

WHAT IS GREEN GENTRIFICATION AND HOW TO PREVENT IT

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Bachelor of Science in Systems Engineering

By

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Green infrastructure is becoming more and more popular to control storm water runoff as opposed to traditional “grey” forms of storm water management. The American Planning Association says green infrastructure “is the interconnected network of open spaces and natural areas... that naturally manages stormwater, reduces the risk of floods, captures pollution, and improves water quality” (Wise, 2008, p. 1). For the technical portion of the project, the capstone team will seek to implement smart and sustainable green infrastructure technologies for the City of Charlottesville by creating flood modeling and sensing capabilities to determine which areas are flooding in real-time. The flood modeling team analyzed Charlottesville’s storm water management system by providing a ranking of storm inlet structures that would most be most likely to flood using geographic information system (GIS) data. The sensor team created a device that will allow the city to monitor flooding levels in inlet structures in real time to determine what flooding relief strategies will be needed. The City of Charlottesville, now possessing a peak flow analysis of inlet structures and a flood monitoring sensor, has the capability to find problem areas throughout the city quickly and create new, appropriately-designed storm water control measures that can prevent flooding. The STS section, tightly coupled, will focus on how investing in green, sustainable infrastructure, such as the solutions the capstone team is building for Charlottesville, can marginalize the most socially and economically vulnerable of long-term residents in a neighborhood. An Actor-Network Theory (Latour, 1990) framework of green infrastructure’s complex socio-technical environment will be analyzed to understand what factors can help prevent the marginalization of low-income residents.

URBANIZATION AND CLIMATE CHANGE CAUSING A NEED FOR GREEN INFRASTRUCTURE

Over half of the world's population now lives in cities and the United Nations projects that 66% of the population will live in cities by 2050 (2014). While urbanization, the migration of people from rural areas to urban and suburban areas, has many benefits, it does not come without a bevy of problems. One such problem is that stormwater runoff increases dramatically as natural pervious surfaces, which allow water to percolate to the ground underneath, are replaced by impervious surfaces such as buildings, roads, and parking lots. Uncontrolled stormwater runoff can lead to flooding, soil erosion, widened stream channels, and destroyed local ecosystems (Department of Energy & Environment, 2019). Flooding has resulted in over \$16 billion in property damage over the past decade in the United States which makes it the biggest source of economic loss out of all natural hazards (Li & Landry, 2018, p. 175). The stormwater management and flooding problem is destined to only get worse from rising sea levels, more intense storms, and higher humidity level due to climate change (U.S. EPA, 2015, p. 1). Cities and towns are starting to invest in new, sustainable storm water management systems that will be able to protect neighborhoods from heightened levels of stormwater runoff due to urbanization and climate change.

Storm water management systems have become more important for cities to develop as impervious infrastructures replaces existing natural pervious lands. Charlottesville, an old historic city created in 1762 (Jordan, 2015), has had to retroactively build a revised storm water management system underneath the city's existing urban and suburban infrastructure due to new stringent stormwater regulation acts since the passing of the Clean Water Act in 1972 which

emphasized the importance of a well-designed stormwater system to offset the effects of land development on the local hydrology (Franzetti, 2016).

Across the world, urbanization has had lasting impacts on local hydrological systems. The Desert Water Harvesting Initiative (2013) explains how replacing natural surfaces with impervious surfaces such as buildings, roads, and parking lots can cause multiple problems:

Natural land cover generally acts as a sponge, with well-vegetated soils and wetlands absorbing the majority of rainfall and snowmelt that falls on them and slowly releasing the small amount of water that is not absorbed. As that natural land cover is paved over with impermeable surfaces, rain and snow can no longer soak into the ground and instead accumulates as runoff. This urban runoff flows in much higher volumes and with greater velocity than it had pre-development. To mitigate flooding within urban areas, cities direct this runoff to a storm sewer system or along city streets, where the runoff gathers volume and speed. When the runoff reaches the receiving water body, it can cause extensive damage such as bankside erosion, channel scour and widening, and vegetation damage or removal (p. 1).

Figure 1 below helps show how runoff can increase fivefold when natural land is turned into urban landscape. Cities like Charlottesville have developed intricate storm water management systems in order to mitigate the effects of increase

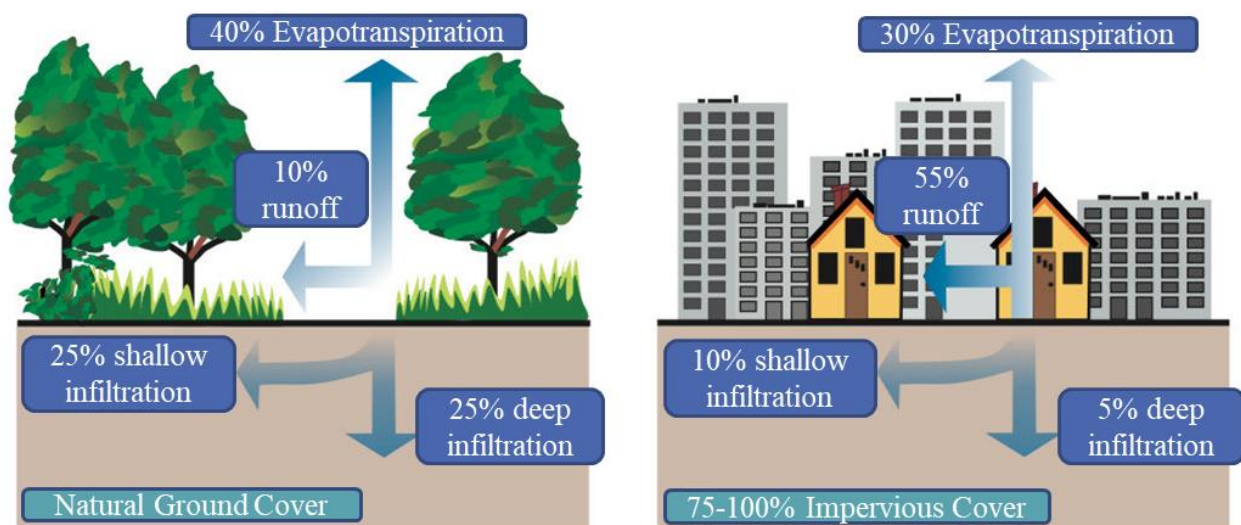


Figure 1: Relationship between impervious cover and surface runoff: Impervious cover in a watershed results in increased surface runoff (Finley, 2019).

d storm water runoff; however, many of these systems are outdated due to new stricter regulations and the increasing effects of climate change

Many state and local governments have started to create tougher regulations in regards to the allowed rates of volume and flow of storm water for newly developed land. For instance, Pennsylvania's "Stormwater Management Act," passed in 1978, was enforced in order to fix the inadequate management of stormwater runoff resulting from land development (Pennsylvania Department of Environmental Resources, 1978). The Act ruled that developers would have to "assure that the maximum rate of storm water runoff is no greater after development than prior to development activities" (p. 7). The Act had successfully been able to protect nearby land owners by reducing maximum flow rates, but it did not help reduce the total volume of runoff. Thus, 25 years later, the state of Pennsylvania revised their regulations to also include storm water volume considerations in order to better mimic the natural hydrological cycle of developed areas (Welty & Traver, 2003). Tougher stormwater regulations, like those passed in Pennsylvania, are causing many stormwater management systems built in prior decades to become outdated including Charlottesville's stormwater management system. Civil engineers in cities across the country have had to come up with innovative solutions to return developed lands back to a natural hydrological cycle to prevent flooding, soil erosion, and vegetation damage, which has often led to creating green infrastructure to replace outdated systems.

On top of outdated stormwater systems due to new regulations, climate change exacerbates the issues caused by stormwater runoff due to increases in temperature, rising sea levels, higher humidity levels, and more intense storms. The average global temperature has increased by 0.74° C since pre-industrial times which has caused sea levels to rise by 8 inches in the past 100 years from both the thermal expansion of the oceans and the melting of glaciers and

snowcaps (EPA, 2017). Rising global temperatures have also contributed to higher humidity levels that NASA reported can cause “increasingly intense cycles of droughts and floods as more of a region’s precipitation falls in a single large storm rather than a series of small ones” (2005,

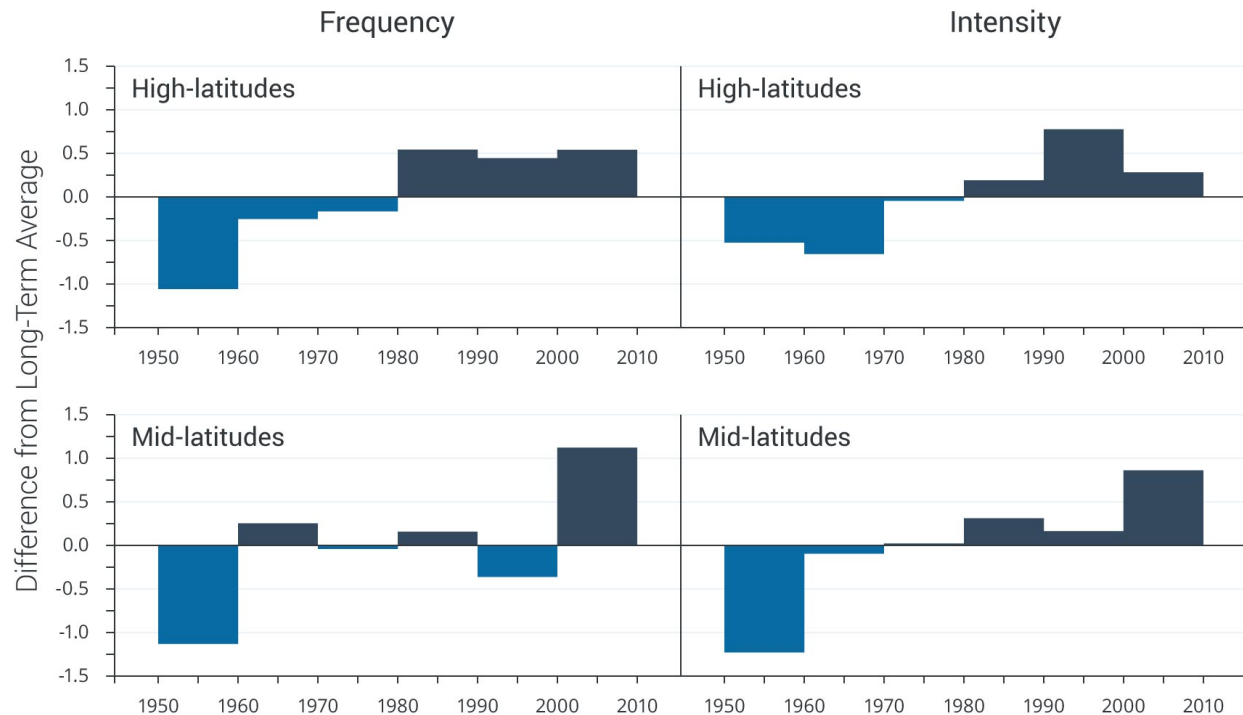


Figure 2: Variation of winter storm frequency and intensity: Differences in long-term averages for high latitudes and mid-latitudes in the Northern Hemisphere, Adapted by Finley from National Climate Assessment, 2014)

p. 1). The Northern Hemisphere is already facing more intense storms more frequently over the past century as can be seen in Figure 2 below.

Increasingly intense storms and floods means cities need to start preparing now to prevent catastrophic disaster in the future, causing many cities to come up with comprehensive plans to combat climate change. Boston, in October 2018, unveiled their “Resilient Boston Harbor” plan that transforms Boston’s waterfront by using sustainable infrastructure to protect the city from future flooding events (City of Boston, 2018). The City of Boston, particularly vulnerable to climate change induced floods, plans on using a vast combination of elevated

roadways, strengthened seawalls, protective waterfront parks, elevated harborwalks, green transportation, and other sustainable infrastructure strategies to protect Boston's neighborhoods and citizens (City of Boston, 2020). Similarly, Miami has devoted \$400 million to make the city resilient to rising sea levels by investing in better stormwater infrastructure, making new recreational parks, creating new regulations favoring sustainable buildings and land use, and elevating roadways (City of Miami, 2020). Many cities are finally accepting the flooding effects of climate change and are starting to create wide-ranging mitigation and adaptation plans revolving around superior green infrastructure to protect their own neighborhoods.

Together, urbanization and climate change are causing major flooding issues across cities around the world that already have outdated water drainage systems designed for a non-climate changing world. As flooding becomes more and more frequent, cities are starting to invest in new green, sustainable stormwater management systems to prevent widespread property and ecological damage. The following STS research examines what green gentrification is, why it happens, and ultimately find strategies that can prevent green gentrification while looking at different case studies throughout multiple cities.

SUSTAINABLE INFRASTRUCTURE CAUSES GREEN GENTRIFICATION

Two environmental justice experts, Hamil Pearsall and Isabelle Anguelovski (2016), claim that investing in new sustainable infrastructure has become almost apolitical since sustainable infrastructure has the "tripartite goal of economic growth, environmental quality, and social justice" (p. 1); however, when put into reality, these plans often marginalize the most vulnerable of long-term residents in the neighborhoods where new sustainability efforts are put into place. Many researchers and environmental justice activists have criticized this marginalizing effect of green and sustainable infrastructure and have coined this effect as

environmental or green gentrification. According to Kenneth Gould and Tommy Lewis, co-authors of “Green Gentrification: Urban Sustainability and the Struggle for Environmental Justice”, green gentrification is “the process... started by greening initiatives that create or restore environmental amenities [that] draw in wealthier groups of residents and push out lower-income residents, thus creating gentrification” (2016, p. 23). Typically, new sustainable development plans are made in conjunction with commercial developers and local officials to revitalize a community that has lacked environmental amenities such as the amenities pictured in Figure 3 below.

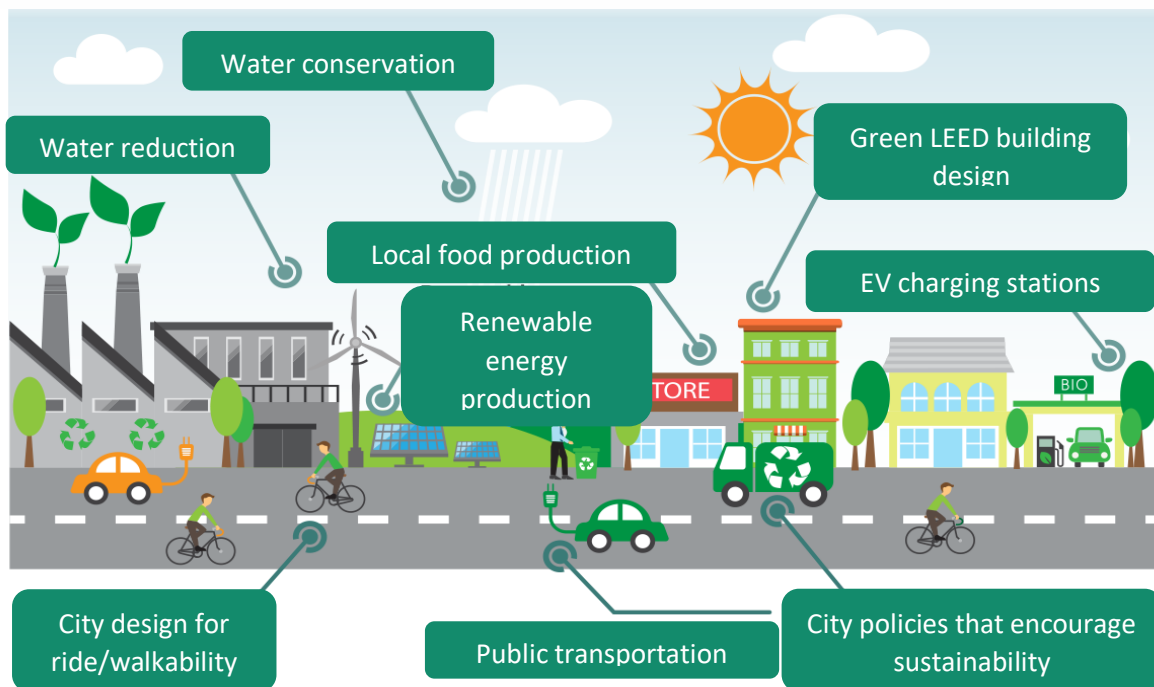


Figure 3: Green Cities: Graphic of common environmental amenities that cause environmental gentrification (Environment Ministry, 2018)

While greening initiatives have been successful in producing environmental and economic sustainability, they have not promoted social sustainability. Gould and Lewis (2016) explain how new environmental amenities marginalize long-term residents:

Existing and potential environmental amenities price out the current group of residents and draw in a wealthier group. The displaced become a new form of “environmental

refugee” who are forced to flee from enhanced environmental improvements which increase quality of life and property values simultaneously. In many instances, such green-led redevelopment is intentional, as investors and public officials create new or renewed green spaces as a means to raise property values and tax revenues (p. 24).

Even though sustainable development often promises to promote social equity, it often does the opposite causing low-income and minority residents to move to other neighborhoods with worse environmental hazards, further perpetuating the cycle of inequality.

Galia Shokry, James Connolly, and Isabelle Anguelovski, a team of urban geographers at Autonomous University of Barcelona, conducted a study on Philadelphia’s recent climate resiliency plans to understand whether or not green infrastructure causes gentrification. Shokry et al. (2019) explain that Philadelphia, for its *Greenworks* and *Green City, Clear Waters* sustainability plans, started in 2009 and 2011 respectively, “has gained nationwide status as a model for wide-scale urban green stormwater infrastructure and seems to be successfully layering a new green and resilient identity over one of the most racially and economically segregated cities in the US” (p. 4). Shokry et al. found that new green resilient infrastructure over time was significantly correlated with gentrification in Philadelphia’s neighborhoods from 2000 to 2016 which suggests that green infrastructure is not equally beneficial to all parties (p. 10). While green roofs, rain gardens, wetlands, tree trenches, and other green resilient infrastructure successfully provide climate resiliency, neighborhood aesthetics, mitigation of air pollution, and improved mental wellbeing for residents, green infrastructure frequently ends up pushing out the residents that the infrastructure was intended for.

Some people argue that gentrification is beneficial to society because it brings a much-needed economic stimulus to less affluent neighborhoods through rapid redevelopment and increase in local funding, investment, and spending (Chong, 2017). J. K. Brueckner and Stuart

Rosenthal, two economics professors at University of California, Irvine and Syracuse University respectively, almost see gentrification as inevitable because “eventual redevelopment of aging dwellings in the center [of cities] creates a young downtown housing stock attracts high-income households, leading to gentrification” (2009, p. 29). While redevelopment is necessary to maintain certain living standards and attract residents, this viewpoint fails to recognize two main problems. First, gentrification can cause many problems. Low-income minority residents can be displaced, leaving the neighborhood void of a low-middle income labor, especially those that are of utter importance to neighborhoods such as police and teachers. Increasing rents can cause local businesses to move or go bankrupt. New upscale condominiums and high-rises can segregate socioeconomic classes and minorities even more (Chong, 2017). Second, the viewpoint does not acknowledge that it is possible to mitigate the displacement of previous low-income residents while still being able to revitalize a low-income neighborhood. While there are many benefits to redeveloping low-income communities through new green infrastructure, it is of great importance to understand exactly why green gentrification occurs to figure out what can be done to prevent green gentrification.

UNDERSTANDING WHY GREEN GENTRIFICATION OCCURS

With increasing knowledge and exposure of the effects of environmental gentrification, environmental justice advocates, residents, and community members have started to oppose greening initiatives. In order to successfully create greening initiatives that promote environmental, economic, and social sustainability, an Actor-Network theory (ANT), originally developed by Bruno Latour (1990), that involves all stakeholders must be considered as seen in Figure 4 on page 11 (Finley, 2019). Similar to Jolivet and Heiskamen’s ANT assessment of developing wind farms, Actor-Network theory allows one to see sustainability initiatives as a

hybrid engineering problem “by shedding a light on the complex-technical-natural-political environment that must be built, and in which it needs to be embedded in order to work” (Jolivet & Heiskamen, 2010).

Figure 4 on the next page shows that, traditionally, only public officials, developers, and investors are involved in the designing of green initiatives which leaves several stakeholders such as the residents, environmental justice activists, and community members out of the planning. Leaving these stakeholders out of the participation planning process often causes long-term residents to be forced out of the area due to many of the designs being focused around the normal influential actor’s main motives. Since the main motives for public officials, the local government, developers and investors are higher tax revenue, improved environmental quality, economic growth, and property appreciation, the socio-economic status of current residents is often neglected. As property values and taxes rise due to new green amenities, long-term residents that are often low-income and minority citizens are forced to move to other neighborhoods that are less expensive and more deteriorated; thus, the green amenities often make social inequality worse which is the opposite of what is promoted (Anguelovski et al., 2017).

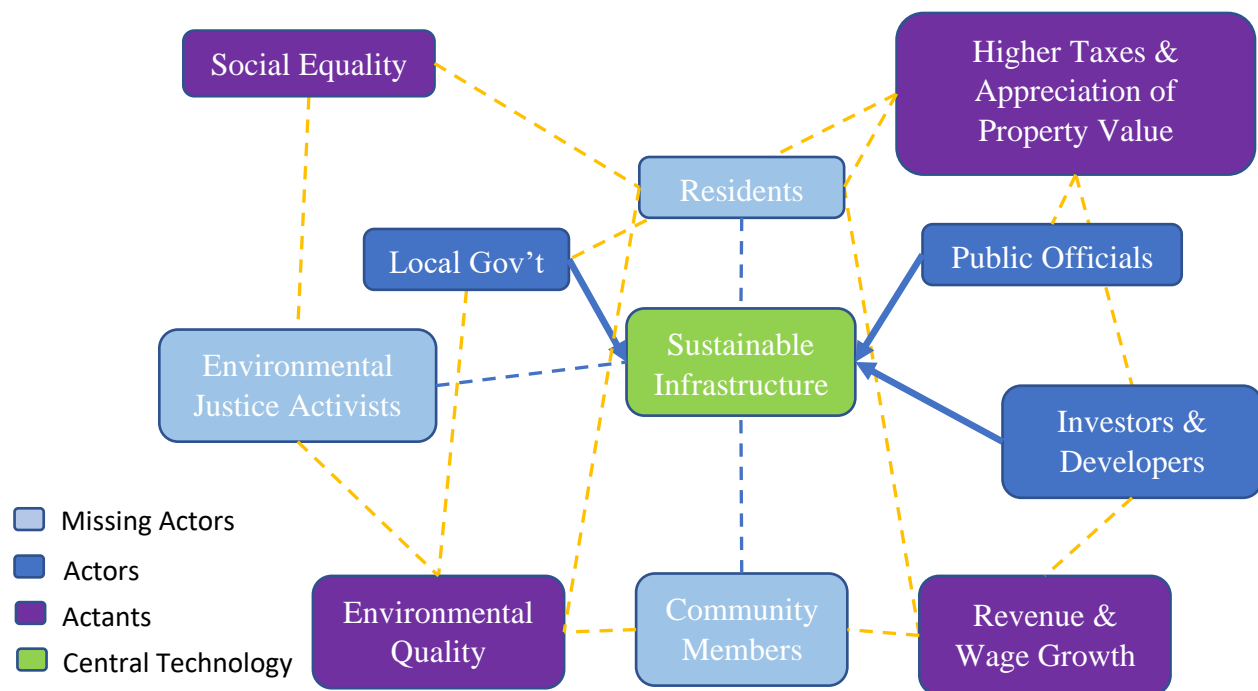


Figure 4: A depiction of the ANT framework for green initiatives: For initiatives to be successful, all stakeholders must be involved and not just the top three powerful stakeholders in the diagram (Finley, 2019).

COMMUNITY-WIDE PLANNING AND AFFORDABLE HOUSING ARE NECESSARY

For green amenities to provide economic growth, environmental quality, and social equality, stakeholders whose motives are aligned with social equality of local citizens must be involved in the participation planning process such as neighborhood residents, environmental justice activists, and local philanthropies. Collective neighborhood involvement in the planning process of green initiatives has shown some success in preventing environmental gentrification by community members, residents, and environmental activists through multiple strategies such as community involvement, protesting, job training and development, and leveraging environmental regulations; however, as Pearsall and Anguelovski, two leading experts in environmental gentrification, note, more research needs to be done on the effects of green initiatives on social equality and how green initiatives can provide more socially just outcomes

(2016, p. 4). Also, for community planning to be effective, the downside and upside effects of sustainable infrastructure needs to become common knowledge to low-income and minority communities and not just to research experts (Hardy, Milligan & Heynen, 2017). Widespread knowledge of gentrification will make sure that the consequences of redevelopment and green infrastructure are well understood and that preventing gentrification becomes a priority during planning sessions.

Many tactics that can be used to mitigate green gentrification are the same as the tactics used to mitigate regular gentrification because the only difference between the two is the type of infrastructure that causes property values to rise. No matter where gentrification is expected to occur, some form of affordable housing must be considered in order to retain low to middle-income residents and their occupations. Affordable housing has become more necessary over the past few decades as shares of incomes spent on housing has risen sharply especially for low-income households. According to the Joint Center for Housing Studies of Harvard University, the cost-burdened share of renters (households that spent more than 30% of income on housing) increased from 23.8 percent to 47.5 percent from the 1960s to 2016 (2018, p. 5). On top of overall rising rent costs, new developments for housing are typically aimed for high income households as they provide a more stable and profitable cashflow to developers. As Levy, Comey, and Padilla, three principal researchers at the Urban Institute, suggest, some combination of permanent affordable housing, rent price controls, and asset building must be a part of plans to build green infrastructure to allow low-income residents to stay (Levy, Comey, & Padilla, 2007).

Across all affordable housing plans community engagement is essential in order to ensure proper usage, upkeep, and maintenance over time. Levy et al. explain that depending on the stage of redevelopment or green gentrification and land availability and cost in neighborhoods,

strategies can shift from retaining current low-income housing stock and producing new affordable housing stock to creating mixed-income housing and inclusionary zoning regulations (p. 77). For example, Oak Park in Sacramento decided to use vacant property redevelopment to produce new affordable housing since the land was still cheap during early stages of revitalization, whereas Uptown in Chicago uses voluntary inclusionary zoning to provide benefits to developers that provide affordable housing such as waving permit fees and paid assistance in improvement projects (p. 25, 70).

Besides increased community engagement and affordable housing, other strategies can be employed to not only prevent green gentrification but also to promote social equality. These strategies include leadership development, job training and creation, existing local business investment, and resident wealth creation. In Cully, Oregon, a nonprofit organization called Verde has successfully implemented multiple programs to increase civic engagement and provide jobs for residents in a rapidly gentrifying neighborhood. The Lideres Verdes Leadership program is an eleven-month program that teaches residents how to represent their community in advocacy testimonials and to organize the community around important neighborhood matters. Past graduates have been able to by successfully attract municipal investment to implement new safe pedestrian and cycling infrastructure in Cully which has had a major impact on the community especially for children going to school (Wilson, 2019). Also, Verde offers job specific training, English classes, financial planning, and professional certifications to residents in the program. Thanks to Verde's efforts to benefit the existing community, Cully has seen very little displacement to date. Other wealth and asset building tactics can be used such as the IDA program in Reynoldstown, Georgia. The IDA program provides homeownership and budget counseling classes to low-income households as well as matching financial support to save up in

purchasing a home (Levy, Comey, & Padilla, 2007, p. 28). Preventing existing local small businesses from being displaced is also very important as many of them employ lower-middle income residents. Similar tactics for affordable housing can be used such as affordable workspaces and regulatory zoning to help businesses cope with rapidly rising rents (Ferm, 2016). Communities and politicians can decide to use a variety of approaches to limit displacement of residents and businesses in their depending upon their current stage of gentrification and existing local geography or development.

While communities and politicians have a myriad of options to combat gentrification with, it is certain that there is not one golden solution that works perfectly. Mitigating the displacement of low-income residents takes a wholistic approach that combines multiple strategies depending on the situation. Figure 5 on the next page below shows a framework solution on how cities can prevent gentrification through five main strategies. First, all stakeholders must be involved, engaged, and committed to new projects that benefit the neighborhood. This involvement will help ensure that the green infrastructure is equitable for all and not just high-income residents will be moving in. Second, all the stakeholders must be aware of the benefits and consequences of green infrastructure. Green gentrification should become common knowledge so that the most vulnerable know how it could affect them. Third, new green infrastructure projects should include plans for affordable housing. Providing affordable housing through rent controls, zoning, retaining existing or producing new affordable housing will ensure that low-middle income households, that are often vital to neighborhood's wellbeing, are able to stay. Fourth, local cities should partner up with local philanthropies to create programs that provide residents assistance with job training, unemployment, wealth building and financial planning. Fifth, cities and communities should be prepared to protect small business

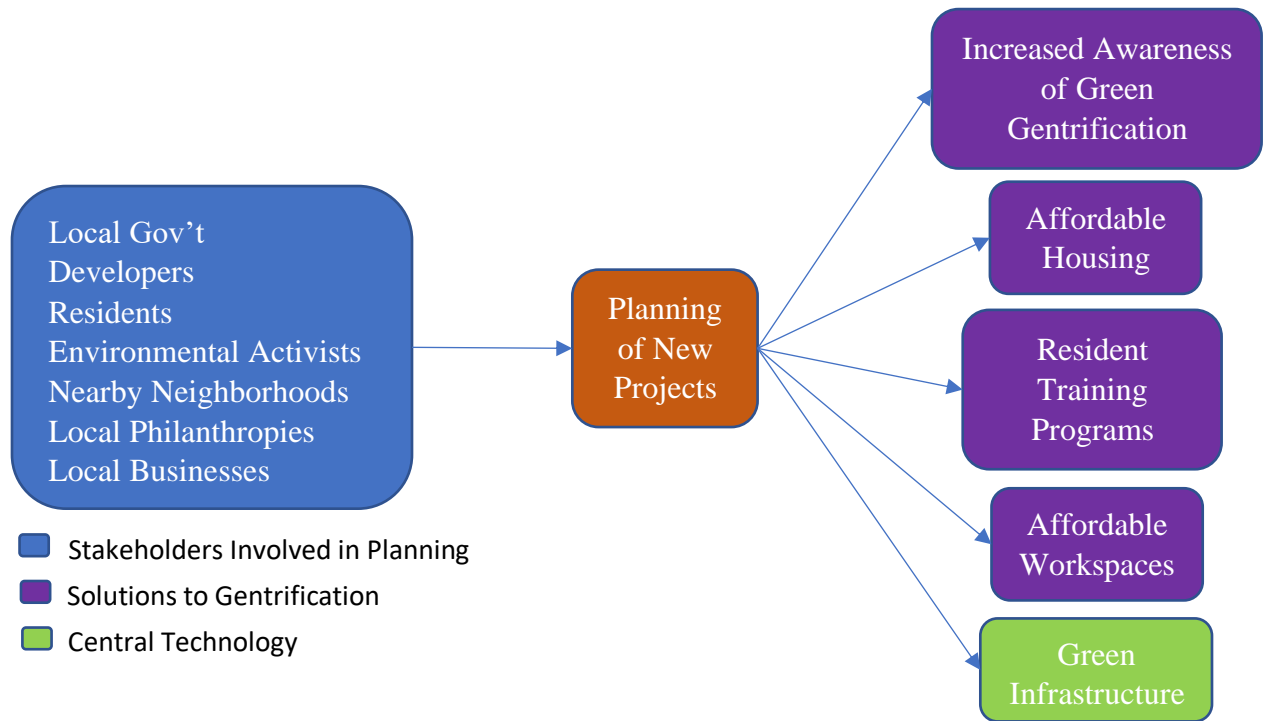


Figure 5: An updated planning model for green infrastructure: For green initiatives to be successful socially, all stakeholders must be involved in planning as well as all four solutions on the right should be considered (Finley, 2019).

from higher rents by providing affordable workspaces so that the neighborhood's culture and identity can stay intact. These five tactics are generalized and do not provide an exact rulebook on how to prevent the displacement of lower income residents. Also, the recommended solutions do not encompass all possible strategies to mitigate gentrification. Each neighborhood that is experiencing or that will experience gentrification should use different strategies according to what is appropriate for that specific neighborhood. The five strategies suggested should be used as a framework to understand what aspects of new green infrastructure projects should be included to ensure the project's added value to the neighborhood is equally distributed throughout the neighborhood. More research should also be done to understand what neighborhoods are prime for green infrastructure, what strategies are most effective in preventing displacement, and what groups of residents are most likely displaced (Anguelovski et al., 2019).

Further research in these areas will allow policymakers to make more efficacious and targeted plans for green infrastructure. As the world tries to adapt and mitigate urbanization's and climate change's effects on neighborhoods through green infrastructure, it is imperative that we, as a society, understand how we can use green infrastructure to not only prevent further social inequality but to promote social equality, economic growth, and climate resiliency.

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