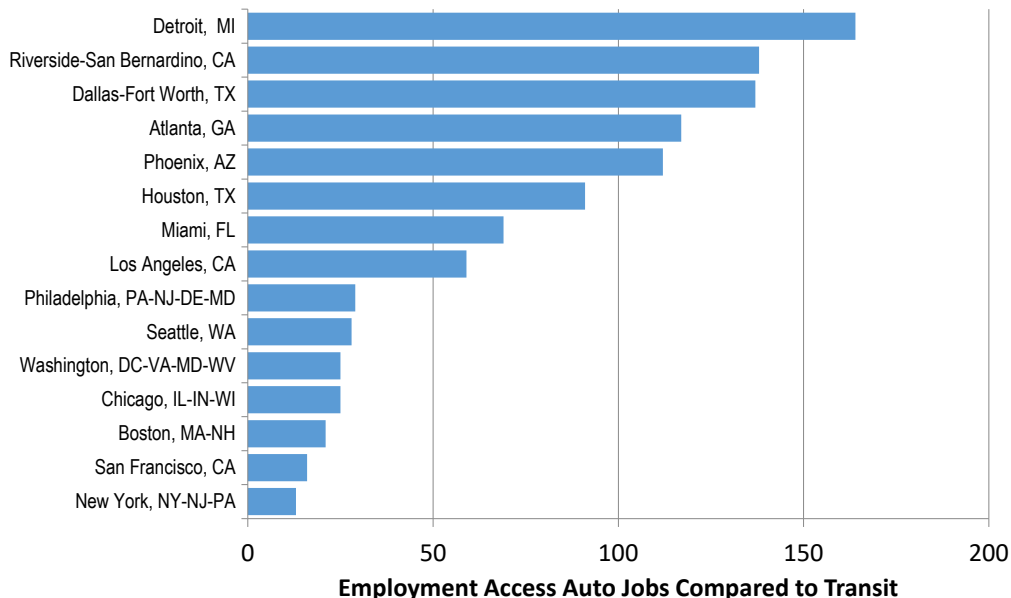
Various sources: See note in text

Figure 6

Perhaps the most telling issue around transit is job accessibility. Employment access by transit in US metropolitan areas is strikingly low. For example, in the metropolitan area with by far the best transit system, New York, 13 times as many jobs can be reached by the average employee by car as by transit in 30 minutes. Another way of putting it is that in New York, cars provide access to 1,200% more jobs than transit. In Houston, access to jobs by car is 91 times what it is by transit — cars provide 9,000% more access to jobs than transit does.¹⁵

Auto v Transit Access to Jobs: 30 Minutes

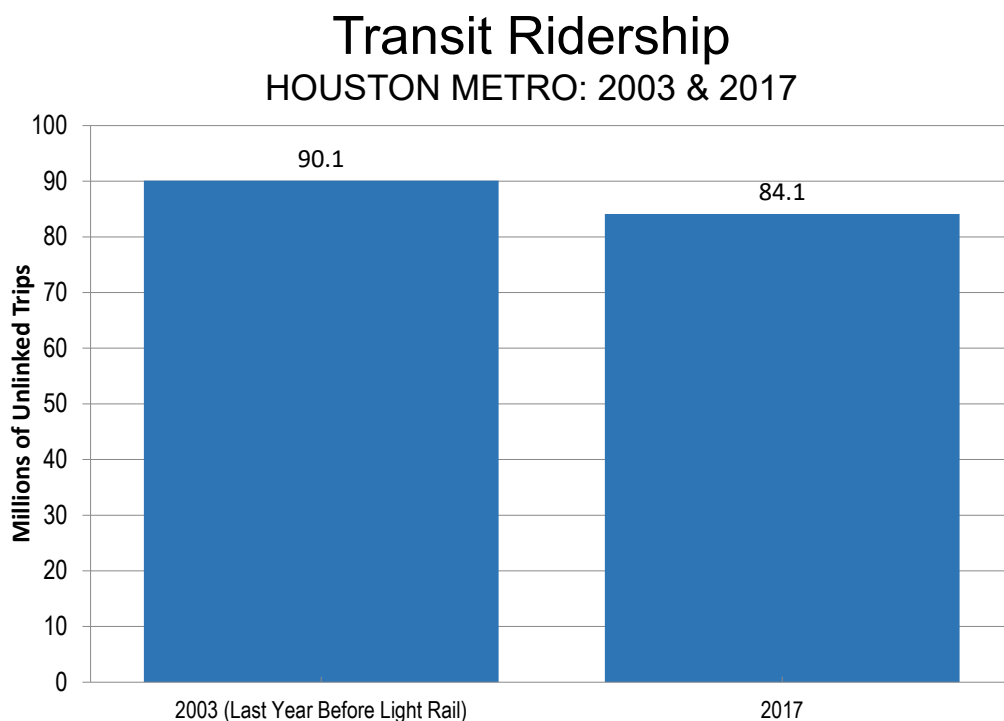
15 LARGEST METROPOLITAN AREAS: 2015



Derived from American Community Survey, 2016

Figure 8

With these challenges, costly rail systems have not resulted in any material change in how people travel in US metropolitan areas. This does much to explain why new transit systems have not attracted Houston’s automobile drivers. Despite opening 22 miles of light rail since 2004, Harris County transit ridership has dropped, while the county’s population has grown by nearly 1,000,000.



From: American Public Transit Ridership Reports: Bus & Rail

Figure 9

HOW ELEVATED MaX LANES CAN HELP

It seems like there would be a way to create an elevated road that helps people get out all the time.¹⁷ *Wesley Highfield, professor of marine sciences at Texas A&M University at Galveston, who specializes in flood resilience.*

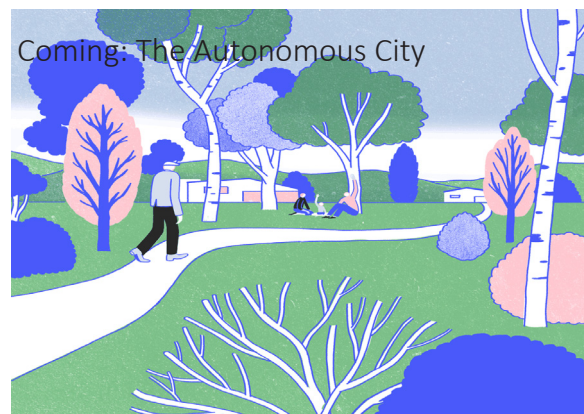
Harvey exposed the need for elevated roads that could improve evacuations, and help first responders get around the city during flood events. Raised roads would decrease reliance on low-lying, water-conveying roads. Since the beginning of the decade, there has been discussion of how modern technologies could help pave the way to the “Third Generation Roadway.” Individual travel could be made more ‘intelligent’ using sensor technology, allowing for greater speeds and safety.¹⁸

A network of managed express lanes (MaX) — also called high-occupancy toll lanes or HOT lanes — has been proposed to improve freeway movement in the Houston area.¹⁹ By elevating lanes, Houston could keep transport going, even during floods. The Texas Department of Transportation should consider this approach to better preparing the area for future floods.

TRANSFORMING SUBURBIA THROUGH AUTONOMOUS MOBILITY

If autonomous cars achieve the lower costs their proponents anticipate, they could vastly improve the mobility of low income workers through ride sharing and shared ownership. Autonomous vehicles would be especially significant in places where reasonable travel times to metropolitan jobs cannot be achieved by mass transit. Without other options, those unable to afford cars are severely disadvantaged by the widespread geography of employment opportunities. Polycentric Houston, with its excellent road system, flat topography, and year-round warm weather, is a good match for the latest innovations in electrified, automated mobility.

In the future, large scale adoption of a solar-powered, electrified, personal autonomously driven (AD) mobility system would allow designers to radically transform the capacity of the suburban landscape to act as a massive storm water retention zone. New suburban communities with this technological ability would be able to significantly decrease their amount of pavement, which in turn would generate multiple environmental benefits. This is particularly true in Houston's case, since it has the opportunity to build new developments. These new suburbs could contain far more permeable land areas than current suburbs do, since driveways, roads, and other paved surfaces would be reduced or repurposed.



Newly absorbent landscape surfaces can offer an array of options in addition to flood mitigation: heat island reduction, shade enjoyment, and environmentally beneficial plant and animal habitats. Suburban neighborhoods, particularly when heavily wooded and covered by grass, are also ideal places to sequester carbon, a critical goal in responding to climate change.²⁰

None of these can be achieved in a paved-over city center. Berger suggests, "If autonomous vehicle technology was adopted at a large scale... then some of suburbia's biggest negative impacts could be diminished."²¹

SUSTAINABILITY, INNOVATION, AND RESILIENCE

Houston's dispersed urban form could help in other areas of resiliency, as well, such as in the production and distribution of electricity.²² One of the biggest problems of major storms has been the breakdown in the electrical grid. As British scholar Hugh Byrd has noted, the roofs of suburbia would be ideal places to use photovoltaic solar technology on a dispersed basis. In the future, he suggests, if this usage becomes commonplace, "...suburbia will have a renewed role as both a collector and supplier of energy, a characteristic that cannot be achieved in the higher density CBD [Central Business District]... suburbia is likely to become more energy efficient than compact housing form."²³

Finally, a resilient metro requires better tools to assess flood risks, in order to craft specific, location-based solutions and communicate risks. We suggest the region invest in an accessible platform that uses innovative mapping technology and digital tools to communicate a variety of risks in real time, so residents can make informed decisions without having to navigate a labyrinth of federal and public agency data. A beta study model of what a comprehensive, automated resilience and vulnerability mapping system would look like is being developed by researchers at the MIT Norman B. Leventhal Center for Advanced Urbanism.²⁴

WHAT KIND OF CITY DO WE WANT?

Policy decisions on intensification should be based on the technologies of the future, and not those of the present and past.²⁵

The focus among many academics and those in the media on the need to revoke the Houston model of development poses great questions about the future of our metropolis. Houston, as former Rice University Architecture Dean and world renowned urban theorist Lars Lerup has observed, "... is motorized, broken up and attenuated from the very start." Lerup sees this form as a source of innovation growth, and a reflection of popular preference and upward mobility. In contrast, observers who have never spent time in places like Houston like *The New York Times*' architecture critic Michael Kimmelman, see density as the preferred "response to environmental threats," and praise slums as "not just a blight, but a potential template for organic urbanism."²⁶

But Houston cannot realize greater resiliency — social, economic or environmental — by seeking to duplicate an urban system attuned to the needs of cities forged before 1950. Rather than devastate that which has made Houston so successful, we suggest policies that would enhance its appeal, such as ensuring affordability, economic opportunity, and higher incomes.

Houston gives people what they want, including a single-family home; its strength lies at the personal, not the mega-social level. It is an opportunity city. As author Erika Griever notes, few people move to Houston "for fun." They come from around the country and the world for opportunity. "Everyone who is there," she writes, "is there for a practical reason."²⁷ This practical motivation is the essence of Houston, and should help shape our response to Hurricane Harvey.

ENHANCING THE HOUSTON MODEL, NOT DESTROYING IT

We do not view Harvey as a disaster that requires a total course correction. Instead, we believe that Houston can adapt to climatic events — even worse events than we have seen — within the market-oriented system that has been its essence. Texas, and especially the Houston area Municipal Utility Districts (MUDs) assume responsibility for developing substantial infrastructure for new development, such as control of fresh water, waste water, floods, and arterial streets. Any financial burden is assumed by the MUDs, which issue bonds serviced by home owners. Evaluating the ultimate test of Hurricane Harvey, a report commissioned by the Texas Association of Water Board Directors found that "Houston's network of MUDs was extremely resilient in the face of Harvey, largely provided utility service without interruption during the storm, and has very low risk of default on bonds."²⁸

As a diverse region, rich with newcomers and immigrants, Houston faces challenges shared by other cities with those characteristics. Over time, their residents form a grassroots foundation. In the aftermath of Harvey, the involvement of these new arrivals gained national attention, with observers noting that "...In devastated Houston, 'nobody hates anybody' as people come together."²⁹

This kind of grassroots activism may seem outdated in our current era of environmental determinism, focused largely on limiting human agency and aspiration. Since the early '70s, there have been widespread claims about upcoming environmental disasters ranging from mass starvation to the exhaustion of natural resources, marking a defensive approach to human progress. Most recently, this has been tied to climate change.³⁰ Many of these predictions, as *Foreign Policy* magazine has suggested, proved inaccurate or overblown, often embarrassingly so, but have shaped opinion, notably in the media and academia.³¹

Yet whatever the results of environment change, it is the historic place of cities to confront and alleviate them. Rather than listen to those who would prefer to see Houston experience slower economic growth or become unaffordable, we need to look ahead to ways to make our region more resilient. Although there is clearly room for improvement, Houston's urban form contains many of the essential ingredients for sustained resiliency *and* continued growth.

We will accomplish both these goals not by shrinking, but by being innovative. For nearly a half century, Houston has been at the forefront of urban change and adaptation. There is little reason to believe this cannot continue in the half century to come.

(Appendix) EXHIBIT: HARRIS COUNTY JUDGE ED EMMETT'S PROPOSED 15-POINT RESILIENCY PLAN ³²

1. Create a regional flood control/water management organization similar to the Transportation Policy Council at the Houston-Galveston Area Council. This will allow for multi-county coordination of flood control and water management.
2. FEMA flood plain maps need to be revised immediately to reflect the impact of Harvey. Development rules should focus on restricting development in the 500-year flood plain instead of the 100-year flood plain -- or the 100 year flood plain needs to be vastly redefined and updated.
3. A third reservoir should be built to protect the west and northwest sections of Harris County. Rather than waiting on federal funds, the reservoir should be funded by the State of Texas' "rainy day fund." The reservoir should be part of a larger project to create a state or national park for the Katy Prairie
4. The U.S. Army Corps of Engineers should immediately fund the four Harris County Flood Control District projects that are now ready for completion. Those four are Brays Bayou, White Oak Bayou, Hunting Bayou and Clear Creek. New flood maps showing the impact of these projects should be released so homeowners will know if their property will remain flood prone.
5. Old watersheds in developed areas in Harris County should be identified. For example, those areas downstream from Addicks Reservoir need to know where an "uncontrolled release" over the spillway would flow.
6. The Harris County Office of Emergency Management, working with municipalities and special districts, should develop a state-of-the-art flood warning system and localized evacuation plans. Such plans should use recognized volunteer organizations to assist first responders. The Harris County Sheriff's Office and the Community Emergency Response Teams should have a defined water rescue effort featuring private boats and high-water vehicles.

7. Lake Houston and Lake Conroe should be converted to serve as Flood Control facilities in addition to serving as water supplies. Lake Houston should be restored to maximum storage capacity, and the San Jacinto River Authority should create retention/detention capacity upstream of Lake Houston. And the San Jacinto River Authority should have representation from Harris County.
8. The Harris County Emergency Operations Center should be expanded to assist emergency operations for smaller surrounding counties.
9. The roles and responsibilities of municipal utility districts and other special districts should be clarified to include flood control and storm water management, in cooperation with the Harris County Flood Control District. Existing districts should be studied for untapped capacity, and new districts developed with flood control in mind. Until a true 100-year flood level is defined, the 500-year level should be used for detention purposes.
10. All underpasses that have the potential for drowning should be identified and equipped with automatic barriers or be part of a comprehensive manual plan for closures. In addition, vehicle manufacturers should be encouraged to develop technology to detect high water.
11. The Harris County Flood Control District should develop comprehensive plans for every major watershed in Harris County, with immediate attention given to the entire length of Buffalo Bayou and to plans to divert storm water around downtown Houston, either through a canal or tunnel system.
12. Federal, state and local governments should implement a buyout and/or elevation program for all homes located in the 100-year flood plain or that have flooded repeatedly. Such a buyout/elevation program should use traditional government funding and private funding, such as social impact bonds.
13. The State of Texas should institute clear rules for approval of development plats in unincorporated areas, specifically those areas in the extraterritorial jurisdiction of a city. Additionally, there should be clear requirements for disclosure of flood risk to homebuyers and renters.
14. The U.S. Army Corps of Engineers should restore the dams and detention areas of Addicks and Barker reservoirs to first-class condition including, if necessary, removing dirt and vegetation within the reservoirs.
15. Given the population of unincorporated Harris County and the restrictions on incorporation and annexation, Harris County should be allowed some ordinance making power and should receive a portion of the sales tax collected in unincorporated areas. To continue to exclusively rely on the property tax is fundamentally unfair and unsustainable.

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