

**Analysis of the Sociotechnical Effects of Urban Greening in Washington, D.C.**

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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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## **Introduction to Urban Greening**

As global climate change damages the environment, the world is shifting toward the use of sustainable and green technology, one example being stormwater green infrastructure (GI). Stormwater GI is a more sustainable and natural way to control stormwater, and, as climate change worsens, the demand for GI increases. Consequentially, as more GI is established in communities, it also creates disparity. Urban greening benefits the environment, but it negatively affects the community in the marginalization of different groups as well, leading to green gentrification. This phenomenon is important to consider in Washington, D.C. as Mayor Muriel Bowser set a sustainability plan to make the city “greener and healthier” (Benjamin, H. 2021). Washington, D.C. is experiencing rapid gentrification, partially due to urban greening (Anguelovski et al., 2021). As more GI is incorporated into D.C., it is important to consider all of the effects that the green technology will have on the society, not just the benefits. The societal effects of urban greening present themselves as a wicked problem, for there is no apparent solution to the negative impacts that they cause. Additionally, the GI acts as a technological fix, for it is helping solve climate change problems, but it is not the ultimate fix. The use of the wicked problem and technological fix frameworks will show the effects of the urban greening on the society and coping strategies to overcome the negative impacts. While analyzing urban greening and developing coping strategies for the negative impacts, the following question will be answered: how does the presence of green technology affect the society of Washington, D.C.?

## **Research Question and Methods**

Documentary research is the main method to study the effects of urban greening in Washington, D.C. This method guides the research into different categories including background, evidence, arguments, and methods. With this research method, the sources are

easily organized and retrieved based on the need in the paper. Alternative methods of research include discourse analysis and historical case studies. Discourse analysis provides sources that are nontraditional, for example a relevant tweet. The historical case studies method provides sources that set the historical context of Washington, D.C. and gentrification. Some keywords used to guide the research include: green gentrification, urban greening, technological fix, wicked problem, and Washington, D.C. The sources range in a variety of including academic papers, new articles, and Washington, D.C. city information sites. The majority of the data was found through the D.C. government website as it needed to be specific to the city. The sources were organized based on relevancy to each section of writing. Three main groups categorize the relevant information: urban greening in D.C. as a whole, urban greening specifically in Navy Yard, and urban greening specifically in Anacostia.

### **Overview of Urban Greening**

Human mistreatment of the environment through rapid development and burning of fossil fuels has led to the current climate crisis. One of the largest contributors to climate change is the burning of fossil fuels which release carbon dioxide into the atmosphere. As carbon dioxide, and other fossil fuels, inhabit the atmosphere, they absorb heat that would otherwise be released. The resulting heat absorption leads to the warming of the planet. According to the National Academy of Sciences, the temperature of the Earth's surface has been raised approximately one degree Celsius from 1900 to 2020 (National Research Council 2020). The global temperature increase has resulted in various impacts some of which include increases in frequency and intensity of storms and droughts (US EPA, 2014). The effects of these storms and droughts lead to additional burdens on urban areas. With increasing frequency and intensity of storms, the current stormwater management facilities are overwhelmed by the volume of runoff. Additionally, with

a lack of green areas to help cool the land, cities are becoming warmer with the intense heat waves in the phenomena called urban heat island effect (US EPA, 2014). One option that aids in stormwater management as well as urban heat island effect is urban greening.

Urban greening is the act of adding green areas, full of vegetation, throughout cities. These green areas not only provide shade, but provide air cooling through the process of evapotranspiration as well. Through evapotranspiration, vegetation takes in energy from the sun in order to release water vapor into the atmosphere (Bowler et al., 2010). This process leads to cooling as the heat is transformed instead of being retained in an impermeable surface like asphalt (Bowler et al., 2010). Urban greening comes in different forms ranging from simply planting trees in the city to incorporating green infrastructure (GI). Green infrastructure mimics natural processes of filtering water and managing runoff through manmade green areas for example, vegetated roofs, rain gardens, or permeable pavement. GI is a helpful alternative to pipes systems in urban areas as it adds natural and green elements to a city as well as providing water benefits for example, filtering out pollutants or handling loads of stormwater in a natural way. Though urban greening provides many benefits to areas, it can have negative impacts too.

As urban areas undergo greening, they also face the threat of green or environmental gentrification. Green gentrification is the phenomena in which the addition of green areas raises the property value and unintentionally pushes out the lower socioeconomic people that inhabit the area (Kogan, 2018). The idea of environmental gentrification was introduced in the early 2000's in an economic study about air quality. The study shows that the cost of living increased in an area as the air quality was improved (Sieg et al., 2004). This phenomenon has grown in relevancy in recent years as urban greening is becoming more common. This trend tends to marginalize some people groups resulting in wealthier people moving in and less wealthy people

having to leave. Many urban areas are striving toward greener cities, including the nation's capital, Washington, D.C. The nation's capital is experiencing rapid gentrification and it is important to reflect on the potential causes, one of which being green gentrification (Anguelovski et al., 2021). D.C. Mayor Muriel Bowser has rolled out the Sustainable D.C. 2.0 Plan that aims to make the city "healthier and greener" (Benjamin, 2021). In order to lessen future bad effects of urban greening, the technology must be analyzed to come up with possible coping strategies.

### **Wicked Problem Framework**

One framework that is helpful in analyzing urban greening is the wicked problem framework. A wicked problem is defined as a problem that does not have definitive definition or solution creating a complex issue that affects many people. The concept of a wicked problem was introduced by Horst Rittel and Melvin Webber, professors at the University of California Berkeley. In their paper, "Dilemmas in a General Theory of Planning", Rittel and Webber discuss different qualifications that make a problem wicked and how they are related to planning. Some of the important qualifications that a problem needs to meet in order to be considered a wicked problem include: the problem has no definitive definition or solution, the problem is unique and cannot be solved by trial and error, the problem is a symptom of another problem, and the problem can be explained in different ways leading to different solutions (Horst et al., 1973). Though Rittel and Webber explore what makes a wicked problem wicked, they do not address the coping strategies that accompany wicked problems, and, in this case, wicked problems in planning. The concept of a wicked problem and coping strategies to overcome the effects are discussed in the article, Sustainable Engineering Science for Resolving Wicked Problems, written by Thomas Seager and Arnim Wiek, Arizona State University Professors, and Evan Selinger, a professor at Rochester

Institute of Technology. This article is similar to dilemmas in a General Theory of Planning in that it shows what a wicked problem is and how sustainability specifically fits into the framework. The article additionally discusses how a wicked problem should not or cannot be solved, but it can be monitored and controlled (Seager et al., 2021). This idea is a new and important aspect to wicked problems that is not touched on as much by Rittel and Webber. With the unsolvable nature of wicked problems, coping strategies or resiliency strategies are good ways to approach the problems.

### **Technological Fix Framework**

The second framework for the analysis of urban greening is the technological fix framework. Technological fix framework is defined as the use of technology to solve a problem facing a society. A technological fix does not focus on changing the society to solve the problem; it focuses on using the technology. Alvin Weinberg, a nuclear physicist, coined the term technological fix in his report *Beyond the Technological Fix*. The report discusses how technological fixes are merely temporary remedies that help solve a problem until another problem appears. He refers to the fixes as “band-aids” as they cover the surface issue, but do not dig deep to find the deeper causes (Weinburg, 1978). Similar to Weinberg, Jeff Douthwaite, a former professor and politician, wrote *Commentary: The Terrible Temptation of the Technological Fix* which addresses the idea of a Technological Fix in a society. Douthwaite writes that technological fixes are necessary in a society and provide short term benefits (Douthwaite, 1983). Both authors stress that technological fixes are temporary yet necessary in our society, and that it is not possible to get to the root of every large problem immediately.

## **Results and Discussion**

Urban greening brings both positive and negative effects to the communities where it is implemented. On the positive end, the greening benefits the communities through counteracting urban temperature rises and stormwater related flooding. On the negative end, the addition of green spaces and green technology leads to green gentrification and the disproportionate displacement of minority groups. Through viewing this problem as unsolvable, coping strategies to counter the poor affects are the best way to work toward a better community. All people deserve to reap the benefits from urban greening.

### **Green Infrastructure as a Technological Fix**

Green technology acts as a technological fix in urban areas as it is temporarily solving issues caused by past human actions and climate change. Climate change is directly affecting the health of cities regarding stormwater management and temperature. Rainfall events are projected to increase in intensity as well as how often they occur. In Washington, D.C., the precipitation depth for a storm that has a hundredth of a percent chance of occurring is predicted to increase from 8 inches to 13.5 inches by the 2080s (*Climate Ready DC*). Additionally, climate change increases the intensity and amount of extreme heat events. Washington, D.C., for example, is predicted to see an increase from 11 heat emergency days to 40-75 by the 2080s (*Climate Ready DC*). The predicted heat outlook will create unhealthy living environments in cities as intense heat events lead to increased heat related illnesses like heat exhaustion or heat stroke (US EPA, 2014). Additionally, the predicted storm outlook will overwork the current stormwater systems as they were designed to handle less intense storms. This system will lead to flooding throughout urban areas. The incorporation of green technology in a city alleviates the strains on the current systems through plants and sustainable designs. When green technology is incorporated into a

society, it does not change how the society operates. The role of the technology is to fix the immediate problem for the near future, but the technology does not fix the root of the problem. The conditions will continue to worsen unless the human actions that contribute to climate change are addressed, making the technology a temporary or band-aid fix. It is important to view the green technology in this way, so future effects can be considered in planning.

Green infrastructure is a common technological fix that aids in stormwater management as well as urban heat island effects. Green infrastructure is a more sustainable and natural way of controlling stormwater as it uses greenery and mimics nature in the design. Plants aid in counteracting the urban heat island effect as larger plants, like trees, provide shade, and all plants cool the air through evapotranspiration (Bowler et al., 2010). In Washington, D.C. specifically, adding green infrastructure and more green spaces not only helps the stormwater systems, but helps the health of the surrounding waterways as well. D.C. has a combined sewer and stormwater system with a capacity. When that capacity is reached, the water overflows into surrounding waterways contaminating the area with wastewater and pollutants. These overflows occur when there is an abundance of stormwater entering the sewer (DC Water). Green infrastructure eases the stress put on these systems by providing alternate spaces for the water to be stored avoiding the sewers. In addition to the technical benefits, greening aids in social benefits too. Green spaces, in urban areas, increase the mental health of people who have access to the spaces, for they create a low stress and natural environment (University of Leeds et al., 2015). Additionally, these spaces promote a healthier lifestyle as people can utilize them for exercise. Green spaces can also be used to bring a community together through events. While urban greening has many benefits, there are negative effects on the society as well.



Urban greening is meant to benefit the whole community, but instead brings negative impacts when it is incorporated into lower socioeconomic areas. These negative impacts often occur in three main steps. First, the green space or green infrastructure is added to a community. Secondly, the property value and cost of living in the area increases. Third, the current residents are displaced as they cannot afford the higher cost. This displacement disproportionately affects minority groups. A group of researchers from Yale studied the effects of stormwater green infrastructure on the displacement of minority groups in Washington, D.C. The study looked at different areas around D.C. where green infrastructure was installed and how the demographics changed. In the study, there were larger amounts of green infrastructure implemented in places with higher amounts of minority groups. The results show that in areas where green infrastructure was installed, the percentage of White residents increased, and the percentage of Black residents decreased. The decrease in Black residents was greater in areas where more green infrastructure was installed (Chan et al., 2021). This case study confirms that there is a connection between the displacement of minority groups and the installation of green infrastructure. This example shows that as more green infrastructure is installed into an area, more minority groups are displaced. This phenomenon, known as green gentrification, is the implementation of green technology that disproportionately displaces minority groups. The displaced people do not receive the benefits of the technology that was originally installed for them.

Green gentrification is not only seen with green infrastructure, but additionally with general green spaces like parks. Alyssa Kogan, a graduate student at Tufts University, studied green gentrification due to parks in Washington, D.C. Kogan's study used GIS to analyze the green spaces in the city and the demographics of the areas that have access to the spaces. Kogan

found that from 1990 to 2015, there were large decreases in Black residents in areas near parks. Additionally, she analyzed income in the areas near parks and found that it slowly increased from 1990 to 2010. From 2010 to 2015 the income passed the average income in D.C. by around 14%. Another important statistic showed that the surrounding neighborhoods, near parks, experience a bigger decrease in poverty compared to the rest of D.C. (Kogan, 2018). Kogan's research shows that, in D.C., there is a connection between the addition of green space and a decrease in the number of Black residents in an area. In all of the scenarios in the research, the number of Black residents was always decreasing, and the number of White residents was always increasing. In this example, the minority groups, in this case Black residents, did not reap the benefits from the green spaces being installed for them because they were displaced shortly after. Both examples show how the green space or infrastructure is added into a community in hopes of alleviating the technical strains as well as providing a positive space for everyone to utilize. The greening itself does not change how the society works, nor does it ultimately fix the root of the problem, in this case climate change. It does, however, open way to a new problem of green gentrification. The green gentrification in urban greening is important to recognize in order to avoid displacement of people groups in the future.

### **The Wicked Problem Nature of Urban Greening**

The wicked problem nature of urban greening is observable in Washington, D.C. Some areas of interest regarding urban greening and green gentrification are Navy Yard and Anacostia, two neighborhoods along the Anacostia River. Historically, these areas consisted mostly of Black residents, and the areas suffered from the polluted Anacostia River. The Anacostia River has undergone many changes throughout the past few centuries. In early America, much of the land surrounding the river was used for farming which led to sediments building up in the river.

Later, industrial pollutants began to enter the river as disposing waste into waterways was the common practice of the time. The waste dumping continued into the 1900s (Fenston et al., 2018). The Anacostia River was full of pollutants and sewage and faded away in the eyes of people in D.C. Today, Ward 8, the area to the east of the river, is dealing with the consequences of the centuries of poor treatment to the river. According to the American Community Survey 5-year estimates, much of the population consists of Black residents at 88%, and the median income for a household in the ward is \$35,245 which is significantly lower than the D.C. average of \$86,420 (U.S. Census Bureau, 2019). The poverty percentage is about double that of D.C. at 32.9% (U.S. Census Bureau, 2019). The area was neglected for centuries, leaving an area that falls below the average wards of D.C. in many categories. Many organizations are working toward restoring the Anacostia River and the surrounding areas that have experienced the neglect through building up the area and adding in beautiful parks and green spaces. This restoration effort comes at the cost of green gentrification, creating a wicked problem.

### **Sustainable D.C. Plan**

Washington D.C. has created a plan to improve the city's sustainability and health called, Sustainable D.C. The plan set goals for various categories some of which include, equity, climate, nature, and water. Regarding nature, D.C. plans to: plant 10,500 new trees every year to ultimately cover 40% of the city with tree cover, add more green spaces with native species and green infrastructure, and target areas that have been deprived of these spaces in the past. Regarding water, D.C. plans to restore the Anacostia River, install 4 million square feet of green roofs, and implement larger scale green infrastructure projects. While D.C. works toward these goals, they have also set equity goals to work toward a more equal community for all of the residents. The plan proposed the creation of an "Equity Impact Committee" and an "Equity

Impact Assessment Tool” to help analyze the equity in the other goals set forth and to focus on the underserved areas of the city (*Sustainable D.C. 2.0 Plan.*). D.C. has recognized the inequality of the city in this plan as they are targeting the areas that have been historically overlooked, but the problem of green gentrification is still present. How is displacement avoided in underserved areas when the new green spaces or green technology is installed, even when considering equity?

### **Navy Yard Redevelopment**

While Ward 8 lies on the east side of the Anacostia River, Navy Yard lies across the river on the west. Navy Yard was historically a large culprit of industrial pollution into the Anacostia River. Historically, the area had a high population of Black residents as many worked in the Navy Yards. The population steadily declined throughout the 1900s and into the 2000s, but there was always a high population of Black residents until around 2010. As of 2018, the percentage of Black residents had shrunk from around 95% in 2000 to 22%. Much of the infrastructure and housing in the Navy Yard was in poor condition throughout the 1900s with little redevelopment other than public housing. In the 1990s, redevelopment of the area began and, as a result, so did the green gentrification (Coldivar-Valencia, 2021). The area was rapidly redeveloped to create a prettier and more successful area bringing in wealthier residents and displacing the less wealthy who lived there. Part of the beautification process involved adding more green spaces and greenery to the area. Figure 1 shows an aerial image of the Navy Yard in 1999 on the left and in 2021 on the right.



Figure 1. Aerial Photos of Navy Yard, D.C. in 1999 and 2021 (Google Earth Pro, 1999), (Google Earth Pro, 2021)

The 1999 photo shows the Navy Yard in early redevelopment phases. In the earlier photo, there is little green space throughout the region. Much of the space is occupied by empty lots and unused warehouses. In the more recent photo, much of the space has been redeveloped into new apartments and green space. Some notable green space additions can be seen along the Anacostia River and the Canal Park in the upper lefthand corner of the 2021 photo. The Canal Park opened in 2012 providing a community space with green infrastructure. The area has bioretention facilities, rain gardens, and large cisterns underground to collect the water. Additionally, the collected water is treated to reduce pollutants on site (*Sites Certified*, 2013). This park is sustainable as it used the water collected as irrigation water and provided all of the positive benefits of green infrastructure, but it also added to the rising property value in creating a beautiful and sustainable public space for the community to utilize. The area surrounding the park has been redeveloped to include luxury apartment buildings that are unaffordable to many residents who previously lived in Navy Yard. One apartment building, the Insignia on M, is located near the Canal Park. The apartment building was opened in 2017 and consists of luxury amenities as well as green features. The apartment features a bioretention green infrastructure facility that collects stormwater through its plants. Additionally, there are planters throughout the

rooftop space and a dog walking rooftop greenspace. The starting price for a one-bedroom apartment is around \$2,500 a month (Insignia on M). This building is only one example of a luxury apartment complex in Navy Yard. However, most follow a similar pattern, starting around \$2,500 a month, and they have luxury amenities, plenty of green spaces, or sustainable amenities. This apartment complex is an example of how the addition of green spaces and green infrastructure affects the area in which they are placed. Here, the urban greening raised the property value leading to apartments that only wealthy people can afford. Due to the wicked nature of this problem, there is no solution that could solve everything. The best way to approach the problem is by recognizing it as a wicked problem.

### **Anacostia and The Bridge Park**

While Navy Yard lies west of the river, Anacostia lies to the east in Ward 8. In contrast to the now wealthy west side, Anacostia is in the least wealthy area. Anacostia has been neglected in terms of green infrastructure and green space in comparison to the Navy Yard redevelopment. In recent years, there has been a push to redevelop the Anacostia River and surrounding areas to fix centuries worth of pollution and neglect. One of the largest projects in the works is the 11<sup>th</sup> Street Bridge Park that will cross over the river and connect Navy Yard to Anacostia (Anguelovski et al., 2021). The bridge park is commonly compared to the New York City Highline in that it is an elevated area with parks, green spaces, artwork, community gathering spaces, and more. Though it is compared to the Highline in design aspects, the creators hope to differ from the Highline in terms of equity. The bridge park developers and creators have created an Equitable Development Plan (EDP) in hopes of avoiding the negative societal impacts like green gentrification.

The park developers recognize that the bridge park will majorly change the property value of the community. The EDP addresses community-driven planning, housing options, job options, and cultural recognition. The project team plans to prioritize the hiring of local residents in construction or park related jobs to meet employment needs in the area during and after the completion of the bridge. Some of these opportunities include supporting young, local artists in training and mentorships. The developers also plan to support the local small business that surround the area. The plan calls for the preservation and expansion of affordable housing in the area. This plan can be accomplished through use of Community Land Trusts in which the organization assists people in buying and keeping a house, and that house stays affordable for future homeowners. Additionally, the developers plan to advocate for more affordable housing options in surrounding areas. The project has community meetings that involve residents, community leaders, and experts in order to hear multiple perspectives and give the community a voice (Bernard et al., 2018). Scott Kratz, one of the directors of the project, coordinated over 200 community meetings to emphasize his interest in community input. Since the project start, community stakeholders have communicated that the project is to benefit the underserved communities on the east side of the Anacostia River (Beatley, 2018). Though the project seems to be taking equitable approaches to this redevelopment, there is still opposition. Some argue that the millions of dollars that are being put toward the bridge could instead be invested in small scale green infrastructure and community planned green space. Even with the EDP, residents still fear green gentrification and displacement. One resident of Anacostia said “I will be good enough to serve you slurpies and hotdogs at the river festival, but not good enough to live there” (Anguelovski et al., 2021). The effects of the Bridge Park will not be clear until a few years after

completion. The property value will inevitably raise in price when the redevelopment occurs, but the coping strategies can only help lessen the effects.

### **Coping Strategies for the Future of Urban Greening**

Though there are no solutions to wicked problems, coping strategies can be used to lessen the effects of the problems. An important step in coping with the wicked problem is initially recognizing that there is a problem. Nothing can aid the situation if there is no problem recognized. A large coping strategy in avoiding green gentrification is to listen to the community and what they want. In a community that has been underserved, adding a large, expensive structure that incorporates fancy green infrastructure is overwhelming and capable of bringing negative societal impacts no matter how well it is thought out. In many cases, the stormwater green infrastructure is necessary as a technological fix for climate change effects, but how the infrastructure is incorporated is not set in stone. Community input is vital in the implementation of green infrastructure. Smaller dispersed stormwater green infrastructure and parks serve the same purpose as a large structure while being a less overwhelming change to the community. After community input is recognized and incorporated, it is important for the developers to consider how the community will be affected by the changes. If a large green project is planned, then the developers must consider how the property value will change. In the lower income areas, there are many residents who rent instead of owning a home. These are the people who are most hurt when the green structures raise the property value. The developers must consider this and have a plan to avoid displacement. This plan may involve having enough affordable housing allotted to the current residents or having a program to help the renters buy property. Community Land Trusts are a helpful coping mechanism in this situation as they provide assistance for people to work toward owning a home and keeping the home (Bernard et al., 2018). It is vital



that these aspects are not ignored, for they will lead to displacement if residents cannot afford rent after the development is completed. Another possible coping strategy is the implementation of a universal income program. Through this program, residents would have a steady stream of income to be put toward living expenses when the value rises. A basic income pilot program was tested in Ward 8 during the beginning of the pandemic in 2020. In this program, 590 families received \$5,500 to cope with the closures and crises from the pandemic. The recipients were initially skeptical of the program as many of them have been underserved throughout their lives. The results showed that that the recipients felt more secure in being able to provide food for their families as well as experiencing better mental health. Additionally, the program was set up to build trust in the community as they have been overlooked and underserved. One of the partners in this program was the 11<sup>th</sup> Street Bridge Park. The director hoped this would rebuild trust in the community (Bliss, 2022). It is important to have trust between the community and the developers because they should work together throughout the entire project. The bridge park models many good practices regarding community input, housing options, and opportunities for residents. These practices help to counteract the poor effects of urban greening. Though the idea of green gentrification cannot be fully avoided in urban greening, the coping strategies make the effects less detrimental to the community. All community members deserve to have access to urban green space and green infrastructure without being displaced.

### **Limitations and Future Work**

This research in this paper was limited to online research through online sources and databases. Though these sources are helpful in understanding the big ideas surrounding green gentrification and urban greening, they are not as personal. An interview with someone affected by green gentrification or experiencing the fear of green gentrification provides a more personal

understanding and a community insight that may not be seen by reading sources online.

Additionally, the research is only based off online observations about the area of interest through Google Earth and Google Maps. This research is not the same as visiting the area and observing in person, but still provides helpful information.

In the future, the effects of the urban greening in Anacostia should be researched. The Bridge Park is opening the door to a more equitable design approach in the area, but the effects are still unclear as it is incomplete. Future research could involve looking into the effects of green gentrification from the Bridge Park and how the Equitable Practices affect displacement compared to a traditional design approach. Additionally, future research should look into how the equitable design approach is incorporated into other similar projects, in D.C. or elsewhere, if the Bridge Park is successful.

## **Conclusion**

Urban greening, through the incorporation of green infrastructure and green spaces, positively affects a community by warding off climate change affects like temperature rises in the city and flooding due to stormwater complications. Greening also provides community spaces that promote a healthier lifestyle and lead to better mental health. Along with these benefits, urban greening negatively affects a community as it leads to green gentrification, especially affecting people in underserved communities. Through incorporating green technology and green spaces as a technological fix, the property value in an area rises and people are displaced. This increase in property value is seen in Washington, D.C. through the redevelopment and greening of The Navy Yard in recent years and how it displaced many Black residents as they could no longer afford the area. The problem of green gentrification is a wicked

problem without one clear solution. In order to lessen the negative side effects, coping strategies that involve the community must be implemented.

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