ADAPTING URBAN FORESTS TO CLIMATE CHANGE

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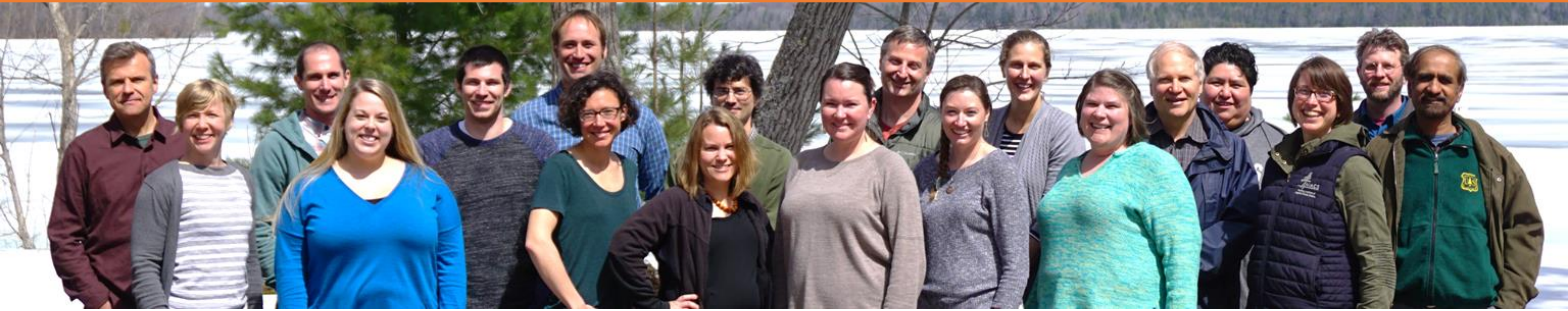

Climate

Carbon

NIACS
Northern Institute of Applied Climate Science

Provides **practical** information, resources, and technical assistance related to forests and climate change

Chartered by USDA Forest Service, universities, non-profit and tribal conservation organizations

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University of Minnesota

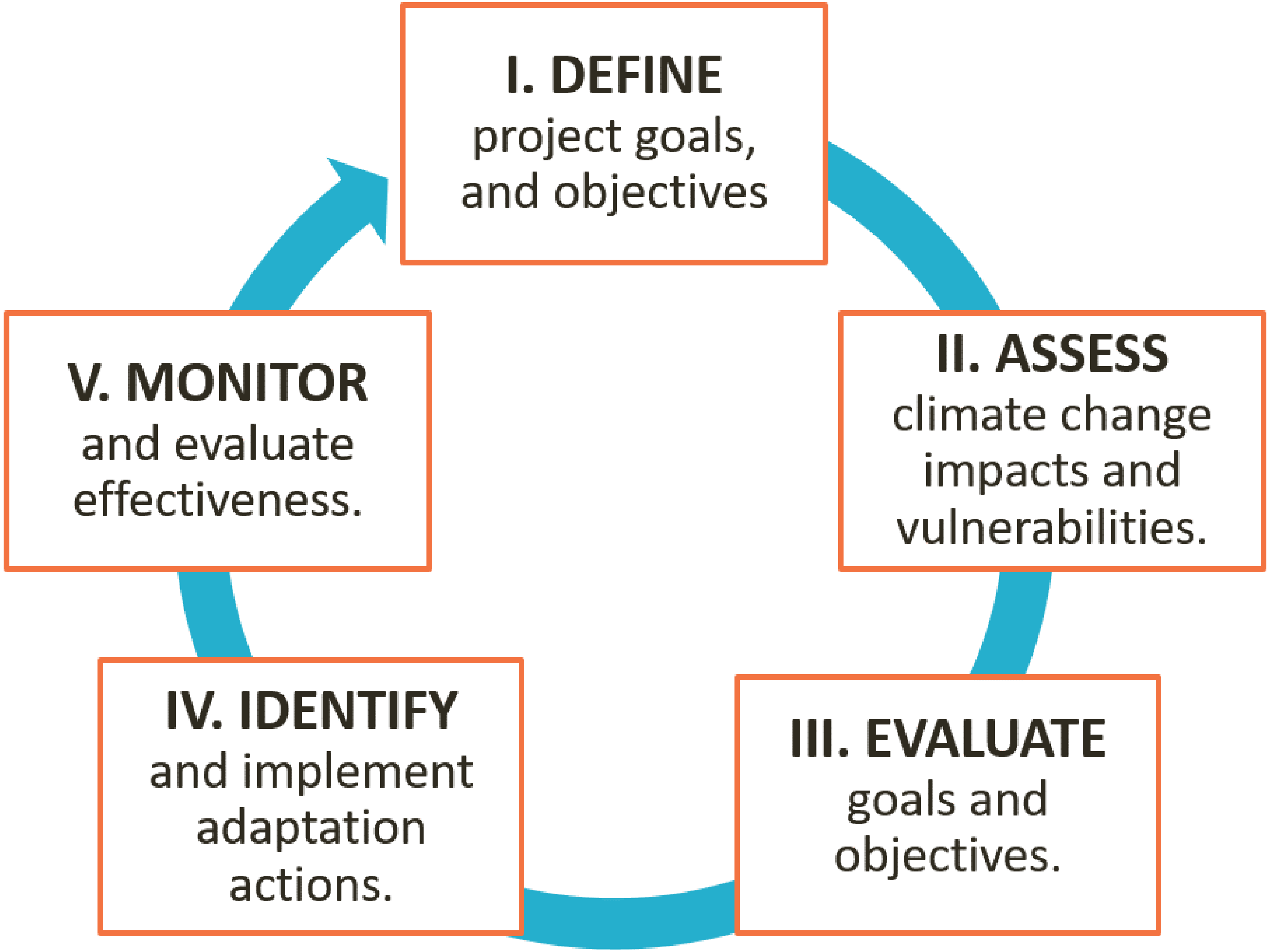
American Forests

The University of Vermont

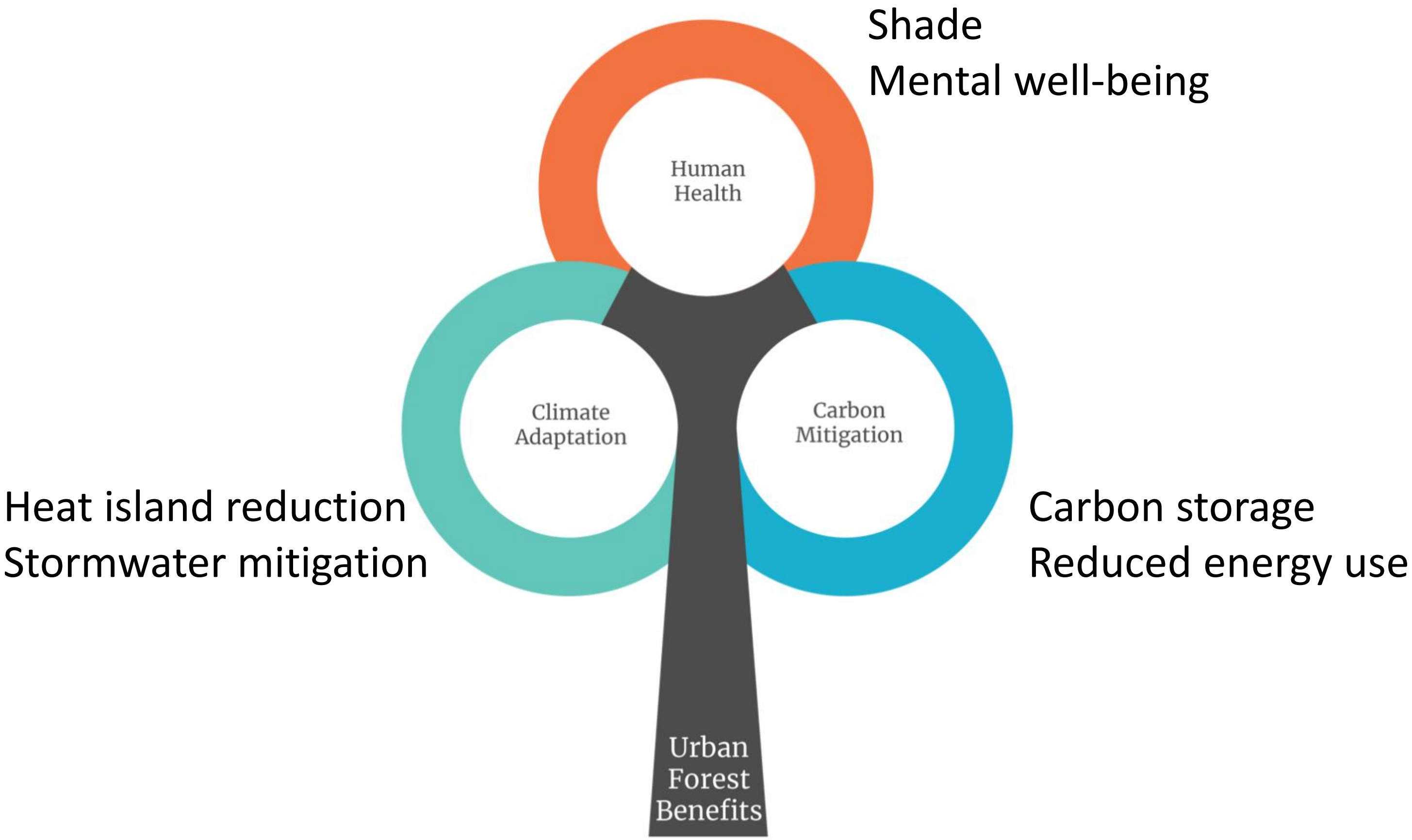
https://www.vibrantcitieslab.com/guides/climate-health-action-guide/

Who is the Action Guide for?

- Urban/community foresters
- Public health professionals
- Climate/sustainability professionals
- Planners
- Landscape architects

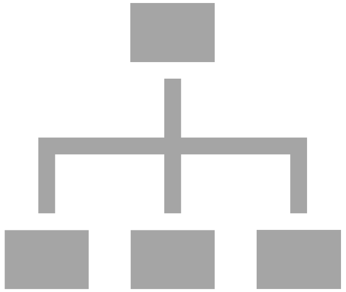

I. DEFINE
project goals, and objectives
II. ASSESS
climate change impacts and vulnerabilities.
III. EVALUATE
goals and objectives.
IV. IDENTIFY
and implement adaptation actions.
V. MONITOR
and evaluate effectiveness.

I.1 Understand Urban Forests Benefits for Climate and Health



I.2 Define Your Project Goals

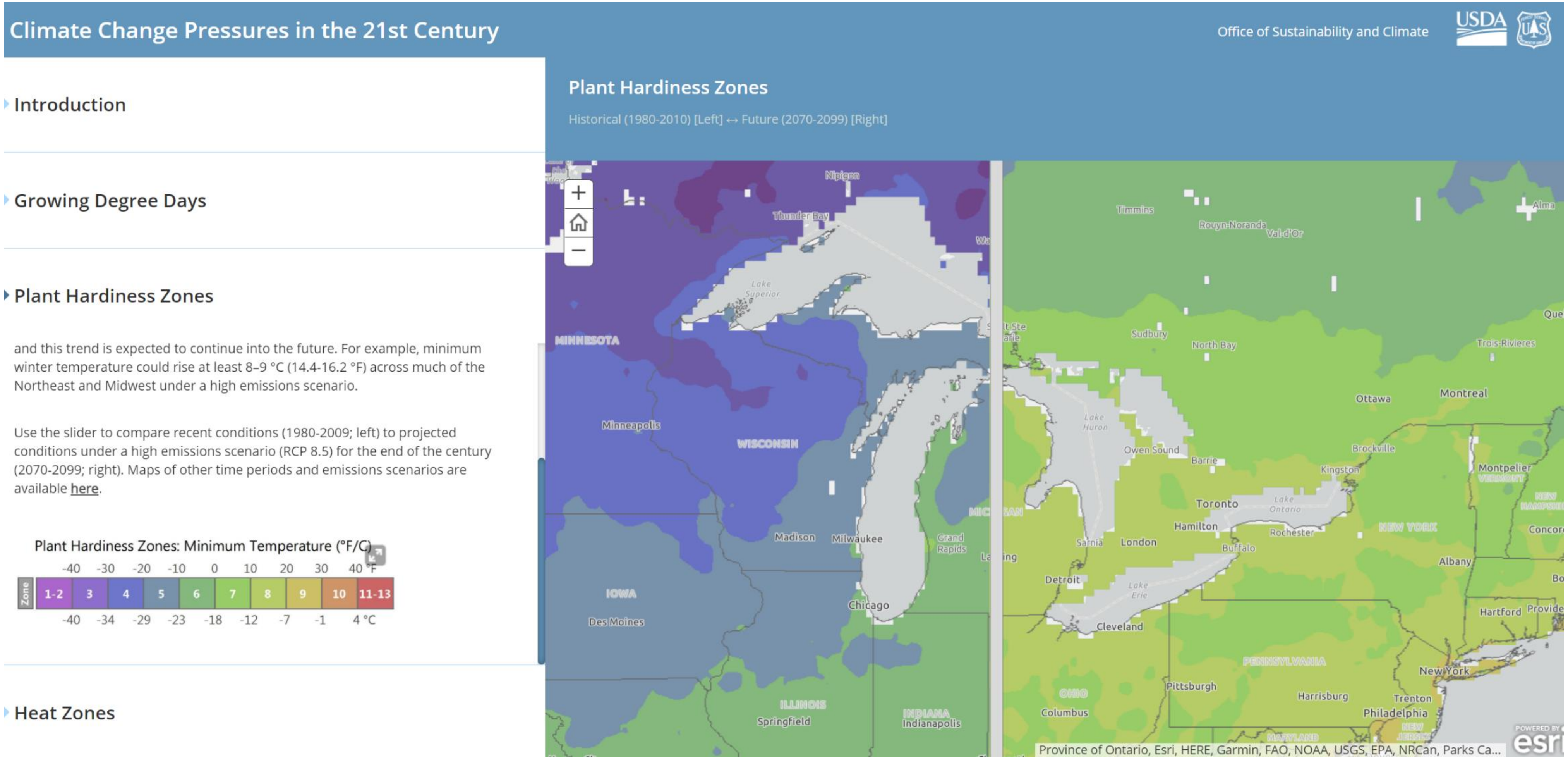
Management goals describe the broad outcomes you are trying to accomplish.



Management objectives are more specific actions that support the completion of a goal.

II.1 Understand Climate and Health Impacts

Hardiness Zones



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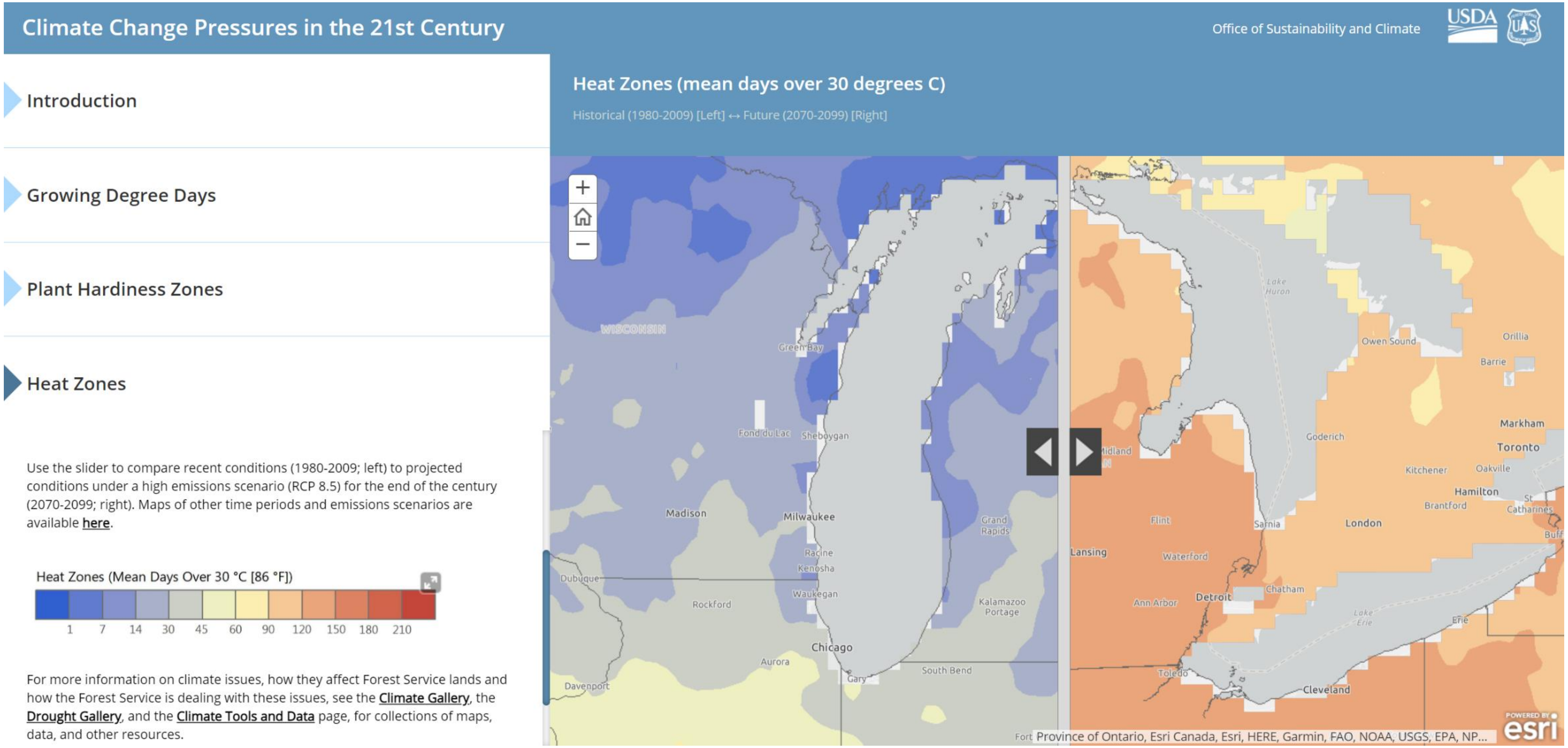
II.1 Understand Climate and Health Impacts

Heat Zones



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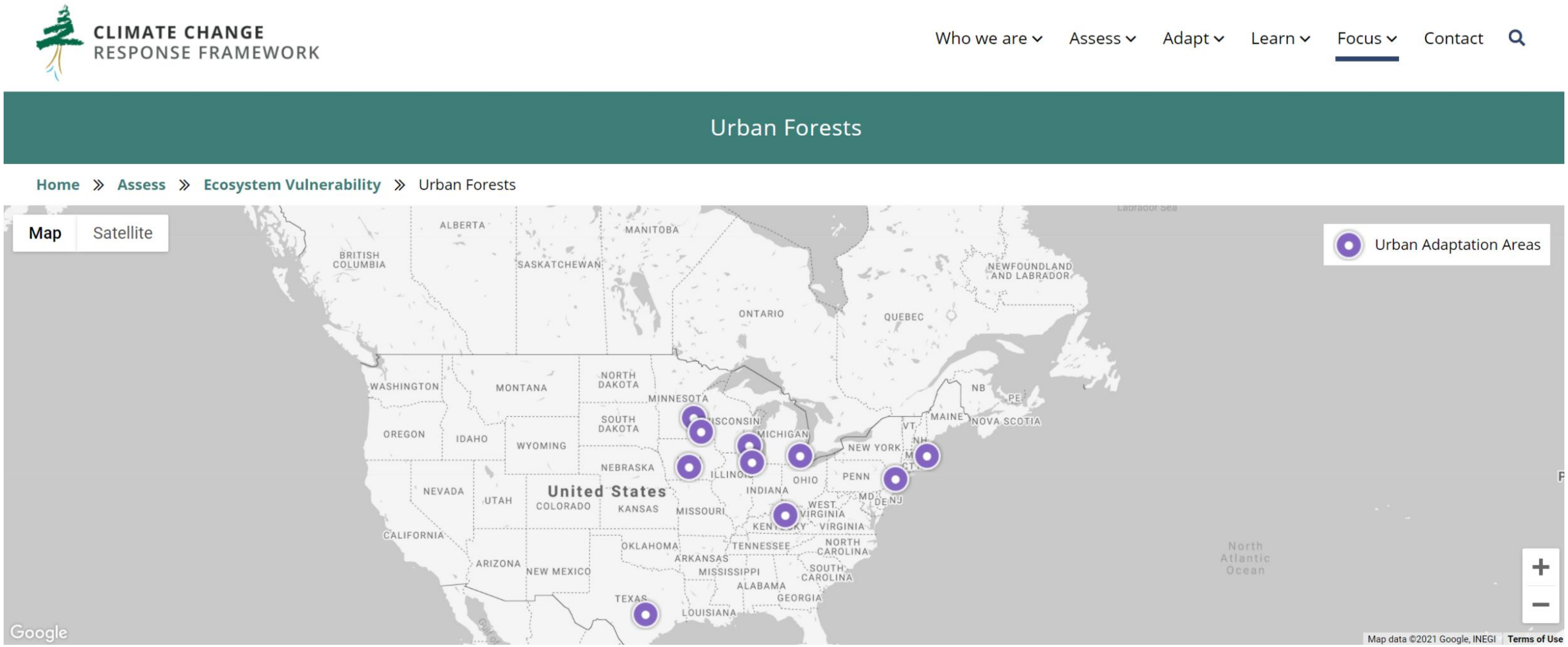
Adaptive Capacity

the ability of a system to accommodate or cope with potential climate change impacts with minimal disruption.

Example of High Adaptive Capacity: Kentucky Coffeetree

- No major pest/disease issues
- Adaptable to a range of soils, climates
- Urban-tolerant
- Low maintenance
- Widely available

II.2 Evaluate Climate Risks in Your Urban Forest



https://forestadaptation.org/urban

II.2 Evaluate Climate Risks in Your Urban Forest

CLIMATE CHANGE VULNERABILITY OF URBAN TREES
DETROIT, MICHIGAN


Michigan Department of Natural Resources

This list was developed to aid Detroit, Michigan community forestry practitioners in selecting trees to reduce climate change vulnerability of their urban forests. It is meant to be a complement to other tree selection resources. Other factors may also need to be considered, such as aesthetics, local site conditions, wildlife value, or nursery availability. It is also important to note that some species may have climate benefits but may not be suitable for planting for other reasons, such as having invasive potential or susceptibility to pests or pathogens.

Vulnerability: Trees can be vulnerable to a variety of climate-related stressors such as intense heat, drought, flooding, and changing pest and disease patterns. Climate vulnerability is a function of the impacts of climate change on a species and its adaptive capacity. Species with negative impacts on habitat suitability and low adaptive capacity will have high vulnerability and vice versa. The following factors were used to determine climate vulnerability:

Urban adaptability: Adaptability scores were generated for each species based on literature describing its tolerance to disturbances such as drought, flooding, pests, and disease, as well as its growth requirements such as shade tolerance, soil needs, and ease of nursery propagation. Scores were assigned to species using methods developed in an urban forest vulnerability assessment for Chicago for trees planted in developed sites. A positive score indicates that a species is tolerant to a wide range of disturbances and can be planted on a variety of sites. A negative score indicates a species is highly susceptible to disturbances and/or is limited to specific planting sites.

Hardiness and heat zone suitability: Tree species ranges were recorded from government, university, and arboretum websites. Species tolerance ranges were compared to current and projected heat and hardiness zones for Detroit, Michigan using downscaled climate models under low emissions (RCP 4.5) and high emissions (RCP 8.5) scenarios for changes in greenhouse gases. Trees were considered to have suitable zone suitability if the species' tolerance was within the range of current and projected hardiness and heat zone through the end of the 21st century.

NOTE: This list was primarily created for species planted in developed sites, such as streets, yards, boulevards, and parks. If you are interested in projected changes in habitat suitability for native species in natural areas, see the Climate Change Tree Atlas at www.fs.fed.us/nrs/atlas/.

Current and projected USDA Hardiness Zones and AHS Heat Zones for Detroit, Michigan. Hardiness zone is determined by the average lowest temperature over a 30 year period. Heat zones are determined by the number of days above 86°F.

Time Period	Hardiness Zone Range		Heat Zone Range	
1980–2010	6		5	
	Low Emissions	High Emissions	Low Emissions	High Emissions
2010–2039	7	7	6	7
2040–2069	7	8	7	8
2070–2099	7	8	7	9

SOURCE: Adaptability scores were assigned using methods developed in an urban forest vulnerability assessment for Chicago by Brandt et al. 2017 (https://www.fs.fed.us/nrs/pubs/gtr/gtr_nrs168.pdf). Future heat and hardiness zone information were provided from: https://usfs.maps.arcgis.com/apps/MapSeries/index.html?appid=96088b1c086a4b39b3a75d0fd97a4c40.

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URBAN ADAPTABILITY:
- \+ ***High:*** *Species may perform better than modeled*
- · ***Medium***
- – ***Low:*** *Species may perform worse than modeled*

ZONE SUITABILITY:
- ✓ ***Suitable***
- ✗ ***Not Suitable***

VULNERABILITY:
- ▼ ***Low:*** *Suitable zone, high adaptability*
- ● ***Low-moderate:*** *Suitable zone, medium adaptability*
- ⊖ ***Moderate:*** *Suitable zone, low adaptability or zone not suitable, high adaptability*
- ○ ***Moderate- high:*** *Zone not suitable, medium adaptability*
- △ ***High:*** *Zone not suitable, low adaptability*

*Invasive species

COMMON NAME	ADAPT	LOW EMISSIONS ZONE SUIT	LOW EMISSIONS VULN	HIGH EMISSIONS ZONE SUIT	HIGH EMISSIONS VULN
Accolade elm	+	✓	▼	✗	⊖
Alleghany serviceberry	+	✓	▼	✓	▼
American beech	·	✓	●	✓	●
American elm	·	✓	●	✓	●
American filbert	·	✓	●	✓	●
American linden, Basswood	·	✓	●	✗	○
American mountain ash	·	✗	○	✗	○
American plum	·	✓	●	✗	○
American sycamore	·	✓	●	✓	●
Amur corktree*	·	✓	●	✗	○
Amur maackia	+	✓	▼	✗	⊖
Amur maple*	·	✓	●	✗	○
Apple serviceberry	·	✓	●	✗	○
Austrian pine	·	✓	●	✗	○
Bald cypress	+	✓	▼	✓	▼
Balsam fir	·	✗	○	✗	○
Bitternut hickory	·	✓	●	✓	●
Black alder	·	✓	●	✗	○
Black ash	–	✓	⊖	✗	△
Black cherry	–	✓	⊖	✓	⊖
Black locust	·	✓	●	✓	●
Black maple	·	✓	●	✗	○
Black oak	–	✓	⊖	✗	○
Black tupelo, Black gum	+	✓	▼	✓	▼
Black walnut	–	✓	⊖	✓	⊖
Black willow	–	✓	⊖	✓	⊖
Blue ash	·	✓	●	✗	○
Boxelder	·	✓	●	✗	○
Bur oak	+	✓	▼	✓	▼
Callery pear*	·	✓	●	✗	○
Chestnut oak	+	✓	▼	✗	⊖
Chinkapin oak	+	✓	▼	✗	⊖
Chokecherry	·	✓	●	✗	○
Cockspur hawthorn	·	✓	●	✗	○
Colorado blue spruce	·	✓	●	✗	○
Common hackberry	+	✓	▼	✓	▼
Common horsechestnut	·	✓	●	✗	○
Common persimmon	+	✓	▼	✓	▼
Cornelian cherry dogwood	·	✓	●	✗	○
Crimean linden	+	✓	▼	✗	⊖
Dawn redwood	·	✓	●	✓	●
Donald Wyman crabapple	·	✓	●	✗	⊖
Douglas-fir	–	✓	⊖	✗	△
Downy serviceberry	+	✓	▼	✓	▼
Eastern cottonwood	–	✓	⊖	✓	⊖

COMMON NAME	ADAPT	LOW EMISSIONS ZONE SUIT	LOW EMISSIONS VULN	HIGH EMISSIONS ZONE SUIT	HIGH EMISSIONS VULN
Eastern hemlock	–	✓	⊖	✗	△
Eastern redbud	·	✓	●	✓	●
Eastern redcedar	+	✓	▼	✓	▼
Eastern serviceberry	·	✓	●	✗	○
Eastern white pine	–	✓	⊖	✗	△
English oak	·	✓	●	✗	○
European ash	·	✓	●	✗	○
European beech	·	✓	●	✗	○
European hornbeam	·	✓	●	✗	○
European larch	·	✗	○	✗	○
European mountain ash	·	✓	●	✗	○
Flowering dogwood	·	✓	●	✓	●
Freeman maple	·	✓	●	✗	○
Ginkgo	+	✓	▼	✓	▼
Goldenrain tree*	+	✓	▼	✓	▼
Gray birch	–	✗	△	✗	△
Green ash	·	✓	●	✓	●
Hardy rubbertree	+	✓	▼	✗	⊖
Hedge maple	·	✓	●	✗	○
Higan cherry	·	✓	●	✗	○
Honeylocust*	·	✓	●	✓	●
Ironwood	+	✓	▼	✓	▼
Japanese elm	·	✓	●	✓	●
Japanese flowering cherry	·	✓	●	✓	⊖
Japanese maple	·	✓	●	✗	○
Japanese pagoda tree	+	✓	▼	✓	▼
Japanese tree lilac	+	✓	▼	✗	⊖
Japanese white pine	·	✓	●	✓	●
Japanese zelkova	+	✓	▼	✓	▼
Katsura tree	–	✓	⊖	✗	△
Kentucky coffeetree	+	✓	▼	✓	▼
Korean mountain ash	·	✓	●	✓	●
Kousa dogwood	+	✓	▼	✗	⊖
Lacebark elm	+	✓	▼	✓	▼
Littleleaf linden	+	✓	▼	✗	⊖
London planetree	·	✓	●	✓	●
Miyabe maple	+	✓	▼	✗	⊖
Mockernut hickory	·	✓	●	✓	●
Mountain maple	+	✗	⊖	✗	⊖
Mugo pine	·	✓	●	✗	○
Musclewood	+	✓	▼	✓	▼
Northern catalpa	·	✓	●	✗	○
Northern pin oak	–	✓	⊖	✗	△
Northern red oak	·	✓	●	✓	●
Northern white cedar, Arborvitae	+	✓	▼	✗	⊖

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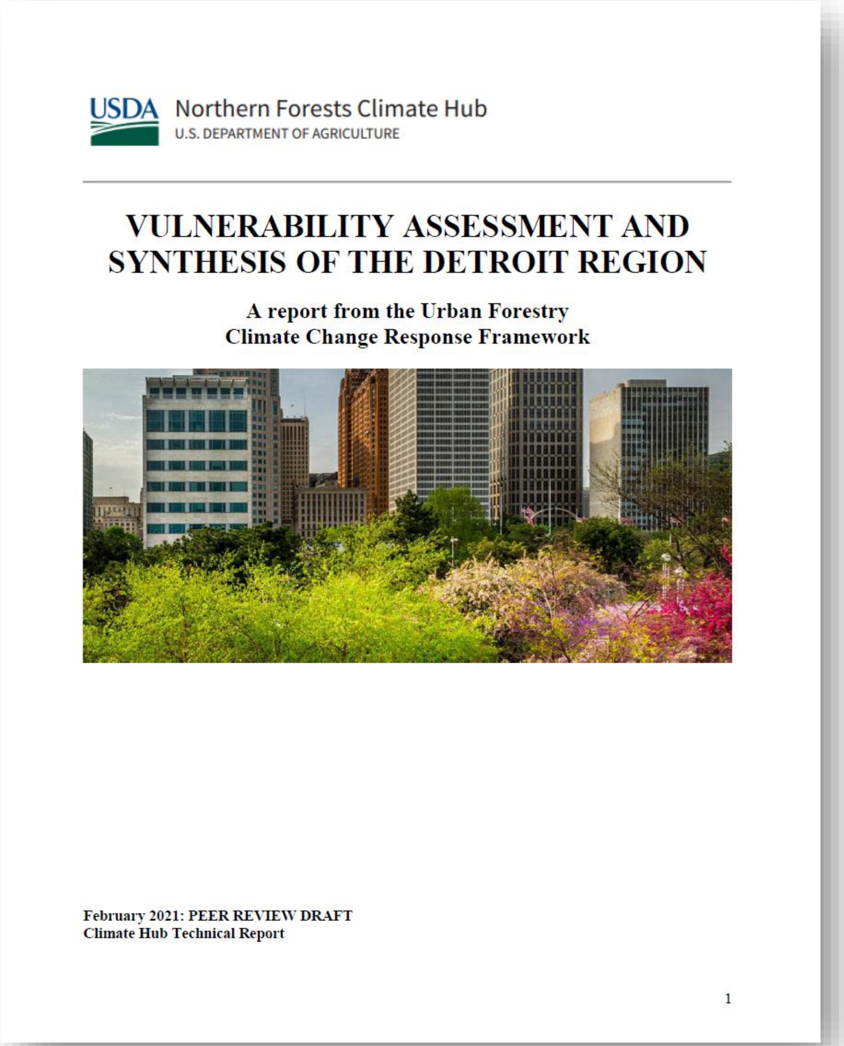
II.2 Evaluate Climate Risks in Your Urban Forest


USDA Northern Forests Climate Hub
U.S. DEPARTMENT OF AGRICULTURE

VULNERABILITY ASSESSMENT AND SYNTHESIS OF THE DETROIT REGION

A report from the Urban Forestry Climate Change Response Framework

February 2021: PEER REVIEW DRAFT
Climate Hub Technical Report

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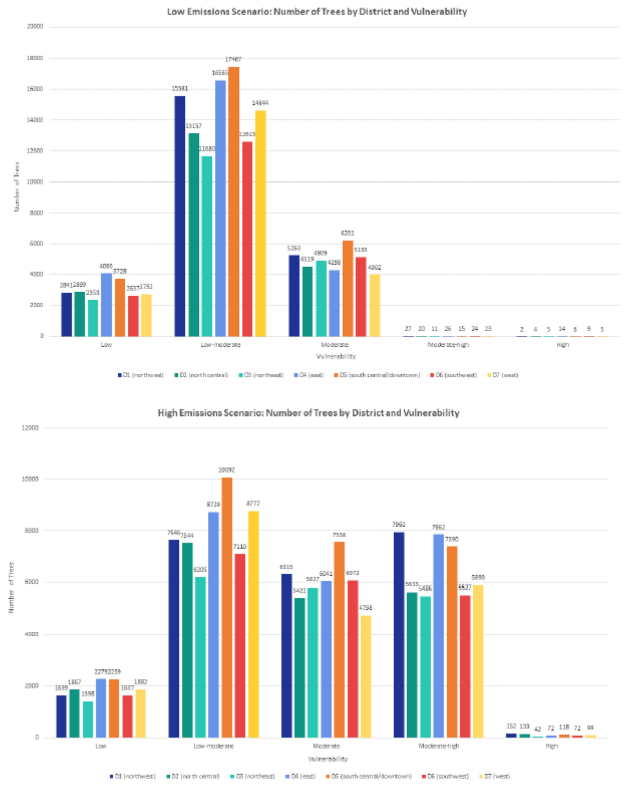

Figure 6.8. Number of Trees by Detroit District and Vulnerability (Low, Low-moderate, Moderate, Moderate-high, High) Under Low and High Emissions Scenarios.

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II.3 Evaluate Risks to Human Health

CHAPTER 4

Human Health Impacts

Urban forests and their associated benefits have become more important for human health as more than half of the nation's population resides in cities. Urban trees provide ecosystem services, such as cooling the air, absorbing rainfall, providing oxygen, intercepting UV light, storing carbon, and reducing air pollution. U.S. Forest Service scientists and collaborators estimate that trees are saving over 850 lives and preventing 670,000 cases of acute respiratory symptoms each year, in addition to providing monetary savings (U.S. Forest Service, 2015).

The interaction between trees and a changing climate will have important implications for protecting human health. A changing climate has the potential to worsen existing health issues and create new issues. The presence and intensity of allergens, biogenic volatile organic compounds (BVOCS), and pests and pathogens are projected to be altered by climate stressors, in addition to heat-related illnesses and mortality, flooding and extreme weather events, increases in food prices, and social, mental, and physical impacts. Adopting proactive management to maintain or adjust species composition may help reduce harmful impacts. The following is a summary of some of the key human health impacts for the Detroit region in relation to the changing urban forest.

The Michigan Department of Health and Human Services and GLISA identified five priority climate-related health effects for Michigan including respiratory diseases, heat-related illnesses, waterborne and vector-borne diseases, and injuries, particularly carbon monoxide (CO poisoning) (Briley et al., 2015).

Air Pollution

A changing climate can increase ground-level ozone and particulate matter air pollution, associated with health issues such as asthma, diminished lung function, increased hospital visits, and premature deaths (CDC, 2020). Ozone formation is affected by heat, methane emissions, and concentrations of precursor chemicals, while particulate matter is affected by factors such as wildfire emissions and air stagnation episodes. As the climate continues to warm, premature deaths related to ozone and particle pollution are projected to increase.

Allergenicity

Climate change impacts the presence of airborne allergens (aeroallergens such as tree, grass, and weed pollen) by shifting the production, allergenicity, distribution, and timing (USGCRP, 2018b). In other words, climate change can alter when the pollen season starts and ends, how much pollen plants create, how much pollen is in the air, how pollen impacts our health, how much pollen we are exposed to, and the overall risk of allergy symptoms (CDC, 2020). Children and those with respiratory diseases such as asthma are predominately vulnerable to aeroallergens, which have the ability to cause allergic rhinitis and enhance asthma and sinusitis (USGCRP, 2018a). In addition, higher winter and spring temperatures can bring earlier flowering for trees such as oak.

Oak pollen in particular is expected to cause an increase in asthma-related emergency room visits (USGCRP, 2018a). Birch pollen production and peak values are also projected to increase by a factor of 1.3 to 2.3 relative to 2000 by 2100, with the start and peak pollen release dates coming two to four weeks earlier (USGCRP, 2018b). Common ragweed, the most common aeroallergen in the U.S., is expected to continue its longer pollen season in central North America (Ziska et al., 2011). Increases in CO_2 and temperature have been found to cause earlier flowering, higher floral numbers and pollen production, as well as increased allergenicity in ragweed (USGCRP, 2018b). However, not all pollen seasons will be extended; as some areas become drier, there may be potential for pollen seasons to shorten due to plant

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Moderate Allergen	
Acer buergerianum	trident maple
Acer campestre	hedge maple
Acer griseum	paperbark maple
Acer miyabei	miyabei maple
Acer nigrum	black maple
Acer palmatum	Japanese maple
Acer platanoides	Norway maple
Acer pseudoplatanus	sycamore maple
Acer rubrum	red maple
Acer saccharinum	silver maple
Acer saccharum	sugar maple
Acer tataricum	tatarian maple
Acer x freemanii	freeman maple
Alnus glutinosa	black alder
Alnus rugosa	grey alder

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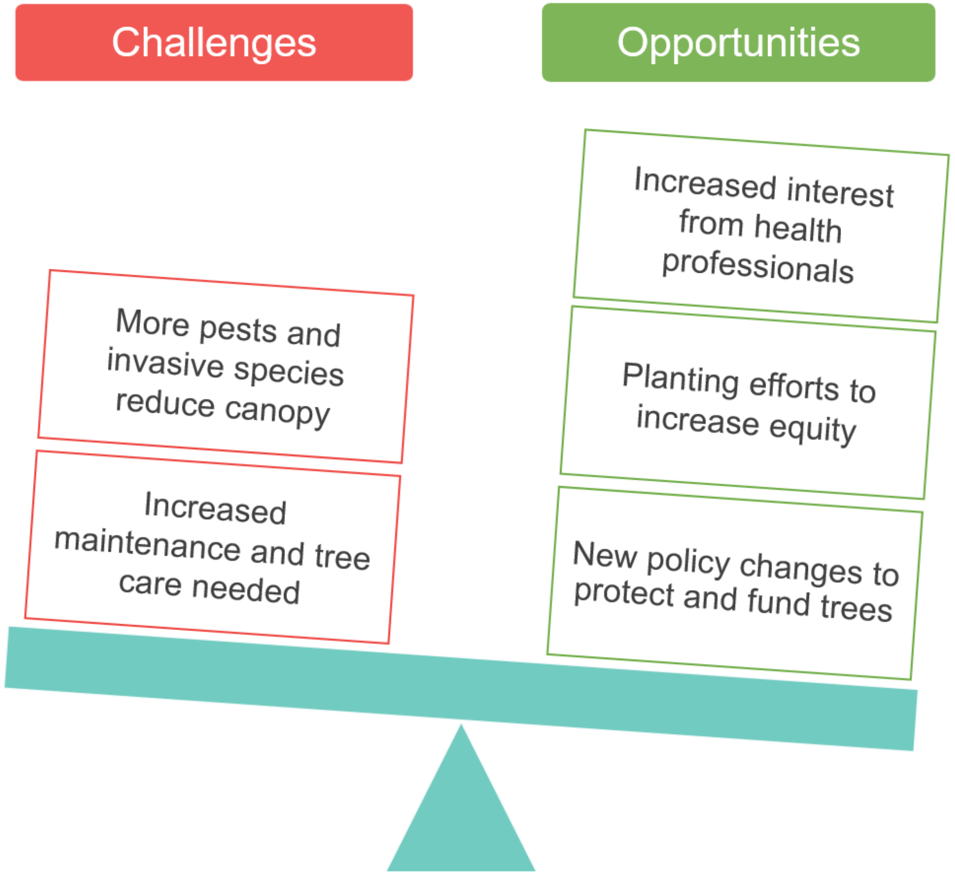
III.1 Identify Challenges and Opportunities



IV.1 Adaptation Strategies and Approaches for Climate and Health

CONCEPT

Strategy: A strategy is a broad adaptation response that is applicable across a variety of resources and sites

Approach: An approach is an adaptation response that is more specific to a resource issue or geography

Tactic: The most specific adaptation response, providing prescriptive direction about actions that can be applied on the ground

ACTION

Adaptation Menu

A collection of plausible adaptation actions that is:

- Specific to a discipline
- Organized into a tiered hierarchy
- Thorough and comprehensive (including opposing ideas!)

URBAN FOREST CLIMATE & HEALTH MENU AT A GLANCE

The following list of strategies and approaches offers a glance at the Urban Forest Climate and Health Menu.[1] The full document includes descriptions of each strategy and approach as well as example adaptation tactics.

Strategy 1: Engage social systems to integrate climate change, urban forest, and human health actions
Approach 1.1: Address socio-ecological systems in early, comprehensive response
Approach 1.2: Integrate urban forestry in climate planning and policy
Approach 1.3: Address climate and health challenges of socially-disadvantaged communities and vulnerable populations

Strategy 2: Reduce the impact of human health threats and stressors using urban trees and forests
Approach 2.1: Reduce extreme temperatures and heat exposure
Approach 2.2: Improve urban air quality conditions
Approach 2.3: Anticipate and reduce human health impacts of hazardous weather and disturbance events

Strategy 3: Maintain or increase extent of urban forests and vegetative cover
Approach 3.1: Minimize forest loss and degradation
Approach 3.2: Maintain existing trees through proper care and maintenance
Approach 3.3: Restore and increase tree, forest, and vegetative cover
Approach 3.4: Sustain locations that provide high value across the landscape

Strategy 4: Sustain or restore fundamental ecological functions of urban ecosystems
Approach 4.1: Maintain or restore soils and nutrient cycling in urban areas
Approach 4.2: Maintain or restore hydrologic processes in urban forests
Approach 4.4: Restore or maintain fire in fire-adapted ecosystems

Strategy 5: Reduce the impact of physical and biological stressors on urban forests
Approach 5.1: Reduce impacts from extreme rainfall and enhance water infiltration and storage
Approach 5.2: Reduce risk of damage from extreme storms and wind
Approach 5.3: Reduce risk of damage from wildfire
Approach 5.4: Maintain or improve the ability of forests to resist pests and pathogens
Approach 5.5: Prevent invasive plant establishment and remove existing invasive species
Approach 5.6: Manage herbivory to promote regeneration, growth, and form of desired species

Strategy 6: Enhance taxonomic, functional, and structural diversity
Approach 6.1: Enhance age class and structural diversity in forests
Approach 6.2: Maintain or enhance diversity of native species
Approach 6.3: Optimize and diversify tree species selection for multiple long-term benefits
Approach 6.4: Maintain or enhance genetic diversity

Strategy 7. Alter urban ecosystems toward new and expected conditions
Approach 7.1: Favor or restore non-invasive species that are expected to be adapted to future conditions
Approach 7.2: Establish or encourage new species mixes.
Approach 7.3: Introduce species, genotypes, and cultivars that are expected to be adapted to future conditions
Approach 7.4: Disfavor species that are distinctly maladapted
Approach 7.5: Move at-risk species to more suitable locations
Approach 7.6: Promptly revegetate and remediate sites after disturbance
Approach 7.7: Realign severely altered systems toward future conditions

Strategy 8: Promote mental and social health in the face of climate change
Approach 8.1: Provide nature experiences to ease stress and support mental function
Approach 8.2: Encourage community and social cohesion for climate response

Strategy 9: Promote human health co-benefits in nature-based climate adaptation activities
Approach 9.1: Co-design large scale green infrastructure and systems to promote health
Approach 9.2: Provide micro-scale experiences for health promotion and healing

STRATEGY 1:

Engage social systems to integrate climate change, urban forest, and human health actions.

Adobe Stock

STRATEGY 2:

Reduce the impact of human health threats and stressors using urban trees and forests.

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STRATEGY 3:

Maintain or increase extent of urban forests and vegetative cover.

Photos: Speak for the Trees Boston

STRATEGY 4:

Sustain or restore fundamental ecological functions of urban ecosystems.

STRATEGY 5:

Reduce the impact of physical and biological stressors on urban forests.

STRATEGY 6:

Enhance taxonomic, functional, and structural diversity.

Photo: Guy Kramer

STRATEGY 7:

Alter urban ecosystems toward new and expected conditions.

Photo: Guy Kramer

STRATEGY 8:

Promote mental and social health in the face of climate change.

STRATEGY 9:

Promote human health co-benefits in nature-based climate adaptation activities.

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IV.2 Select Your Adaptation Actions for Implementation

Time Frames – When would this action be implemented?

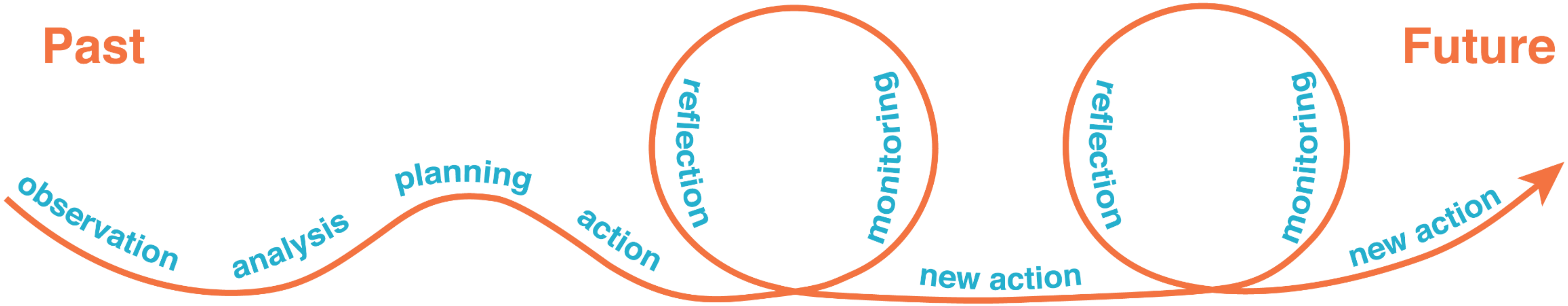
Benefits – What benefits does the action provide?

Drawbacks and Barriers –What drawbacks are associated with this action?

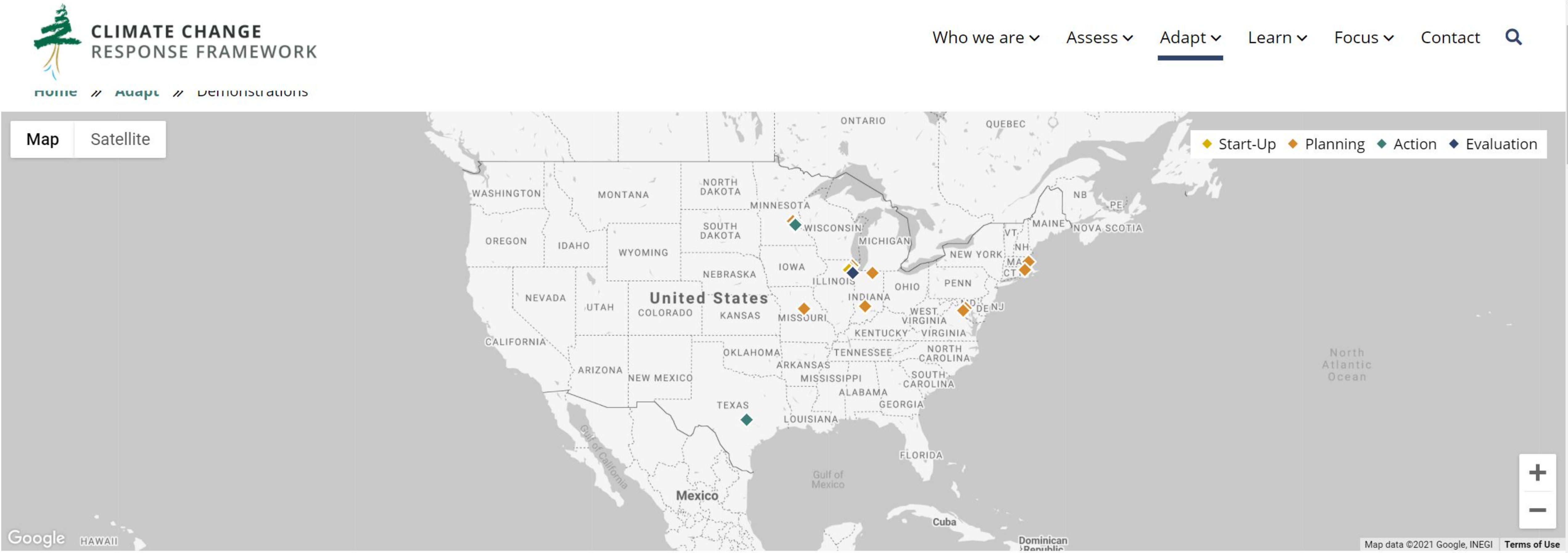
Effectiveness – Does the action meet the desired intent?

Feasibility – Can the action be implemented?

V.1 Create a Monitoring Plan



Examples!



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Providence, RI: Climate & Health Adaptation on a Neighborhood Scale

Providence, RI: Climate & Health Adaptation on a Neighborhood Scale

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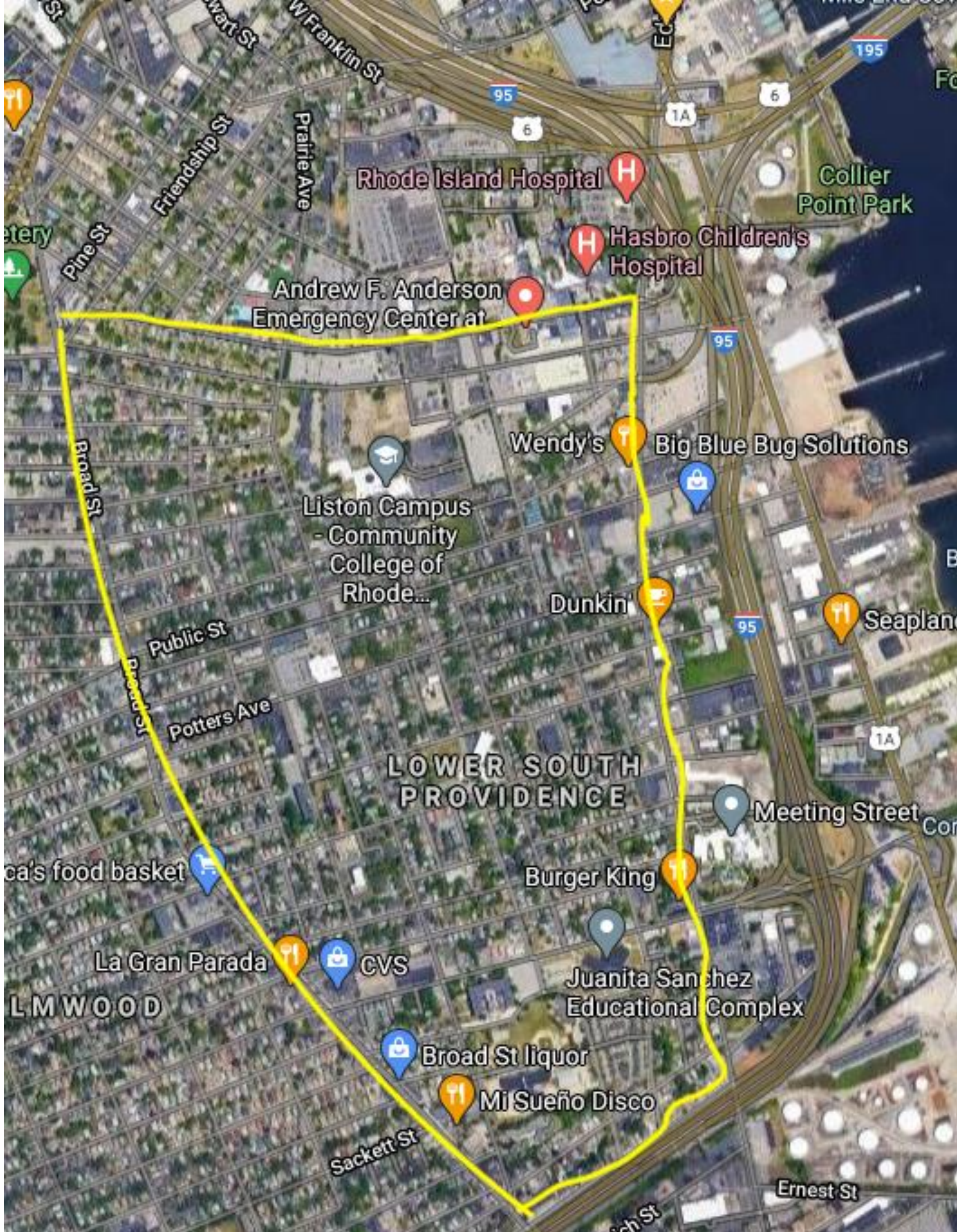
Start-up | Planning | Action | Evaluation

https://forestadaptation.org/adapt/demonstration-projects/providence-ri-climate-health-adaptation-neighborhood-scale

I. Goals

- Increase and enhance canopy cover.
- Decrease stormwater runoff.
- Engage residents, community groups, and institutions.
- Protect existing tree canopy.



II. Impacts

- Warmer Temperatures: The project area is in one of the hottest pockets of Providence.
- Extreme Events:
  - Older trees susceptible to breakage from wind
  - Localized flooding-combined stormwater system
- Altered Soil Moisture and Increased Drought Risk.

III. Challenges and Opportunities

Challenges

- More difficult to establish trees.
- Fewer volunteer day opportunities in summer (heat, storms).
- Less hospital environment for maintenance activities.

Opportunities

- Can plant trees from warmer zones.
- Longer planting season.
- Climate change raises importance of action.

IV. Adaptation Tactics

- Select drought-adapted and wind tolerant trees by examining adaptive capacity scores for individual tree species.
- Develop communication strategies using the local school and organizations.
- Create small green spaces that incorporate nature and are designed by the community.

V. Monitoring

- Number and diversity of new trees planted.
- Number of trees pruned/maintained by volunteers.
- Number of risk assessments conducted and EAB treatments given.

Learn More

https://www.vibrantcitieslab.com/guides/climate-health-action-guide/

https://www.Forestadaptation.org/urban

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AMERICAN FORESTS - SINCE 1875 -

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