Hastings-on-Hudson

2020 Climate Vulnerability Assessment and Future Predictions

Produced by the
Hastings-on-Hudson Climate Smart Communities Task Force
Vulnerability Assessment Committee

Village of Hastings-on-Hudson
7 Maple Avenue, Hastings-on-Hudson, NY 10706

Credits and Acknowledgements

This document was prepared by the core team of the Climate Vulnerability Assessment (CVA) Committee, comprised of the following members: Brad Dunn, Mary Lambert, Ion Simonides, and Mohit Chandra. It could not have been completed without the invaluable help of the Village mayor, municipal staff, the Emergency Team, and the countless numbers of residents who gave their input.

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Overview and Purpose

Climate Smart Communities

In 2009, New York State launched the Climate Smart Communities (CSC) program, an interagency initiative that encourages local communities to take action on reducing greenhouse gas emissions and adapting to climate change. The CSC program is jointly sponsored by the following six New York State agencies: the Department of Environmental Conservation (DEC); the Energy Research and Development Authority (NYSERDA); the Department of Public Service; the Department of State; the Department of Transportation; the Department of Health; and the Power Authority (NYPA). DEC acts as the main administrator of the program. The original focus of the program, developed in 2009, was on encouraging local governments to commit to acting on climate change by passing a resolution containing the 10-point CSC Pledge. The ten required elements of the CSC pledge are as follows:

1. Build a climate-smart community by forming a CSC task force with community members, and connecting to larger climate action networks
2. Inventory emissions, set goals, and plan for climate action
3. Decrease energy use
4. Shift to clean, renewable energy
5. Use climate-smart materials management
6. Implement climate-smart land use
7. Enhance community resilience to climate change
8. Support a green innovation economy
9. Inform and inspire the public
10. Engage in an evolving process of climate action

The certification program, announced in 2014, is the next step in the evolution of the program and provides specific guidance on how to implement the CSC pledge. To be designated a Certified Climate Smart Community, a municipality must go beyond the CSC pledge by completing and documenting a number of actions that mitigate and adapt to climate change at the local level. The CSC program provides a framework for implementing these climate-smart actions and recognizes communities for their accomplishments through a rating system leading to three levels of award: bronze, silver, and gold (the gold level is currently under development).

There are numerous benefits for a municipality that becomes CSC-certified. Certification actions generate cost reductions; result in ecological restoration and climate change adaptation; improve public health and environmental quality; foster energy efficiency and independence; and ultimately improve sustainability and resilience of a community. In addition to the advantages of the actions themselves, CSC-certified communities receive better scores on certain state grant applications, state-level recognition for their leadership, and access to a network of other certified communities, resources, training, tools, and expert guidance.[1]

[1] New York State. (2019). Climate Smart Communities. Retrieved from New York State: https://climatesmart.ny.gov/about/

Hastings-on-Hudson: A Climate Smart Community

The Village of Hastings-on-Hudson was designated by New York State as a Climate Smart Community (CSC) in 2010, with the goal of mitigating and adapting to climate change and reducing its carbon footprint. The Village secured Bronze level certification in January 2020.

Climate Vulnerability Assessment

A climate vulnerability assessment identifies community assets, systems, and populations that are particularly susceptible to the impacts of climate change. A vulnerability assessment is a necessary step in developing a climate adaptation strategy because it identifies and characterizes the environmental, infrastructural, and social elements of a community that need adaptive measures. Generally, vulnerability assessments involve the following steps:

1. Identify climatic hazards occurring and likely to occur within the geographic boundary of interest.
2. Identify community assets, systems, and populations currently and likely to be exposed to the identified climatic hazards.
3. Assess the sensitivity and adaptive capacity of each exposed asset, system, and population to each applicable hazard.
4. Use a scoring or prioritization methodology to rank each identified community facet to inform an adaptation strategy.

Several methodologies exist to complete each step. Some methodologies lean more heavily on technical resources and top-town data collection, while others lean more on qualitative input from community members. As there are benefits and drawbacks to every approach, many communities choose a combination of methods that suit their financial, administrative, and political limitations. The methodology chosen by Hastings-on-Hudson is described in the next chapter.

Vulnerability Assessment Background

Methodology for Projected Future Conditions

Current climate and environmental conditions (i.e. magnitude and intensity of storms and drought, sea levels, etc.) are projected to change in ways that will influence interactions with natural resources. The various platforms that are available to better understand and evaluate how different climate change scenarios are likely to impact Hudson Valley Communities include:

- Columbia University's Hudson River Flood Decision Support Tool
- New York State Climate Change Science Clearinghouse
- Scenic Hudson's Sea Level Rise Mapper
- The Nature Conservancy's Natural Resource Navigator

As these and other tools indicate, there are many possible scenarios that could manifest over the course of this century. The multiplicity of both global and local factors that can influence these outcomes make specific scenarios difficult to predict. It is therefore important to prepare for a range of possibilities. That said, general trends and rough estimates can be employed for adaptation planning purposes.

The framework behind the Hastings-on-Hudson vulnerability assessment is consistent with the requirements of the New York State Climate Smart Communities program, as well as ICLEI's GreenClimateCities framework. The process involved multiple tools and types of data, chosen based on feasibility, comprehensiveness, and replicability for future updates. The context and components of the methodology are described in the following sections.

New York State Climate Change Impacts and Adaptation Framework

The process of developing a climate change impact and adaptation assessment is summarized by the New York State ClimAID program in the eight steps outlined in Figure 1. The Vulnerability Assessment of Hastings-on-Hudson completes Steps 1 through 3: (1) identifying current and future climate hazards facing the community; (2) creating an inventory of vulnerabilities to climate change; and (3) prioritizing those vulnerabilities. Step 4—developing recommendations for specific adaptation strategies—will be a core element of the Village's Climate Action Plan process, which is currently in the planning stages.

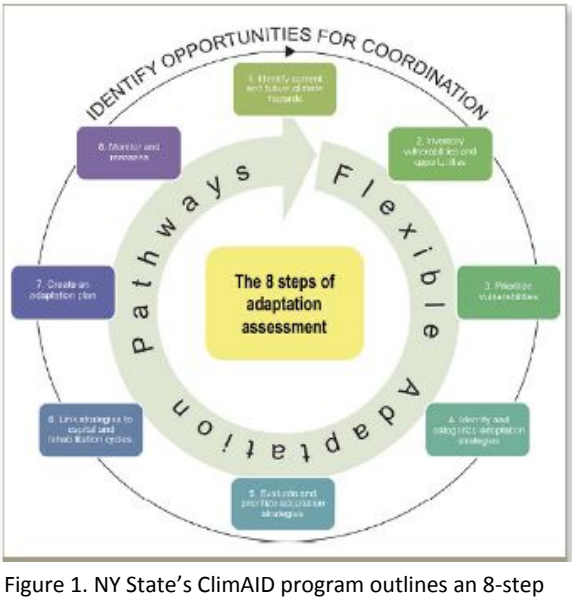

Figure 1. NY State's ClimAID program outlines an 8-step framework to develop climate adaptation strategies.

ICLEI GreenClimateCities

For this climate vulnerability assessment, the New York State ClimAID framework is informed by ICLEI's GreenClimateCities methodology for integrated climate action. The GreenClimateCities methodology tracks closely to the ClimAID framework and in combining them, the two approaches complement each other: they integrate the Village's previous greenhouse gas emissions reduction work, tackling mitigation; and address climate adaptation through the Vulnerability Assessment (Figure 2). Additional benefits of using the GreenClimateCities methodology include process guidance tailored specifically for local governments to "analyze, act, and accelerate" climate action. This builds on the ClimAID framework to include measuring, reporting and verification, which integrates the climate adaptation and mitigation activities that Hastings-on-Hudson currently has underway, and adds Hastings-on-Hudson to a global network of cities, towns, and regions publicly committed to addressing climate change. Under GreenClimateCities, Hastings has already taken the important "Analyze" step to (*a) Commit and Mobilize*, and this Vulnerability Assessment moves Hastings into *(b) Research and Assess*, and (*c) Analyze and Set Baseline*, bringing climate adaptation components in line with the progress the Village has made toward mitigation through its greenhouse gas inventory. Armed with the data in the inventory coupled with this report, Hastings is well-positioned to move into the "Act" phases.

Figure 2. ICLEI's GreenClimateCities framework follows an Analyze-Act-Accelerate pathway for integrated climate action that incorporates GHG emissions reduction, climate adaptation actions, and equitable, inclusive decision-making.

Temperate

Temperate is an online tool created by Azavea, Inc. and ICLEI to assist communities in conducting a climate change vulnerability assessment and developing an adaptation strategy. Temperate features 22 temperature and precipitation indicators derived from either the NASA Earth Exchange Global Daily Downscaled Projections (NASA NEX-GDDP) or the University of California San Diego Localized Constructed Analogs (UCSD LOCA) datasets. In order to predict how the magnitude and/or frequency of climate hazards might change through the end of the century, Temperate includes historical climate

data from 1,000 U.S. cities and averages 33 climate models provided by a variety of research institutions around the world. The Temperate tool identifies potential climate hazards specifically for Hastings-on-Hudson, based on the Village's geographic location (latitude 40.99° N, longitude 73.87° W) and findings from the 2014 National Climate Assessment.

In addition to identifying hazards, Temperate displays the community systems that are likely to be affected. The nexus between climate hazards and community systems is based on the Climate Risk and Adaptation Framework and Taxonomy (CRAFT) developed by the Global Covenant of Mayors for Climate and Energy (GCoM), C40 Cities, and ARUP.[2]

Key Stakeholders and Community Review Process

Key stakeholders include local elected officials, the Village Manager and department heads, the Village Emergency Management Team, as well as various Village boards and commissions, including the Climate Smart Communities Task Force, the Conservation Commission, the Parks and Recreation Commission, and residents of the Village.

In order to identify which of the Village's assets are most vulnerable to the climate changes described, the CVA Committee, a working group of the Climate Smart Communities Task Force, gathered input from the community in four stages. First, an online Climate Vulnerability Assessment survey was sent to residents of the Village in March 2020, to which over 10% of the adult population of the Village responded. Respondents provided feedback on their perceptions of the current state of various infrastructure and systems, and how prepared they perceived the Village was to address climate related vulnerabilities. A range of detailed comments and recommendations were also provided.

Following the survey results and analysis, three online workshops were held, the first with the Village's Emergency Management Team on May 20, 2020. The Emergency Management Team was presented with the climate projections from Temperate, and all relevant climate hazards were discussed as they related to Village assets. Feedback from this Workshop, and from the Community Survey, were used to inform the top climate hazards discussed at the two public community workshops, which followed on June 3 and June 23, 2020. Prior to these workshops, background materials were made available to workshop participants on the Climate Vulnerability Assessment web page. At the workshops, members of the community discussed the relevant climate hazards, as well as pairings of top climate hazards with priority assets in the categories of infrastructure, environmental, and social assets.

Lastly, the process included a review of a handful of relevant Village documents, including its Hazard Mitigation Plan (December 2015), Heat Emergency Plan (2019), and Natural Resources Inventory (2020). Each of these reports contributed important insights and recommendations that were used to substantiate the public feedback received. This final report is informed by these reports, by the key stakeholders from the Village Staff and its Emergency Team mentioned above, as well as by feedback from residents including over 85 residents who attended the public workshops, and 530+ residents who provided feedback via the survey.

[2] GCoM. (2019). Resources for Cities. Retrieved from Global Covenant of Mayors for Climate and Energy: https://www.globalcovenantofmayors.org/our-initiatives/data4cities/resources/

Summary of Findings: Hazards

Top Hazards

Reliable climate data and climate projections help decision-makers identify vulnerabilities and plan for impacts. For this reason, both the New York State ClimAID and the ICLEI GreenClimateCities frameworks begin with gathering and analyzing data on how temperature, precipitation, and other climate indicators are anticipated to change through the end of the century. The Hastings-on-Hudson Vulnerability Assessment examined Temperate tool data from 33 climate models. The results were presented at a May 2020 Emergency Management Team workshop and at two June 2020 Community Engagement workshops. The top climate hazards indicated by the Temperate tool and the Climate Vulnerability Assessment Community Survey, completed in May 2020 (see Appendix A for full results), produced similar results. Due to the fact that the latest scientific evidence indicates that global climate change is on track to exceed an increase of three degrees Celsius, all of the climate data and projections described in this report are for this likely scenario.

The Temperate tool combined with the results of the Climate Vulnerability Assessment Community Survey confirmed the top climate hazards in the short and long-term for the Village of Hastings-on-Hudson as the following:

Extreme Hot Days and Heat Waves

The relevant temperature indicators for extreme hot days and heat waves include average high temperature, maximum high temperature, extreme heat events, and heat wave incidents. All four indicators show an increasing trend through time, meaning that Hastings-on-Hudson is set to suffer more extreme hot days and heat waves in the coming decades than it has historically experienced.

Today, the average high temperature for Hastings-on-Hudson is 64.6° F, while the maximum high temperature is 99.1° F. In the next decade, the average high temperature will increase 0.7 degrees to 65.3° F, and the maximum high temperature will increase to 100.0° F. Changes start to become significant by mid-century, with the average high temperature reaching 67.6° F, an increase of 3.0° F from today, and the maximum high temperature reaching 102.7° F, an increase of 3.6° F from today. By century's end, the changes are striking, as the average high temperature will reach 73.1° F, up a total of 8.5° F from today, and the maximum high temperature will reach 110.1° F,

Figure 3. Map indicating summer temperatures in the New York metro area will be comparable to Lehigh Acres, FL by 2100 if current emission trends continue. Source: https://statesatrisk.org/new-york/all.

up a total of 11° F from today. Even if countries are successful in achieving the climate goal of limiting average global warming to less than 4° F, by the end of the century, the climate in Hastings-on-Hudson will likely be comparable to current climate conditions in Lehigh Acres, Florida.

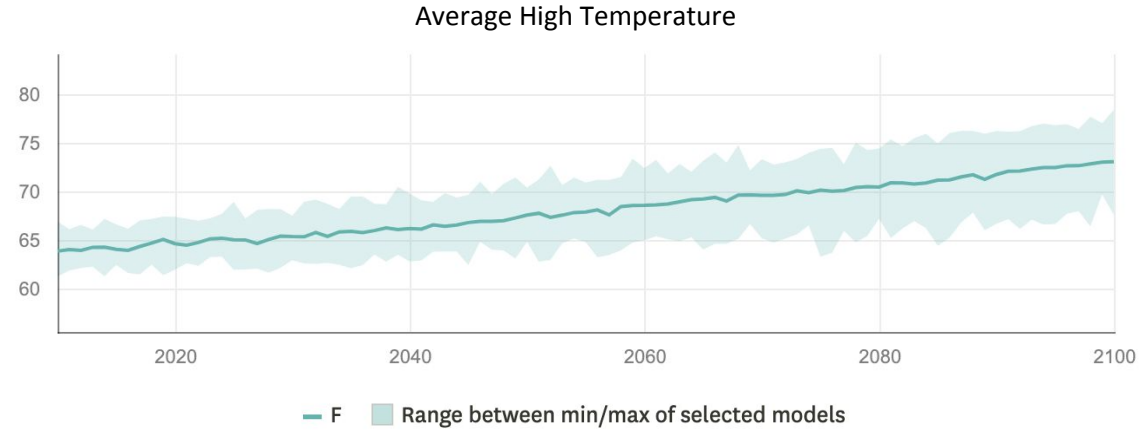

Figure 4. Aggregated average high temperature, generated from daily data using all requested models, from 2010 to 2100. Source: https://temperate.io/dashboard.

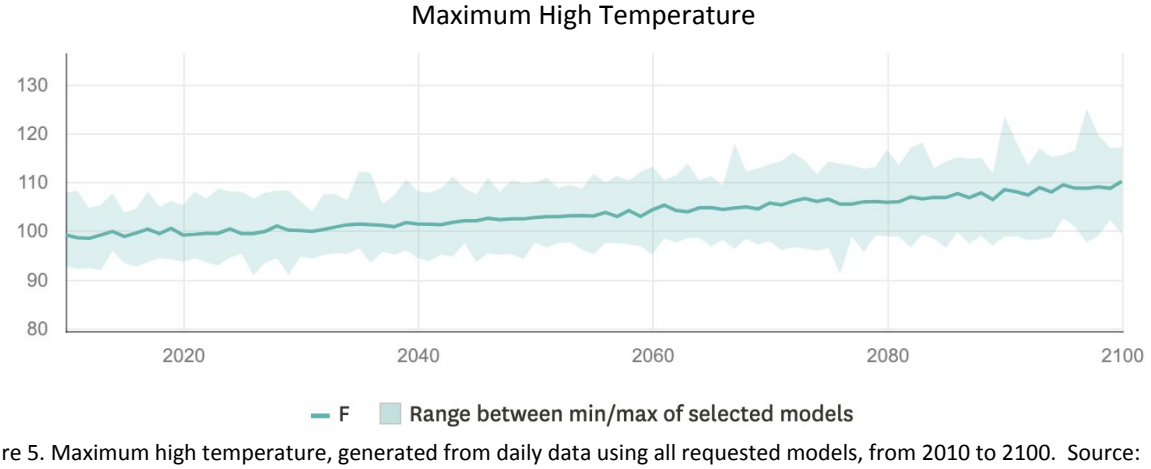

Figure 5. Maximum high temperature, generated from daily data using all requested models, from 2010 to 2100. Source: https://temperate.io/dashboard.

Extreme heat events, defined as when the daily maximum temperature exceeds 99 percent of historic temperature observations with a historic base range year of 1971, will occur on an average of 8.3 days in 2020. There is a slight increase in extreme heat events by 2030, with the count reaching 11.8 days per year of above historic temperatures. By mid-century, the count of extreme heat events will reach 20.6 days per year, and by century's end, Hastings-on-Hudson will experience 61.4 days of extreme heat, or just over 2 months of above historic temperatures per year, a total increase of 53.1 days from today.

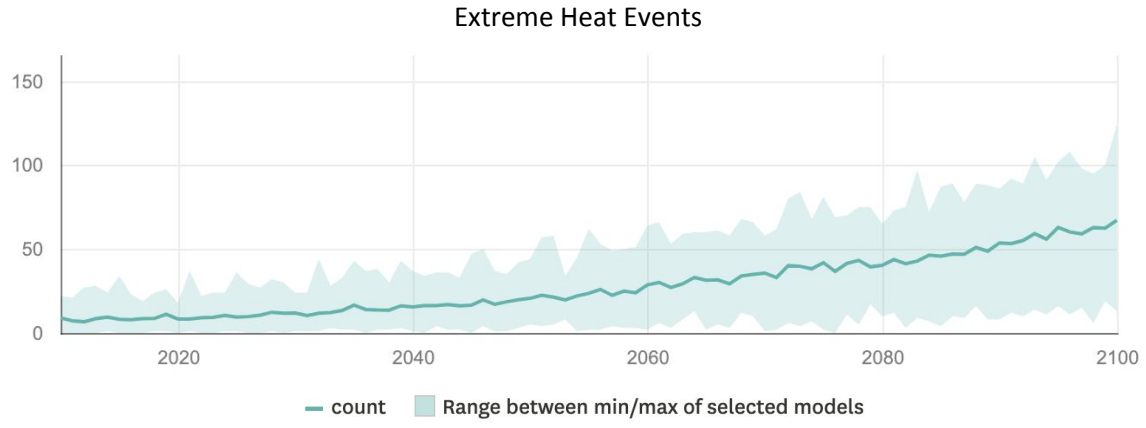

Figure 6. Total number of times per year daily maximum temperature exceeds the 99th percentile of historic observations, with a historic base range year of 1971, from 2010 to 2100. Source: https://temperate.io/dashboard.

Hastings-on-Hudson is projected to experience 2.1 more heat waves every year by 2035. Heat waves are defined as the number of times the daily high temperatures exceeds 41 degrees Fahrenheit above the historic norm for at least five consecutive days, with a historic base range year of 1971. Today, the Village experiences an average of three heat waves per year. By mid-century, Hastings-on-Hudson will experience 6.5 heat waves per year, and by the end of the century, we will experience almost 15 heat waves per year, an increase of 12 heat wave events from today.

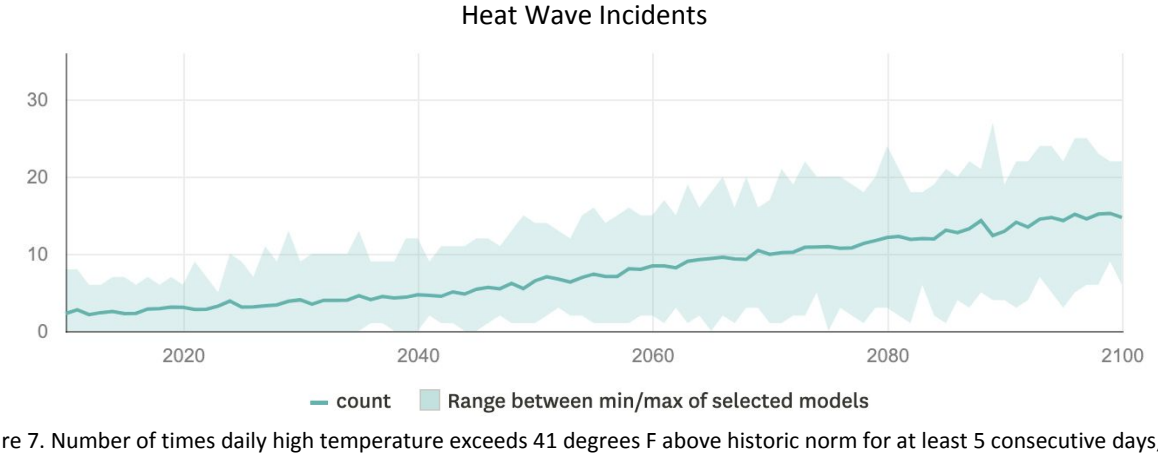

Figure 7. Number of times daily high temperature exceeds 41 degrees F above historic norm for at least 5 consecutive days, with historic base range year of 1971, from 2010 to 2100. Source: https://temperate.io/dashboard.

Severe Storms and Flooding

The relevant precipitation indicators for the severe storms and flooding climate hazards include extreme precipitation events and precipitation threshold. Both indicators show an increasing trend, meaning that Hastings-on-Hudson will experience more severe storms and flooding in the coming decades than it has in the past. These projections should come as no surprise, as historic precipitation data for the northeastern United States show a remarkable 71 percent increase in the amount of precipitation falling during very heavy precipitation events from 1958 to 2012 (Figure 8). In addition, historic data for

Atlantic hurricanes from 1970 to 2010 show an increase in the total number of hurricanes as well as an increase in the proportion of those hurricanes becoming Category 3 or higher (Figure 9).

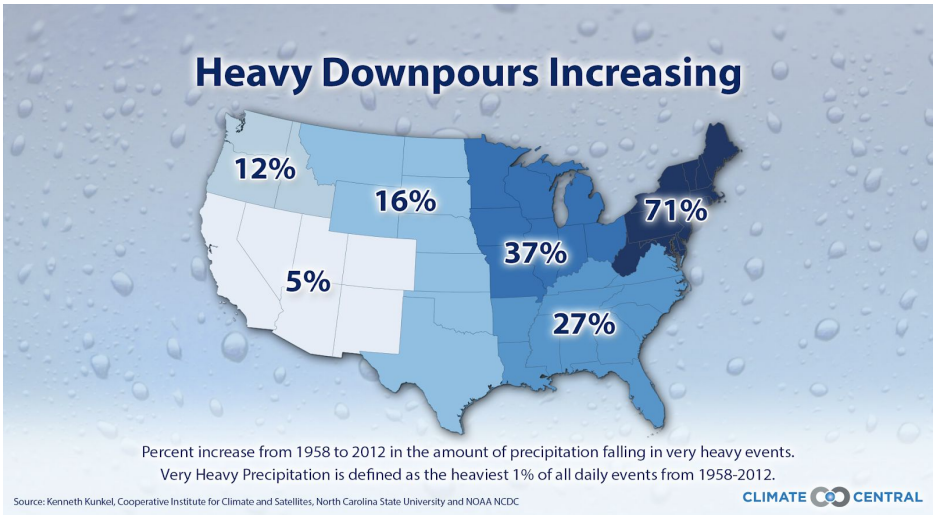

Figure 8. Map of the US with geographic regions showing the percent increase in the amount of precipitation falling in very heavy precipitation events from 1958 to 2012. Source: https://statesatrisk.org/new-york/all.

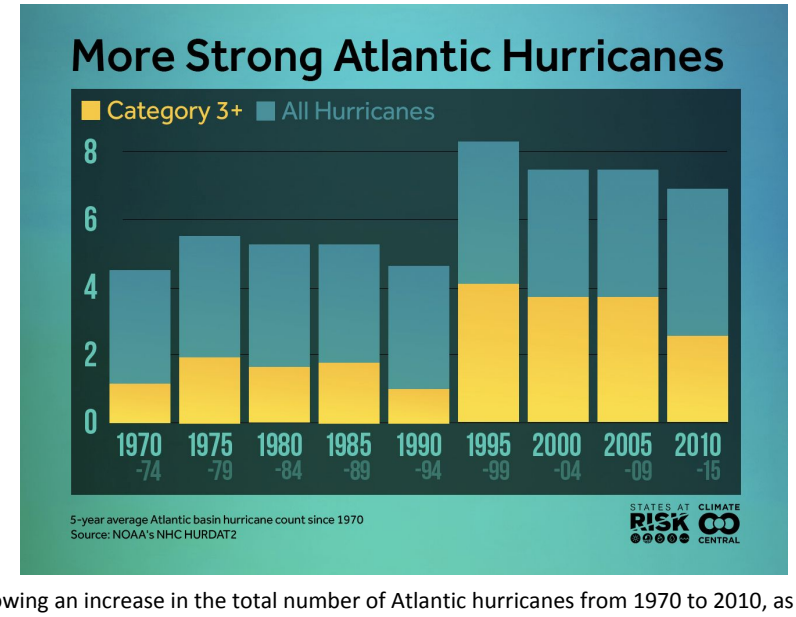

Figure 9. Bar graph showing an increase in the total number of Atlantic hurricanes from 1970 to 2010, as well as an increase in the proportion of those hurricanes becoming Category 3+ hurricanes. Source: https://statesatrisk.org/new-york/all.

The number of extreme precipitation events in Hastings-on-Hudson is projected to nearly double by 2100. We have seen that the Village is projected to experience hotter and more frequently hot days in the coming decades. Higher temperatures in the atmosphere leads to changes in weather patterns and fluctuations in the amount of moisture that is retained in the atmosphere throughout the year. While the total amount of precipitation in Hastings-on-Hudson is anticipated to change only modestly — from an average of 49 inches of annual precipitation today to an average of 54 inches by 2100 — when and how that precipitation falls is likely to change markedly. One change that residents can expect is a doubling of the number of extreme precipitation events in the next 80 years. Extreme precipitation

events are defined as any time the average precipitation on a given day is higher than 99 percent of historical precipitation, compared to a historic base range year of 1971. Today, these extreme events of heavy rain or snow occur about twice per year, and that number is anticipated to reach four or more occurrences per year by the end of the century.

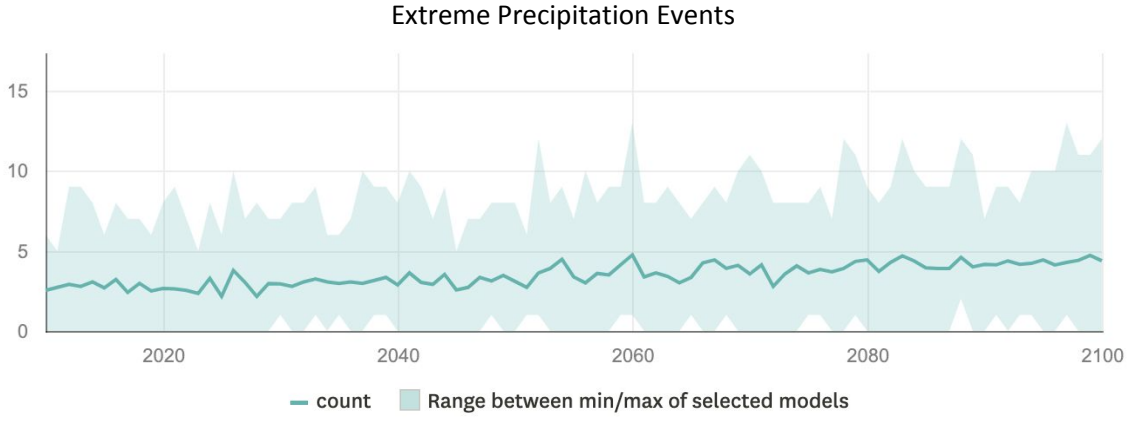

Figure 10. Total number of times per year daily average precipitation rate exceeds the 99th percentile of historic observations, with historic base range year of 1971, from 2010 to 2100. Source: https://temperate.io/dashboard.

A precipitation threshold is defined as the cumulative precipitation amount that generates critical runoffs high enough to cause flooding. Research indicates that peak storm intensity is significantly correlated with a precipitation threshold above which flooding becomes highly probable. This correlation suggests that the projected increases in extreme precipitation events and their intensity will lead to more days where the precipitation exceeds the threshold and causes flooding. The Temperate tool suggests a precipitation threshold of two inches per day for Hastings, and today, the threshold is breached about one day a year. By the end of the century, the precipitation threshold is projected to be exceeded 2.5 days per year.

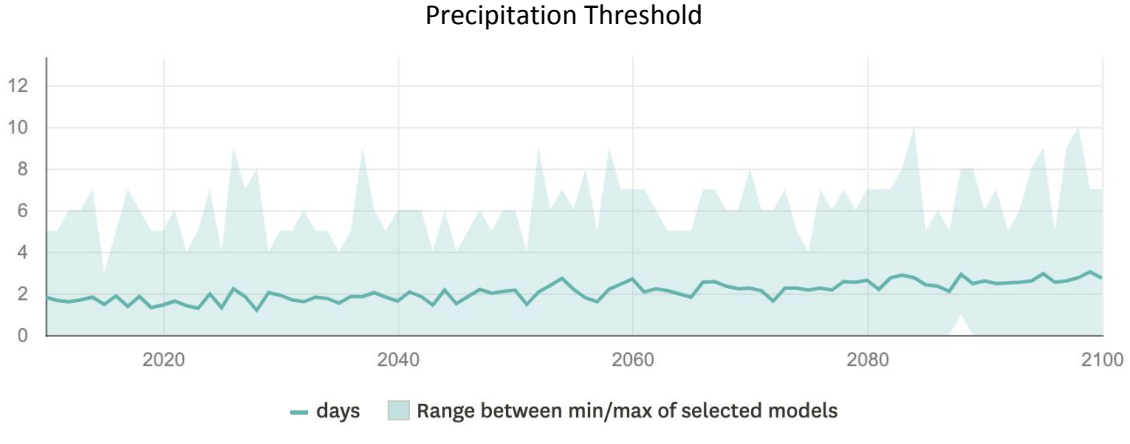

Figure 11. Number of days where precipitation rate, generated from daily data using all requested models, is greater than or equal to 50 millimeters per day, from 2010 to 2100. Source: https://temperate.io/dashboard.

In addition to the precipitation indicators presented by the Temperate tool, other relevant and important indicators for the severe storms and flooding climate hazards are sea-level rise and storm surges. Historic global average sea level change data from 1880 to 2020 clearly shows a 9-inch increase in sea level, as well as an increase in the rate of sea level rise over time (Figure 12). The polar ice caps are melting at a faster rate than scientists predicted, and Hastings-on-Hudson is located in an area that will be especially susceptible to sea level rise. The influx of polar ice melt into the Atlantic Ocean caused by global warming is adding to long-standing regional geological subsidence, causing sea level in the northeastern United States to rise 3 to 4 times faster than the global average. According to the U.S. government's 2018 National Climate Assessment, the sea-level rise in the northeastern United States will likely be within the range of 2 to 6 feet by the end of the century. In the worst case scenario, where countries are unable to limit the average global warming to less than 4° F and the ice caps melt at the high-end of projections, sea level could rise upwards of 11 feet in the northeastern United States. The effects of sea level rise on the Hastings-on-Hudson waterfront can be visualized using the Scenic Hudson's Sea Level Rise Mapper (Figure 13).

Regarding storm surges, while there is limited data on their historic occurrence in the Hudson River and future predictions of their increase or severity, there is anecdotal evidence that storm surges in the Hudson River will increasingly affect Hastings-on-Hudson in the coming years. Hurricane Sandy in 2012 is the most recent severe storm that caused a significant local storm surge. The storm surge flooded a significant portion of the Hastings Waterfront, as it lies only a few feet above sea level (Figure 14). Storm surges necessarily result from severe storms, and the evidence provided earlier in this section showing an increasing trend in the number of Atlantic hurricanes and the number of Category 3 or higher hurricanes suggests there will also be an increase in storm surges that will affect the Village in the future.

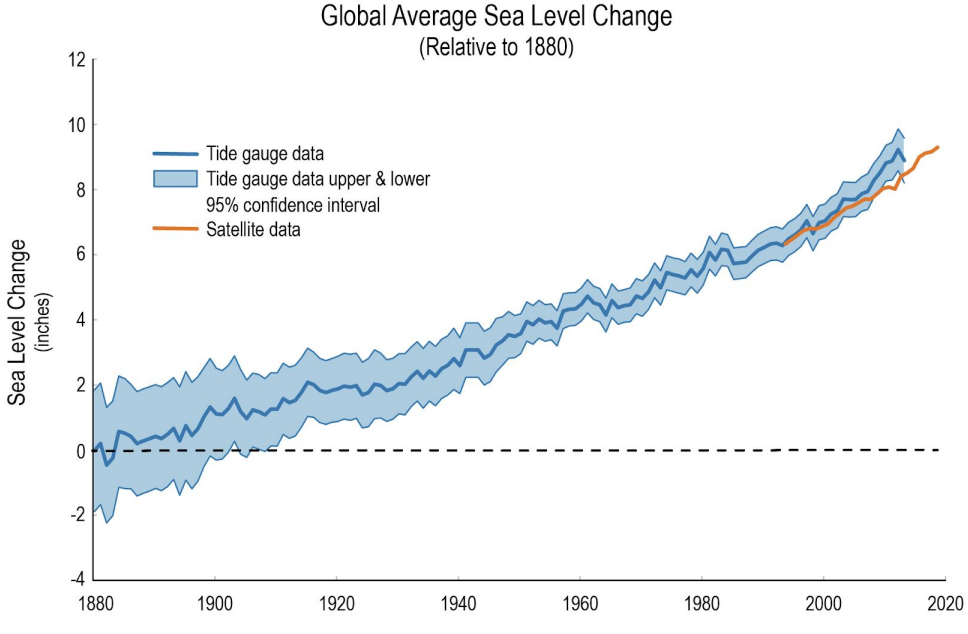

Figure 12. Graph depicting global average sea level change in inches relative to 1880 levels from 1880 to 2020. Source: https://www.globalchange.gov/browse/indicators/global-sea-level-rise#:~:text=Global%20sea%20level%20has%20risen,has%20increased%20in%20recent%20decades.

FIgure 13. Map of Hastings-on-Hudson Waterfront showing the effect of a six foot rise in sea level. Source: https://scenichudson.maps.arcgis.com/apps/MapJournal/index.html?appid=3a3d0dc3884c4637ad0a51f4aa912189.

Figure 14. Image showing the flooded Hastings Waterfront resulting from the storm surge of Hurricane Sandy in 2012. Source: https://dailyvoice.com/new-york/armonk/news/how-you-can-register-for-fema-hurricane-assistance/546629/.

Insect Infestation and Invasive Species

With a warmer and wetter climate, Hastings-on-Hudson residents will face an elevated risk of vector-borne illnesses such as Lyme Disease, West Nile and Zika. Homes, gardens, and the overall ecosystem will face disruption from invasive species that thrive in a changing climate. Although numerous species pose potential threats to our health and habitat, this report will consider the top four concerns identified in our community survey: deer ticks, mosquitoes (from the *Aedes* family), brown marmorated stink bugs, and kudzu.

Deer Ticks

Ticks that transmit Lyme Disease are active when temperatures are over 45°F, and therefore warmer winters will likely lengthen the tick season. By 2065 to 2080, it is projected that the period of elevated risk of Lyme Disease in Hastings-on-Hudson will begin 0.9 to 2.8 weeks earlier than at present. Lyme Disease produces a wide range of symptoms, such as fever, rash, facial paralysis, and arthritis. About 10 to 20 percent of people develop joint pains, memory problems, and extreme exhaustion. Living near wooded or brushy areas can increase risk. Children under 15 and adults 25 to 44 experience the most cases as they spend more time outdoors.

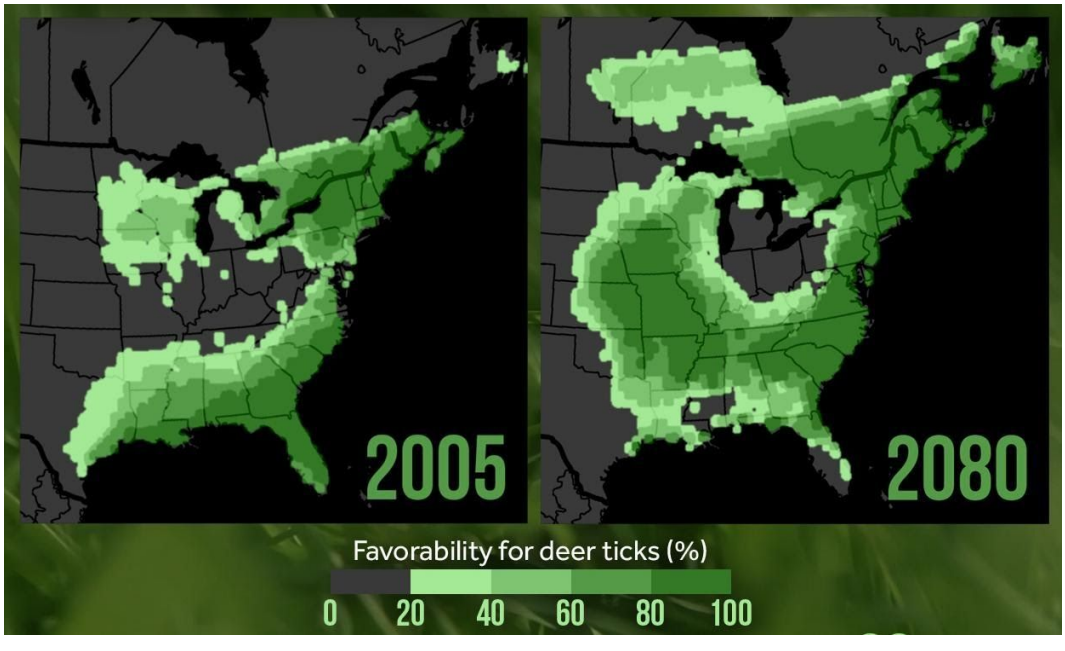

Figure 15. Projections suggest Hastings-on-Hudson will be 100% favorable to deer ticks by 2080.
(Source: J. Brownstein, T. Holford, and D. Fish for Climate Central)

Mosquitoes (Aedes family)

Mosquitoes spread West Nile, Zika, Eastern Equine Encephalitis, and other vector-borne diseases. Mosquito activity is increased when night temps are 50°F or warmer. Mosquitoes' habitat is expected to increase in the Hudson Valley region from the current 5% to 16% in the next two decades, and from 43% to 49% by the end of the century. The populations at greatest risk for disease are those younger than 5 or older than 50. People who live in areas with greater amounts of vegetation, and in older homes, are also more vulnerable to infection.

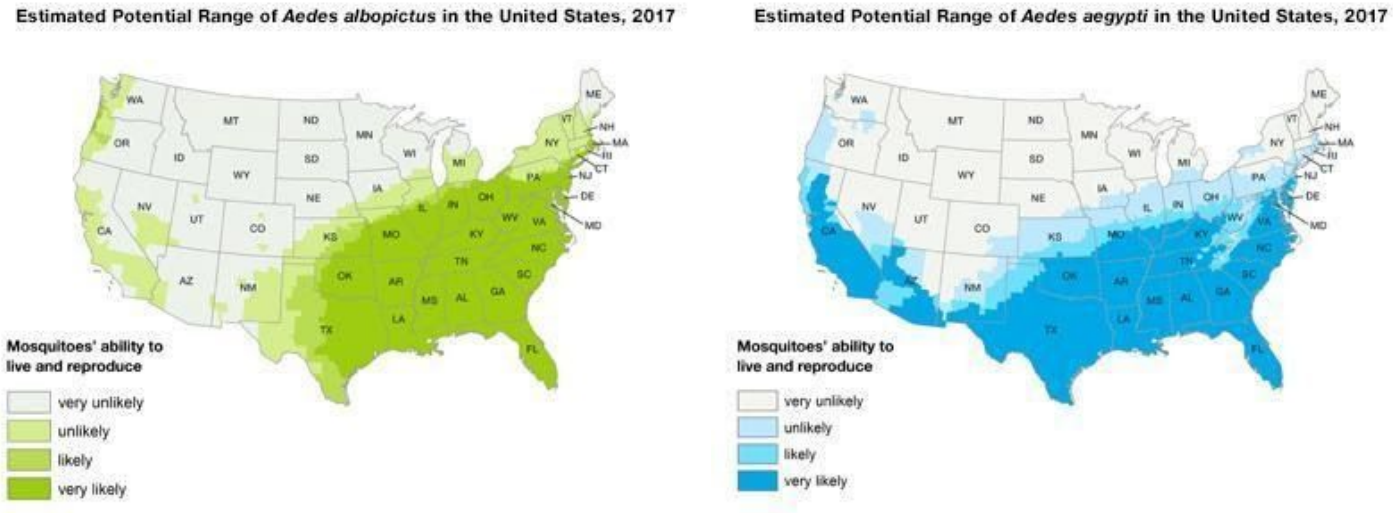

Figure 16. Centers for Disease Control and Prevention. Source: https://www.cdc.gov/zika/vector/range.html.

Brown Marmorated Stink Bugs

Since its first appearance in Pennsylvania in 1996, this highly invasive species from Asia has spread rapidly throughout the Mid-Atlantic region. With no indigenous predators, these bugs pose a significant nuisance to homeowners. Once established — and if left unchecked — an infestation can grow to thousands of bugs in a single home. When they emerge in the spring, they eat ornamental plants, fruit trees, and vegetable gardens. Stink bugs are projected to be firmly established in Hastings-on-Hudson by 2050.

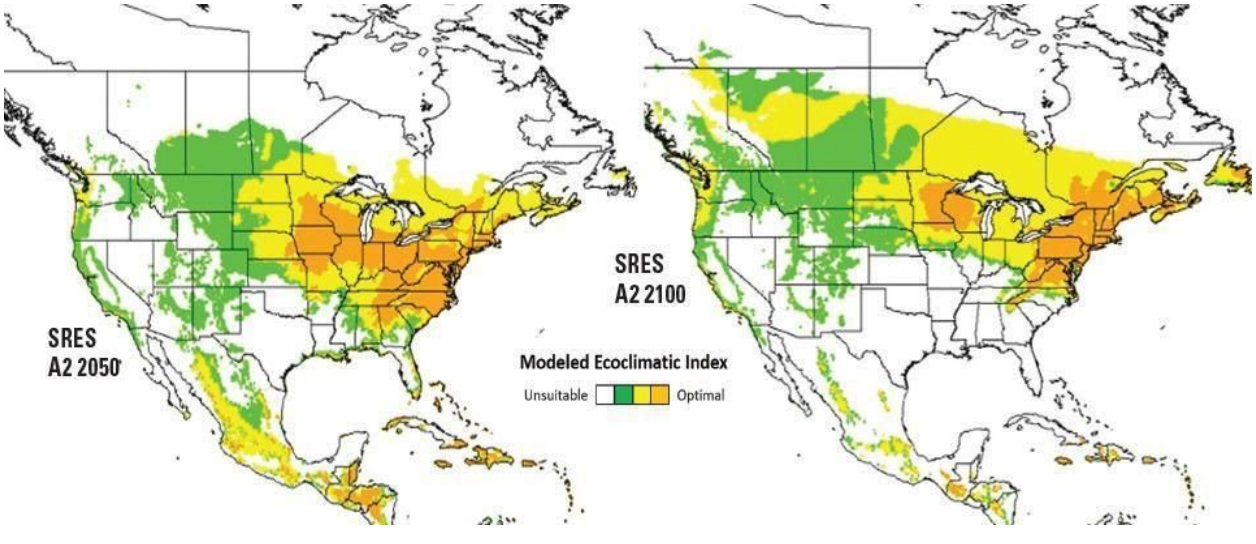

Figure 17. Projections suggest Hastings-on-Hudson will be 100% favorable to stink bugs by 2050.
Source: Climate Central.

Kudzu

Kudzu, aka "The Vine That Ate the South," is a semi-woody perennial vine that is invasive to North America. The vine can trail and climb on a variety of surfaces, including trees, shrubs, ground vegetation, buildings and bare surfaces. Kudzu can grow up to a foot per day, enabling it to quickly engulf large areas and strangle native plant-life. Kudzu has already been detected in lower Westchester, and by 2100 is expected to be entrenched throughout the Northeast and Mid-Atlantic regions.

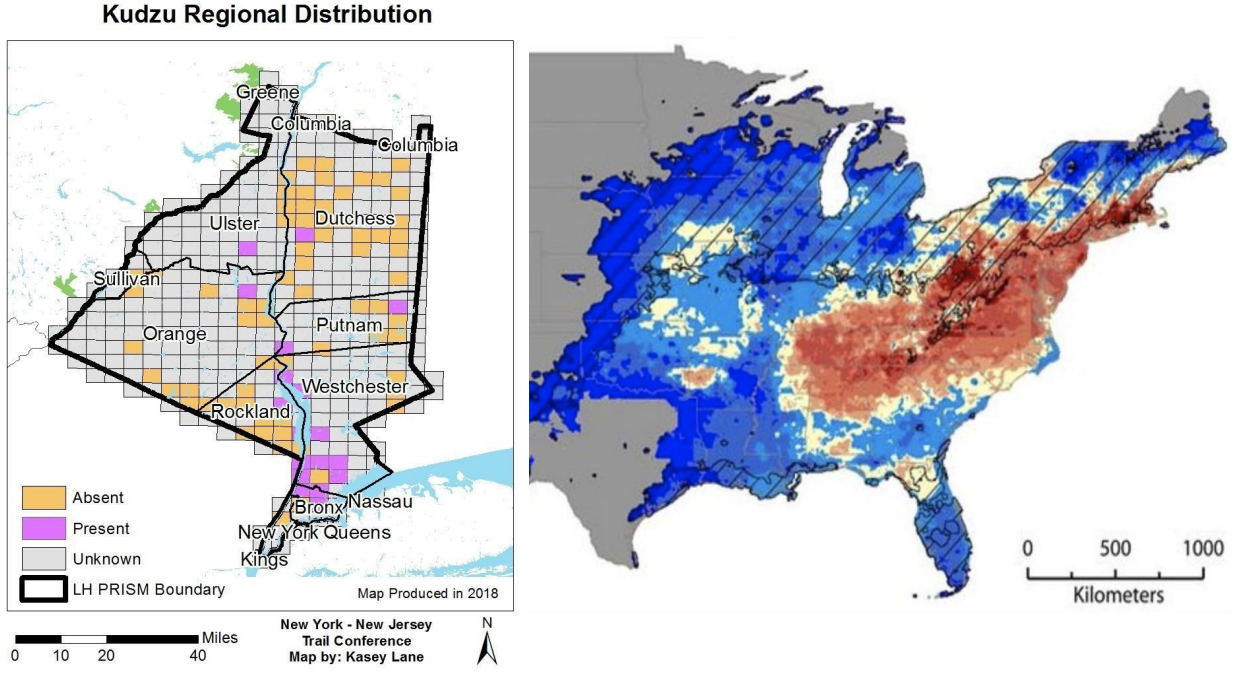

Figure 18. Kudzu has already been detected in areas around Hasting-on-Hudson (left). Projections suggest the Village will be fully immersed in the vine's habitat by 2100 (right). Source: Kasey Lane and Climate Central.

Summary of Findings: Key Assets and Vulnerabilities

To identify which of the Village's assets are most vulnerable to the climate changes described above, the Climate Smart Communities Task Force gathered input from the community in four stages: first, in March 2020, an online Climate Vulnerability Assessment survey was sent out to residents; this was followed by an online workshop with the Emergency Management Team on May 20, 2020; and finally, residents were engaged in two live online workshops, on June 3 and June 23, 2020.

Participants in all three public workshops were asked to identify infrastructural, environmental and social assets in our community; determine which of those assets are most vulnerable to the anticipated changes in climate; and identify and prioritize actions. Numerous assets were identified during the workshops and were then grouped in distinct categories or areas of concern.

Infrastructure Assets (Four categories of concern)

- **Transportation** — The Saw Mill River Parkway, the MTA railroad station, tracks and parking lots, and the Ravensdale Bridge.
- **Systems Infrastructure** — Power supply system, wastewater and sewer infrastructure, and communications systems.
- **Municipal Structures** — The Department of Public Works building, the Fire Department and Fire Houses, Chemka Pool, Hillside Elementary School, and Village Hall (which also houses the Police and Buildings Departments).
- **Other Structures** — Hastings Historical Society, the Jasper Cropsey House, and the American Legion Building.

Environmental Assets (Two categories of concern)

- **Environmental or Natural Assets** — Hillside Woods, Sugar Pond, the Hudson River, Kinnally Cove and the Saw MIll River.
- **Public Parks and Recreation Areas** — MacEachron Waterfront Park, South County Trailway, Old Croton Aqueduct Trailway, Rowley's Bridge Trail and Extension, the Burke Estate, and Reynolds Field.

Social Assets (Two categories of concern)

- **Emergency Services** — Cooling shelters and emergency shelters, volunteer fire department services, ambulance services.
- **Vulnerable Communities and Food Security** — The Food Pantry, the Farmer's Market, Zinsser Community Gardens, and the Andrus On Hudson nursing home.

Infrastructure Assets

Transportation

Flooding on the Saw Mill River Parkway and nearby residential streets was cited as the top transportation-related vulnerability. Almost all of the land abutting the Saw Mill River—including lands

between the river and Saw Mill River Road, and lands extending across the Saw Mill River Parkway—are in the 100-year floodplain. The parkway is historically sensitive to flooding and has become completely submerged after heavy precipitation several times in recent years, rendering it unusable during emergencies. Fortunately, over the last 50 years, work has been undertaken north of the Village that has somewhat alleviated the parkway's flooding in our area; in particular, the Stanley Avenue area used to flood frequently and no longer does.

The MTA railroad station, tracks, and train station parking lot are also a top flooding concern, as they are sensitive both to extreme weather events and long-term climate-related change. The majority of the Hastings-on-Hudson waterfront to the west of the Metro-North railroad tracks is in the 100-year floodplain, and some portions directly abutting the railroad tracks are in the 500-year floodplain. One resident said: "MetroNorth service is frequently insufficient due to extreme weather, fallen trees, flooding, icing of the third rail. The tracks are located right on the river. Some day, these tracks may be under water and are vulnerable to sea level rise flooding and erosion, mud slides, and severe storm events. That infrastructure should be better protected." Ensuring that the Saw Mill River Parkway and MTA station and tracks are adequately adapted to the projected climate changes will require significant investment and engineering. The bridge at the southern end of the waterfront over the MTA tracks was also noted as vulnerable to climate events. Discussion with MTA officials regarding the short and long-term management plans for regional MTA infrastructure was deemed an important action.

Ravensdale Bridge was cited as the third-most-vulnerable transportation asset, as it is the only east-west connection the Village has with the rest of Westchester County and is the only means within the Village to cross the Saw Mill River Parkway when it is flooded. The bridge is currently being replaced, which will greatly increase its adaptive capacity. Beyond these three vulnerable transportation structures, many residents also expressed concern that the Village should do more to encourage walking and biking, to improve community resilience. One resident said, "The Village should make changes to its streets and sidewalks to encourage walking and biking: we need slower traffic speeds; traffic calming with speed humps, bump outs and chicanes; we should reduce the number of lanes; and create safer crosswalks, bike lanes and build more sidewalks."

Systems Infrastructure

The Village's power supply system was considered vulnerable by both the Emergency Team and the community because its physical components are sensitive to extreme weather events and its delivery capacity can be overwhelmed during heat spells due to increased demand for air-conditioning. One resident said, "I have experienced long outages of power during storms, up to a week or more. These could occur more frequently as climate change effects come into play. Blackouts are frequent. Power lines are above ground, which is a huge liability." The adaptive capacity of the system's physical components — the utility poles and network of overhead power lines — is reliant on investment and maintenance from Con Edison. However, backup power generation is less expensive and easier to implement, and increases the system's adaptability to climate changes. Specifically, the Emergency Management Team noted that backup generators are needed at several municipal buildings, and pointed out that only one gas station in the Village is equipped with a backup generator. A resident added, "Storms and downed trees make Hastings vulnerable to power disruptions. I would love to see the Hastings grid become more decentralized and local."

The Village's wastewater and sewer infrastructure ranked second among the concerns, with the Emergency Team identifying numerous culverts that need maintenance, repair or replacement. The wastewater system of the Village is particularly sensitive to severe storms and heavy precipitation events. Many storm drains are too small or clogged to sufficiently channel water, leading to residential flooding and increased erosion. Low lying streets are prone to flooding, particularly Fenwick Avenue and the intersection of Fairmont and Cochrane Avenues, where many storm basins converge and drain out of a single pipe. While some improvements have been made (such as the installation of bigger basins), this area is still vulnerable, in part due to a natural spring near Fenwick that runs under Ravensdale and Dan Rile Park, and eventually reaches Farragut, where it runs alongside Farragut to the Saw Mill. One resident flagged that Hamilton Avenue is particularly vulnerable to flooding as well: "A lot of storm drains are blocked, some by asphalt that got dumped in during road repairs." Since the Village is characterized by a relatively large number of steep slopes, stormwater management has been a serious consideration for several decades. The Village has an active Stormwater Management Plan and the building code mandates that every project is reviewed for stormwater runoff impacts. Regular review and updates of this Stormwater Management Plan will continue to be important.

The communications system of the Village was identified as the third significant concern. As more residents "cut the cord" and go 100% wireless, it becomes difficult to communicate with them during power outages. Residents pointed out that because much of our power, water, and natural gas systems are out of our jurisdiction, we should ensure strong relationships, or even build more formal partnerships with those providers. One resident said, "So much of our infrastructure is beyond our control. We need to develop the right relationships in order to address those vulnerabilities. We might consider identifying who is tasked with managing those relationships."

Municipal and Other Structures

The Department of Public Works building, which stands close to the Hudson River waterfront, was cited as Hastings' most vulnerable municipal structure as it is particularly sensitive to storm surges and the long-term impacts of changes on the Hudson River. The building has flooded several times in the past, including during Hurricane Sandy in 2012, making it difficult to continue services during climate-related emergencies. The Volunteer Fire Department and its various Fire Houses throughout the Village were also a top concern. Structurally, these buildings are generally in good shape, with the exception of documented repairs needed for the DPW building, Hook and Ladder Building, and the Library. Chemka Pool ranked third-most vulnerable to flooding. It is located below Sugar Pond, and in the 1970s the pond's berm broke and the resulting flash flood caused significant damage to the pool complex, as well as to the School grounds. With regard to schools, residents expressed some concerns about the impact of rising temperatures. As one resident pointed out, "The schools don't have central air-conditioning, so there could be problems in extreme heat events." Other frequently cited vulnerabilities to both heat and flooding were Village Hall, which also houses the Police and Building Departments, the Hastings Historical Society, the Jasper Cropsey House, and the American Legion Building. Some of these buildings need roof repairs (or new roofs entirely), as well as removal of old trees and/or branches that could pose a threat during extreme weather events. Taking these steps would increase the adaptive capacity of these structures.

Environmental Assets

Environmental or Natural Assets

Most of the Village's environmental assets were seen as both a vulnerability and a strength (as related to the top climate hazards we face), for their ability to provide open space, natural resources, flood water storage and other ecosystem services, juxtaposed with their vulnerability to flooding and damage from flood waters and storm surge. In particular, Hillside Woods and Sugar Pond were deemed highly vulnerable to climate changes because they are sensitive to all three of the Village's top climate threats: severe storms, extreme heat, and invasive species. In addition to the threat that flooding or extreme precipitation could have on the structural integrity of the pond's berm (described above), the area is especially at risk from invasive species, including plant diseases, vector-bearing mosquitoes, and a number of devastating vines, including kudzu. To help mitigate these problems and increase the area's adaptive capacity, the Village has initiated a multi-year Hillside Woods and Park Restoration effort to rehabilitate and remediate the woods, bring the ecosystem back to health, and increase its adaptive capacity. The Hudson River, specifically at Kinnally Cove, is also vulnerable to storm surges and sea-level rises. Action has been taken to protect this area, beginning with a study (underway) on the effects of erosion that includes identifying measures to protect the ecosystem.

Public Parks and Recreation Areas

Most residents noted the MacEachron Waterfront Park, which lies next to Kinnally Cove and faces many of the same climate-related issues, is the public park most threatened by climate change. The park was completely inundated by Hudson River flooding during Hurricane Irene in 2011 and Superstorm Sandy in 2012. Its adaptive capacity will be improved by the current study that is examining riverfront erosion. Rowley's Bridge Trail and Extension bordering the waterfront, was also mentioned as vulnerable to Hudson river flooding. Restoration plans have been developed for both MacEachron Park and Rowley's Bridge Trail and Extension but neither are yet funded. If these plans are implemented it would help improve the overall adaptive capacity of the waterfront.

The Village's two most active recreational trails were also deemed vulnerable: the South County Trailway, which runs along the Saw Mill River, and which encounters regular flooding; and the Old Croton Aqueduct trail, which faces challenges to its structural integrity and erosion in some places. The Emergency Management Team noted that New York State is responsible for the Aqueduct trail, but the trail has been poorly maintained in recent years, lowering its adaptive capacity. Partnering with the State to maintain these trails was seen as a high priority. Residents also expressed concern about the Burke Estate and Reynolds Field, which are owned and maintained by the school district. Both are high-use athletics assets. Reynolds Field was also called out for its susceptibility to flooding: it flooded in the late 1970s when the Sugar Pond berm just north of Chemka Pool parking lot washed away; and again in 1999 during Hurricane Floyd. As a result, a berm was constructed on the east side of Reynolds Field to protect it, thereby increasing its adaptive capacity for future extreme precipitation events. In addition to threats from flooding, some residents are concerned that changes in zoning could threaten the athletic fields. "Both Reynolds and Burke face a long-term potential threat in that they remain zoned residential. This is not specifically a result of climate change, but is a concern." In general, the Emergency Management Team said many trees in the Village's parks are diseased and susceptible to invasive species. There has been a marked increase in stink bugs, cicadas, termites, ants, ticks and

spiders in the Village.

Social Assets

Emergency Services

With the anticipation of more heat waves and extreme hot weather, residents and Emergency Team leaders alike cited the importance of cooling and emergency shelters, especially during power outages. This spurred a call for more backup generators throughout the Village, which would greatly improve community resilience and the adaptive capacity of all emergency services in the face of future climate changes. The adaptive capacity of the volunteer fire department and ambulance services were also a frequently cited concern. As one resident said, “In general, fire, police and public works services will be facing additional challenges and we should think about how to strengthen them and prepare them for orientation to the challenges ahead.” Further recommendations included calling attention to relevant Village web site information and emergency protocols (such as those outlined in the Village Heat Emergency Plan) and providing and/or communicating additional means for residents to build important support networks.

Vulnerable Communities and Food Security

Food and water availability were identified as a source of concern during the workshops. The Food Pantry and the Farmer’s Market, in particular, are seen as the most vulnerable assets, specifically sensitive to power outages from severe storms and to extreme heat events. Although a strong majority of residents reported that healthy, affordable food is generally available, more than one-third indicated they were not sure whether our food supply would be able to adjust to extreme climate events. One resident said, “It will be important to ensure the health of the farmers market - it is lower impact than industrial food distribution, it stimulates the local economy, and has the potential to serve as a gathering place for the community.” The Zinsser Community Gardens, where dozens of residents maintain organic gardens, was also cited. “Many people have vegetable gardens, but my impression is that the lots of most residents are not suitable for gardening. This may be a problem if we need to resort to cultivating more foods at home.” Equally, the municipal water supply system was identified as potentially being sensitive to a changing climate. The Emergency Management Team said the system’s underground pipes are aging and some need replacement. As one resident pointed out, “Water systems will be put under significant stress. Wider efforts to reduce water consumption and instill best-practices should be in place now. Strategic planning for worst-case scenarios around water, which is critical to all life, need to be thought out. There's no way to predict what water shortage/crisis we may face.” Another resident said, “We don't know about the integrity, age or upkeep of the infrastructure. We have experienced poor communications and slow responses to local leaks. Our pipe infrastructure is old, which may be a concern.” As for specific populations that are threatened by climate changes, the Andrus On Hudson nursing home was deemed most vulnerable, as well as those with fewer means.

Conclusion

This document identifies, analyzes, and prioritizes the effects of relevant climate hazards on major assets in the Village of Hastings-on-Hudson. The process of undertaking the Climate Vulnerability Assessment has revealed the commitment of municipal officials and staff, Village boards and commissions, as well as a large number of residents, to the protection of the many unique and irreplaceable Village assets that were identified as part of the study. This Climate Vulnerability Assessment report was informed by both the science and by the perceptions of residents and Village Staff on potential climate hazards and priority assets. At each stage of the process, the feedback received was wide-ranging and thoughtful.

In recognizing that perceptions and priorities change, however, the CVA Committee, the CSC Task Force, and the Village are committed to furthering this dialog and continuing the climate adaptation and resilience training and planning process. Next steps include the drafting of a Climate Resilience Vision and a Climate Action Plan, a process scheduled for 2020 to 2021. Beyond these steps, a re-review of this report may take the form of an updated assessment or may be part of an independent major Village planning exercise, such as the creation of a Local Waterfront Revitalization Plan (LWRP), or as part of a Comprehensive Plan exercise. Regardless, the Village is committed to a review of the report at least once every five years.

The authors of this report are confident the report will be helpful both as input for future municipal plans and development projects and in helping the Village implement climate adaptation efforts in a cost-effective and efficient manner. With further dialog, research, prioritization, re-assessment and planning, the authors believe this Climate Vulnerability Assessment will serve as the foundation for an overarching Climate Action Plan and a Climate Resilience Vision that will guide the long-term sustainability of our Village in the coming years.