HOPKINS | MN

The City of Hopkins: Advancing Park Equity and Accessibility

ESPM 4041W: Problem Solving for Environmental Change

University of Minnesota:
College of Food, Agricultural, and Natural Resource Sciences

Report 10 of 10

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Table of Contents

List of Figures

List of Tables

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Executive Summary

The City of Hopkins, Minnesota has the opportunity to adapt to and mitigate climate change impacts by implementing the recommendations presented in the findings of this report. University of Minnesota students collaborated with the city of Hopkins, urban planners, and the Minnesota Department of Natural Resources to create this report which offers the next steps which are tailored to the specifics of Hopkins. These next steps will be for the 2040 Comprehensive Plan that the City of Hopkins will be finalizing later this year.

This report is the result of that partnership and includes research, data collection methods, and final guidance for Hopkins to use. To complete this report, data collection was done using various data collection and analysis tools, as well as literature review.

Using scientific literature and available local data our recommendations are that Hopkins catalog the makeup of its urban canopy within its geographical boundaries, beginning with building out a comprehensive detailed report and database of the species makeup on each street, then expanding to parks and other lands. Then, we recommend that Hopkins prioritize underrepresented tree species that are adapted to future climate projections. Additionally, Hopkins could also plant or maintain existing populations of Oak, Little-leaf linden, and American hophornbeam. In cases where Maple, Aspen, Tarmac, or Elm trees are already planted, it would be beneficial to maintain and preserve those existing trees, instead of replacing them with new ones.

This work supports communities by preparing for issues that future generations will have to face. Adapting urban forests can not only help now through creating a better visual environment but can also reduce invasive species and create more habitats for native animals. Long term, these changes will prepare the community of Hopkins against the adverse effects of climate, such as increased temperatures and flood risks. These recommendations will create the groundwork for future generations in an ever changing climate.

Introduction

The world has been going through cycles of differing climates ranging from glacial advance and retreat to warmer mean global temperatures. However, in recent human history, there has been rapid warming of the earth due to human activity. A sharp spike in atmospheric carbon and subsequent warming of the globe can be attributed to the burning of fossil fuels and deforestation by humans (Dean, 2019; Denchak, 2018). Climate change has and will continue to have catastrophic real-world consequences for communities across the globe. Specifically, in the Midwest, temperatures are expected to increase between 4.5° and 9.5° Fahrenheit by 2085 and large rain events with greater than one inch of precipitation will become more frequent (Kunkel et al, 2013). Increased temperatures will allow for greater establishment of invasive species, pathogens, and pests alike within the region. Furthermore, warmer temperatures will contribute to an increase in the frequency and severity of disturbance regimes, including wildfires (Handler et al, 2014). Increased seasonal soil moisture and large precipitation events will increase the likelihood of flood events (Demaria et al, 2016). The urban heat island effect and albedo (reflection of incoming solar radiation back into the atmosphere) are other issues. Urban areas have more human-made structures compared to nearby rural areas and are likely to exacerbate climate issues due to a decrease in albedo, or an increase in the absorption of solar radiation (Akbari, 2008). Impervious road surfaces and buildings increase the frequency and severity of flood events (Hollis, 1975) by preventing infiltration. Hopkins urban forest is fragmented and generally has low biodiversity. This low diversity means these trees are less likely to be resilient in the face of more extreme future climate conditions (Hoffman & Sgrò, 2011). Fragmentation and being surrounded by developed areas prevents migration north to deal with rising temperatures (Iverson et al, 2004). Therefore, a more resilient urban forest can improve livable human habitat.

Communities, like Hopkins, will experience negative impacts of climate change ranging from potential flooding due to increased rainfall and the reduction or even loss of native species that are sensitive to changes. Adapting the urban forests can provide a lessening of the urban heat island effect, flood impact reductions, and increasing carbon storage and sequestration (Safford et al., 2020). Urban forests are an integral aspect of green infrastructure and are therefore a great place to start in the process of climate change adaptation. As a result of increased temperatures and atmospheric carbon, urban forests may become more productive for the foreseeable future and work to better mitigate climate change impacts

(Butler-Leopold et al, 2018). The effects of climate change can already be observed, so urban planning should adhere to future climate ("adaptation") rather than current or native conditions. The recommendations for Hopkins adaptation to climate change laid out in this report will propose steps to protect and mitigate the effects of climate change for subsequent generations and posterity.

As key stakeholders, citizens should have input in the process of adapting their communities to climate resilience. By connecting with the citizens of Hopkins and allowing them to provide input and voice concerns regarding the changes we propose, we can make more informed suggestions on how Hopkins should alter their urban forests. Through use of strategic outreach campaigns, diverse groups of Hopkins' residents can be engaged. Working alongside city staff, materials can be communicated to residents via existing and future outreach platforms.

Objectives

This comprehensive report will explain the methods and resources used to estimate the severity of climate change in regard to precipitation and temperature, map areas of interest that have the highest potential for flood and storm impacts, create recommendations on species, placement, and management to maintain forests. In addition, developing methods of outreach regarding public mitigation and comprehensive adaptation methods.

Hopkins Vision

As stated in the Natural Environment portion of the draft 2040 Comprehensive Plan, "Hopkins is focused on becoming an environmentally healthy and sustainable city, whose policies and investments focus on building and site efficiency, protecting and restoring natural resources, and improving the resiliency of the community" (City of Hopkins Advisory Committee, 2019).

Class Vision

Through collaboration with Hopkins city staff and officials, and Minnesota DNR Urban Forestry, the University of Minnesota's Environmental Science, Policy and Management fall 2020 capstone students seek to foster a resilient, equitable, and sustainable community. The projects aim to uphold the city's vision of cultivating their built, natural, social, and economic environments through education, management practices, and city ordinances.

Climate Change Adaptation and Urban Forest Report Vision

Provide an array of adaptation & mitigation plans and proposals for public educational outreach regarding Hopkin's urban forests to reduce flood and storm impacts while increasing social and environmental benefits in the present and for posterity.

Methods and Research

Site Description

Hopkins is a small community located in Hennepin County, Minnesota in the United States (44°55′50.77″N, 93°24′6.09″W). Hopkins is approximately four square miles in size and is surrounded by the larger, west suburban communities of Minnetonka (to the west), St. Louis Park (to the north and east), and Edina (to the south). As shown in the figure below, the City of Hopkins has an active community with 19 unique parks and nature areas. The city has also dedicated itself to serving the community and building an environment to last generations.

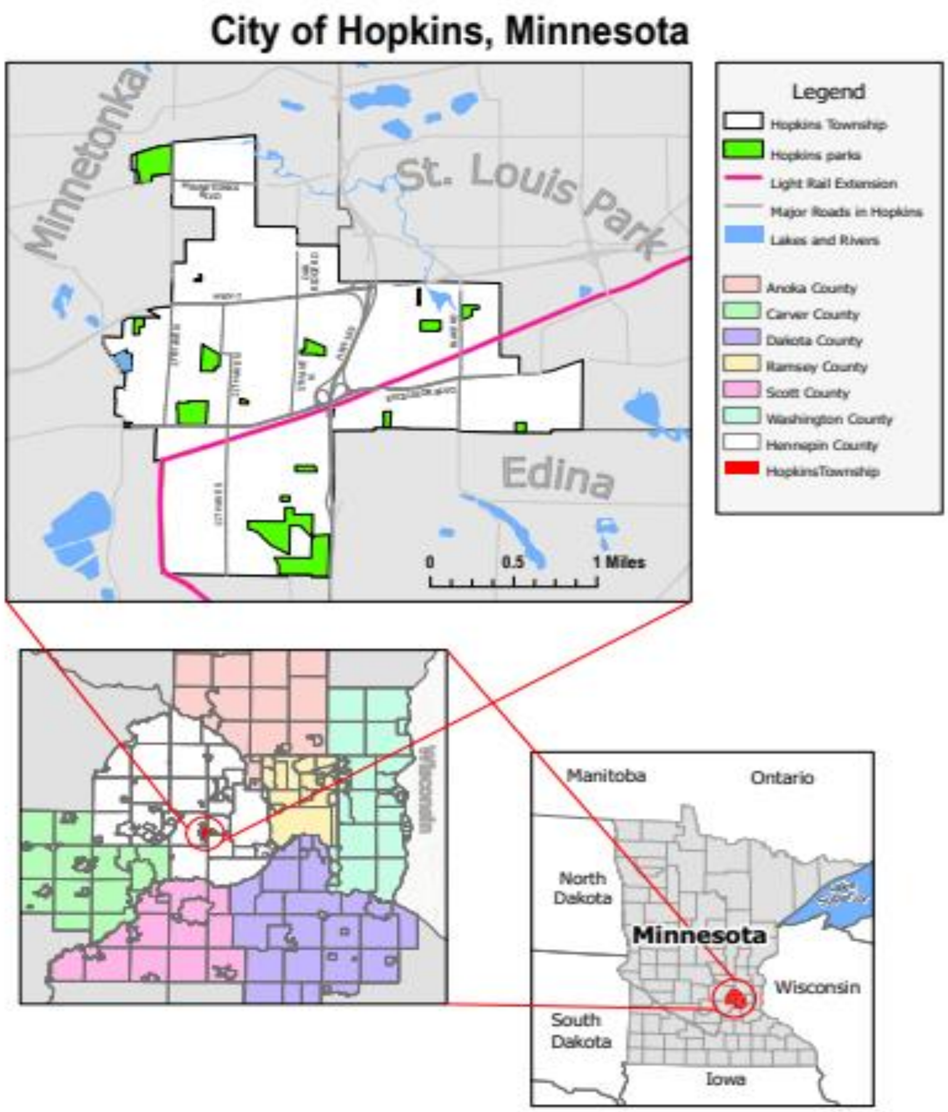

Figure 1. City of Hopkins: Relative to Neighboring Cities and Counties (Dirk Last, November 2020)

Hopkins has a total population of approximately 18,300 residents living in 8,773 housing units, with 32.7% of residents being homeowners and the remaining 63.3% renting (Minnesota Compass, 2020). The median household income is $55,025. From 2014 to 2018, 87.5% of workers in Hopkins used personal vehicles for transportation, although these numbers may have shifted dramatically due to the COVID-19 pandemic and ongoing recession.

Hopkins' current urban forest is dominated by the maple/beech/birch forest type group (i-Tree, 2020). The basal areas of specific species can be found in Table 1. Basal area is a common term referring to the average amount of area occupied by the cross-section of a tree trunk. This data comes from National Land Cover Database data compiled by iTree and is an estimate from 2011. This estimate includes natural and urban areas that may not be managed by Hopkins.

Table 1. Basal Area by Species for the Maple/Beech/Birch Forest Type Group

Specie	Common name	Basal Area (sq ft)
Acer negundo	boxelder maple	1409
Fraxinus pennsylvanica	green ash	327
Populus deltoides	eastern cottonwood	143
Prunus serotina	black cherry	142
Ulmus rubra	slippery elm	114

Research Techniques

Sister City Tool

To assess the severity of the effects of global climate change on Hopkins urban forests, the University of Nebraska Lincoln's Sister City tool was used to make an estimate of changes in temperature and precipitation for the next 80 years (High Plains Regional Climate Center, 2020). These climate predictions will be used to recommend current plantings to be adapted to future climates. Using the Federal Emergency Management Agency's (FEMA) flood hazard and risk data, we made inferred predictions about the likelihood of flooding in Hopkins (FEMA, 2020).

MN DNR Reference Tool

To ensure the best recommendations for tree species, the Sister City tool (High Plains Regional Climate Center, 2020) was used to generate a reference point for future climate in comparison to the MN DNR 2010 survey of Hopkins urban forest (Table 3) (High Plains Regional Climate Center, 2020). The sister city was selected based on minimum winter temperature for 2050 cross-referenced with the USDA Hardiness Zone maps, which informed species recommendations.

iTree

To generate the best tree recommendations, we utilized iTree. This program is a suite of urban and rural forestry assessment tools designed to help with quantifying and valuing the benefits, ecosystem services, monetary values, and potential health risks of trees and forests around the world. It is used in tree and forest management and advocacy, designed and developed based on peer-reviewed, USDA Forest Service Research (i-Tree, 2020). This program provides information regarding how beneficial certain trees will be in given areas in regards to flood resilience or drought tolerance, but for the purposes of this report was used to generate informational maps about plantable area, waterways and planting recommendations.

Literature Review

Alongside information gathering, we conducted a review of the relevant scientific literature. The literature review included compiling a list of resources on various relevant topics ranging from the effects of climate change on urban forests, existing developmental plans, interactive maps, research publications, and longitudinal studies. Throughout the report, graphics show how climate, specifically precipitation and temperature, will shift in the near future and over the next century. Software used to generate tables included i-Tree (i-Tree, 2020) and the UMN Natural Resources Atlas interactive map (Natural Resources Research Institute, 2020).

Outreach

There are many ways to reach out to the community members and residents of Hopkins. In evaluating best practices for community outreach, we’ve partnered with the Outreach Media Campaign for Urban Forests group in this course to propose relevant outreach recommendations to best inform the Hopkins residents about climate change in their city and get their opinions and feedback regarding suggestions. Effective outreach examples include questionnaires, surveys, and interviews (Masri et al. 2020).

Findings

To begin our research, we reviewed multiple journal articles related to urban forests and climate change. In the article *Quantifying urban forest structure, function, and value: the Chicago Urban Forest Climate Project,* from the journal Urban Ecosystems, it is reported that urban trees provide long term benefits that are valued at more than twice their present cost, due to their ability to clean the air by reducing the amount of air pollution, and sequestering carbon, as well as reducing energy costs by providing shade, and reducing nearby temperatures (McPherson et al., 1997).

In a study of three urban forests in Canada, Ordóñez and Duinker found that the main stressors for urban forests under future climate regimes will be drought exposure, heat, wind events, insects and diseases, specialist species in regards to climate and establishment and proliferation of young trees (Ordóñez & Duinker, 2015). This article also highlighted the interactions between climate change and urban forestry. While climate change presents a great danger to urban forests, urban forests are also a valuable tool for climate change mitigation and adaptation.

Additionally, in a journal article from Nature Communications titled *Strategically Growing the Urban Forest Will Improve our World*, emphasis is placed on the ways in which fostering healthy urban canopies helps deliver a wide array of ecosystem services for growing populations. These services are critical to both human mental and physical wellbeing, and biodiversity alike (Endreny, 2018). While many urban cities see a loss in trees over the years as development expands, there is an opportunity to strengthen urban forests through the planting of tree species to promote ecosystem services. Urban forests consist of street trees, urban parks, and peri-urban forests (Endreny, 2018). Other green spaces with trees, such as riparian corridors, rooftops, and nurseries are critical as well. Ecosystem services from trees can be categorized as cultural (e.g., spiritual, recreational), provisioning (e.g., food, water), regulating (e.g., climate and flood control), and supporting (e.g., pollination, soil formation). Furthermore, effects such as shade help reduce the urban heat island effect. This cools buildings, residential homes and the air through transpiration, dampens noise pollution, and cleanses the air and water through filtration and capturing of harmful particulate matter (Endreny, 2018).

As reflected in tables 2, there is a predicted drastic 9.0° F increase in temperature by the year 2099. The 9°F increase is significant when looking at a certain tree's tolerances. The implications are clear: trees unable to tolerate the rise in temperature will die out, while more resilient species will endure. This is particularly present in Maple trees, with the possibility of "moderate to severe climate-driven stress." Maple trees currently make up nearly 24% of Hopkin's tree population (Oswald et al. 2018). Predictions from table 2 show by 2099 Hopkins will have a 0.47 inch precipitation decrease in the summer, but a 2.77 inch increase in the spring. The increase in precipitation can lead to flooding and flash-flooding in areas with less vegetation, areas situated near bodies of water or areas consisting of mostly non-permeable surfaces.

Table 2. Projected average temperature that Hopkins is likely to face in the summer months as well as the projected average precipitation in summer and spring. It is reported in 30 year intervals, also noting the deviation from the current average in parentheticals (High Plains Regional Climate Center, 2020).

	Average projected normal temperature (°F)	**Average projected normal precipitation (in.)**	
30-year intervals	**Summer Temperature**	**Summer Precipitation**	**Spring Precipitation**
2021-2050	73.7 (+2.0)	12.50 (-0.09)	9.54 (+1.63)
2031-2060	74.9 (+3.6)	12.44 (-0.15)	9.63 (+1.72)
2041-2070	76.3 (+5.0)	12.45 (-0.14)	9.91 (+2.00)
2051-2080	77.7 (+6.4)	12.31 (-0.28)	10.21 (+2.30)
2061-2090	79.1 (+7.8)	12.19 (-0.40)	10.4 (+2.53)
2071-2099	80.3 (+9.0)	12.12 (-0.47)	10.68 (+2.77)

A substantial portion of Hopkins (91-100%) has impervious cover (Figure 2), putting drainage areas at more severe flood risks (Hennepin County Geographic Information Systems, 2017). Areas high in impervious surfaces are flood-prone and will become even more vulnerable to flood damage due to increased precipitation in spring and summer (Table 2).

Figure 2. Impervious coverage map (Hennepin County Geographic Information Systems, 2017)

The i-Tree program was used to develop maps of tree cover, plantable area, riparian areas, and impaired waterways, as well as an auto-generated planting priority map (Figure 3).

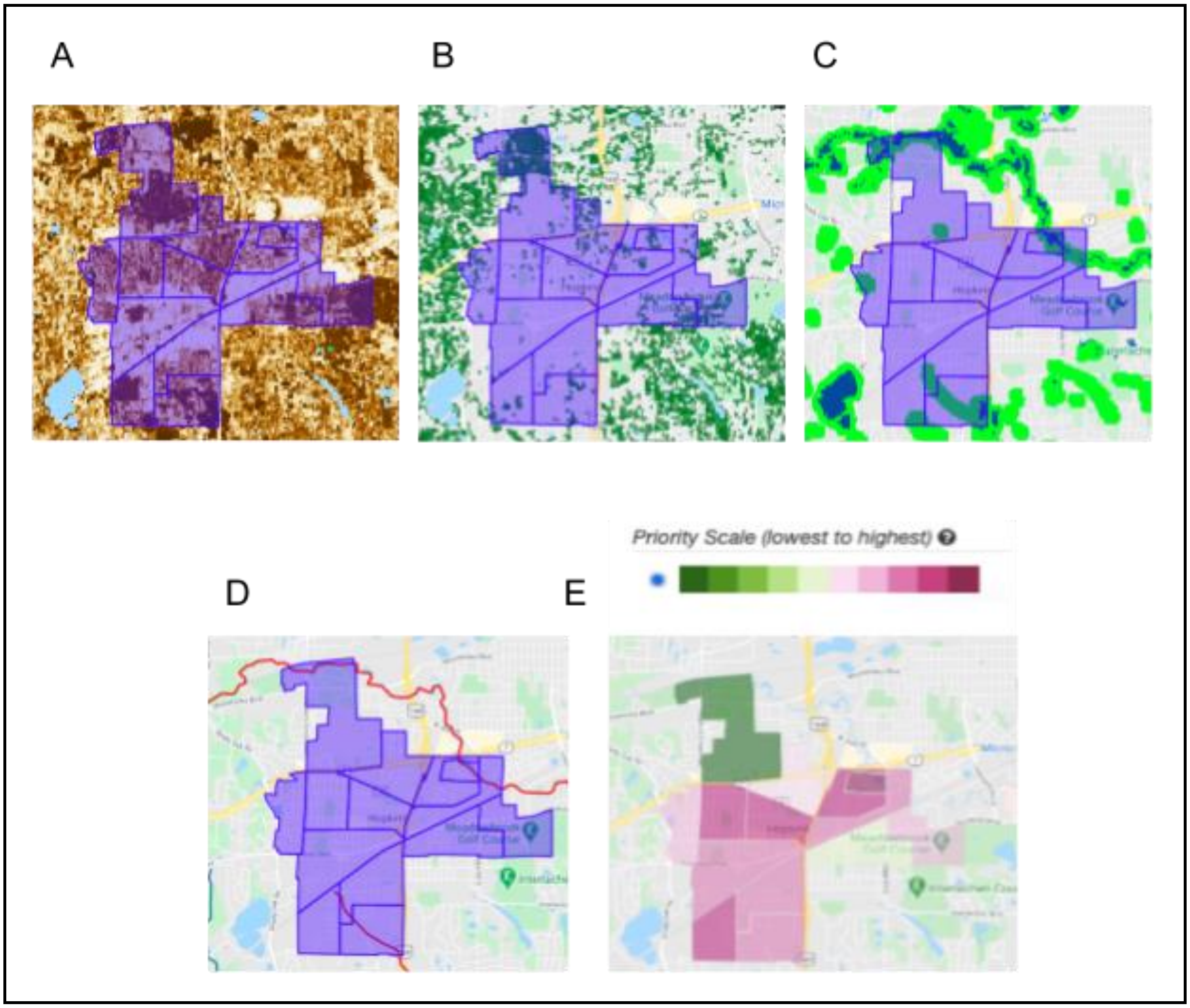

Figure 3. i-Tree Maps; blue areas represent the various neighborhoods that make up Hopkins' boundaries. A shows tree cover in brown, with darker areas showing denser tree cover; B is plantable areas in Hopkins in green; C is riparian areas in green and floodplains shown as the blue areas within riparian areas; D is impaired waterways as red lines; E is an auto-generated tree planting priority, on a scale from green to purple as low to high priority (i-Tree, 2020).

The reference point determined by the Sister City tool for winter low temperature was Trempealeau Dam 6 in Wisconsin, residing in the same hardiness zone as Hopkins, - 4b: -25° to -20° (F) (High Plains Regional Climate Center, 2020).

Table 3. DNR 2010 Community Tree Survey for the City of Hopkins, Hennepin County

***Only maintained areas are surveyed**

Genera	Population	Genera %	Small	Medium	Large	Super
Acer (Maple)	10,900	23.9%	23.7%	32.0%	26.6%	17.6%
Fraxinus (Ash)	8,500	18.5%	19.9%	18.5%	45.4%	16.2%
Picea (Spruce)	7,900	17.3%	15.3%	46.5%	38.1%	0%
Malus (Apple)	3,600	7.9%	54.3%	41.3%	4.3%	0%
Ulmus (Elm)	2,200	4.8%	10.7%	25.0%	23.2%	41.1%

The following trees are genera that are less common in Hopkins and have been shown to be more resilient to climate change:

The *Gingko biloba* (commonly known as the gingko tree, or maidenhair tree), is more tolerant of elevated O_3 in the atmosphere. This is important because O_3 is tropospheric ozone, one of the more wide-spread air pollutants (Xu et al., 2015). Furthermore, *Ginkgo biloba* has also been shown to be tolerant of de-icing salt (Johnson, 2018). Trees not being tolerant of de-icer is a common issue in ecosystems, because salting roads is common practice in Minnesota. It is recommended when considering potential planting sites for these trees to not be under any power lines, as this leads to high maintenance and risk (Johnson, 2018). As the female variety of the ginkgo produced malodorous fruit that would clutter streets, a male variety is recommended.

Celtis occidentalis (also known as a hackberry) is a medium to large deciduous tree that already exists in Hopkins. According to the 2010 tree census (Table 3), around 2.7% of the Genera in Hopkins are *Celtis* (MN DNR, 2010). By planting more of these genera, there will be an increase in biodiversity among trees which is a quality that is advantageous when it comes to dealing with climate change. Hackberry trees are also well adapted and tolerant to drought, allowing for survival during the predicted longer periods without precipitation in Hopkins, according to the USDA Forest Service Climate Change Atlas - Climate Change Atlas, n.d.).

Gymnocladus dioicus (also known as kentucky coffeetree) is a native species to Minnesota (Bobinac et al., 2019). Fruit dispersal is very limited and fruitless male varieties are available, making street sweeping for this species easier. Both the fruit and leaves are poisonous, so herbivory and parasitism has a lowered probability of occurrence. The *Gymnocladus* genus is currently absent (or under- represented) from Hopkins, so adding this species would generally increase biodiversity (Table 3).

The *Amelanchier canadensis* (commonly known as the serviceberry or juneberry) tree is recommended for Hopkins because it is shade tolerant, moderately drought tolerant, and can survive in a variety of soil types. It is not native to Minnesota, but is native to North America (Sheahan, 2015). It has also been shown in studies to be more resilient to extreme weather conditions which are evident with climate change (Kasworm etal., 2012).

Recommendations

The City of Hopkins can set the foundational groundwork and pave the way for subsequent generations and posterity to be able to have a healthy environment through planning and implementing measures to grow a robust and resilient urban canopy.

The USDA recommends multiple strategies for reducing storm damage in urban environments (UDSA, 2016). Recommendations for reducing fuel for wildfires are of lesser importance because of the low forest density in Hopkins and the presence of the fire department. Wind and ice damage recommendations deal with the removal and pruning of weak or dead limbs to prevent infrastructural damage. For urban areas, this management is most important around areas of concern, such as hiking trails and playgrounds, as well as at the margins of forests where wind power is greatest. The city can use free software such as iTree to overlay satellite imagery layers to strategically target impervious surfaces and low-density areas. This means utilizing development projects to reimage and revitalize the downtown core and urban corridor with three newly planned LRT stations.

From our partnership with the Outreach Media Campaign for Urban Forests group in this course, we recommend the City of Hopkins utilize their social media accounts, including our recommendations in a newsletter, likely along with information from our partner groups, and posting a flyer physically in town or online. These outreach methods can be altered to suit other cities with differing demographics.

In addition to these recommendations, Hopkins can also actively take steps outside of expanding urban canopy coverage to tackle climate change such as decarbonization and wetland/grassland restoration and conservation. In areas with 91-100% impervious cover, finding plantable space for trees would be difficult. Therefore, facilitating the creation of smaller rain gardens, composed of wetland and grassland species, can be strategically placed at low elevation points to filter and store runoff. Coupling multiple solutions in a multifaceted approach is what is demanded of a problem of this proportion. It will also take collaboration which transcends geographical boundaries.

Based on the MN DNR rapid survey (Table 3), Hopkins has a basic idea of the public tree population. However, Hopkins can better understand the composition of its urban forest through a comprehensive and updated tree urban inventory. While inventories can be expensive to complete, the Volunteer Urban Tree Survey group of the project has designed a volunteer-based inventory outline and recommendation. An updated tree survey will inform the City on the number and location of specific tree species, helping it better understand how its urban canopy will react based on varying degrees of climate change and temperature/precipitation shifts between the next decade and end of this century.

We recommend that areas with large amounts of impervious surfaces are targeted for adding trees. Trees in these areas will greatly help retain water and improve soil health, serving as a buffer for increasing drainage and overall infiltration. Trees increase nutrient input, soil layers, help prevent erosion, and overall, improve the health of soil (Uthappa et al. 2015).

An updated tree inventory will help the City plan out what types of trees should be planted in strategic locations and what species should be replaced based on climate projections, and what species should be prioritized in preparing the urban canopy for climate change and its effects. For example, we do not recommend the city plant any ash trees, as they are susceptible to emerald ash borer infestations which damage the trees and are also susceptible to flooding (Kennedy, 1990; Stewart and Krajicek, 1973). Current ash trees can be protected from future infection to save costs compared to replacement (Purdue University, 2008). The Ash Management Planning for Urban Forests group from our course has specific recommendations on managing ash, and their deliverables can assist Hopkins in finding partnerships, and treatments for removing any infected ash trees where treatment is unsuccessful. The ash trees should be replaced with species that are not susceptible to drought, flooding, invasive species, or rapid changes in precipitation or temperature, as listed below.

When examining the types of species to plant now for the future, it is important to note availability. There are multiple sourcing options within the state of Minnesota, particularly in the immediate Twin Cities metro area and surrounding suburbs. Tree nurseries carry a wide array of trees ranging in size and species. Therefore, Hopkins can diversify its sourcing of tree saplings and medium-sized trees for planting and transplanting by working and coordinating with not just one, but multiple nurseries to ensure high-quality saplings that meet supply demands. Additionally, if nurseries do not have the recommended trees in stock, contract growing could be used. Contract growing involves large property owners picking specific species to be grown at the nursery versus wholesale plant sales (American Native Plants, 2019). This would allow the nursery to grow the requested trees from seed - once trees reach a suitable size they can be transported for the City of Hopkins to plant. This would allow for Hopkins to grow the best trees for their geography and needs and allows the nursery to make a profit on a species that they do not normally stock, with both partners planning and preparing in advance.

Species Recommendations

We recommend that Hopkins prioritize ginkgo, hackberry, kentucky coffeetree, and serviceberry trees. Additionally, Hopkins could also plant or maintain existing populations of oak, little-leaf linden, and American hophornbeam. In cases where maple, aspen, tamarack, or elm trees are already planted, it would be beneficial to maintain those trees, instead of replacing them. Increasing tree biodiversity is a priority, and planting more of the same species would not facilitate higher levels of biodiversity. Hopkins already has a lot of these genera (Table 3), so adding more trees that are less common throughout Hopkins but are also well equipped to handle the issues that climate change has in store, would be beneficial. These recommendations factor in both low vulnerability to climate change, as well as species that can perform well for street use within the big woods regions of Southeast Minnesota (Johnson, 2018; U.S. Forest Service, 2020).

Climate change will amplify many existing stressors to forest ecosystems in the Midwest, such as invasive species, insect pests and pathogens, and disturbance regimes. This is important for Hopkins because it means that they should avoid planting trees that are most susceptible to invasive species, pests, and pathogens (Handler et al., 2014). We recommend treating when necessary but not planting new trees vulnerable to current pests or pathogens. This means no new plantings of ash, oak, cherry, plum, or dogwood, as these trees are especially vulnerable to beetles, and climate change makes the beetle breeding season longer and could result in huge outbreaks even with significant treatment (Handler et. al, 2014). Hopkins should avoid white pine and red pine as these species would not be expected to fare well under climate change in this specific region (Parmesan & Yohe, 2003). Furthermore, we believe that expansion of urban canopy coverage should be coupled with wetland and grassland restoration (shrubs and grasses) and conservation of endemic species in this area would be impactful when it comes to climate change resilience, compared to restoring forests which may not fare well. Space to plant and the amount of land that is available are also important considerations.

The City of Hopkins can begin the process of building a resilient, robust urban canopy that will thrive under projected circumstances and prepare the city’s forested areas, parks, and city streets alike to withstand climate change. The City can prioritize open spaces and plots of land which currently have gaps in the urban canopy, planting more trees in these unutilized spaces will go a long way in providing climate resilience in the long term.

Conclusion

In conclusion, the City of Hopkins can take the necessary steps to set the foundational groundwork for subsequent generations and posterity through the improvement of its urban forest. Through the strategic management of natural and community resources Hopkins City Planners can better prepare the city for the inevitable changes in the climate and a warming planet. Because of this, the City can greatly expand and strengthen its existing urban canopy coverage. Trees take decades to mature, therefore, understanding and planning for the future of the urban forest are incredibly important (Hopkins, 2019).

Climate change will amplify many existing stressors to forest ecosystems in the Midwest, such as invasive species, insect pests and pathogens, and disturbance regimes. This is important for Hopkins because it means that they should avoid planting trees that are most susceptible to invasive species, pests, and pathogens (Handler et al., 2014). Protecting Hopkins from climate change while combating global warming begins with tree planting. Trees provide invaluable benefits for urban municipal and rural communities alike. Trees can directly provide or indirectly foster all four main ecosystem services: provisioning, supporting, regulating, and cultural. Trees greatly improve air quality and soil integrity, reducing adverse health effects of the citizenry and residents. Furthermore, trees reduce the urban heat island effect, collect particulate matter, sequester carbon, and curb nutrient runoff.

Comprehensive planning for a reimagined urban canopy begins by inventorying the makeup of Hopkins' existing canopy within city limits in preparation for expansion. Once this information is acquired, data on current forest life needs to be collected and studied to determine how these species are going to be affected. From there, recommendations on tree species and placement can be made. These data are important because it pertains to tree placement, which can increase water infiltration, as well as heating and cooling costs to a building (Moser, 2011). Due to the nature of the problem and its breadth of effects, input from Hopkins citizens is essential. With this information, Hopkins can follow steps to acquire the trees it needs to properly adapt to the future climate. To do this effectively, it is paramount to take global climate change into careful consideration when planning.

Climate change is a challenge facing all communities regardless of size. By planting trees better prepared to withstand changing climate, urban heat-island effect and energy use will decrease for Hopkins residents, and health of humans and ecosystems will vastly improve over time.

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