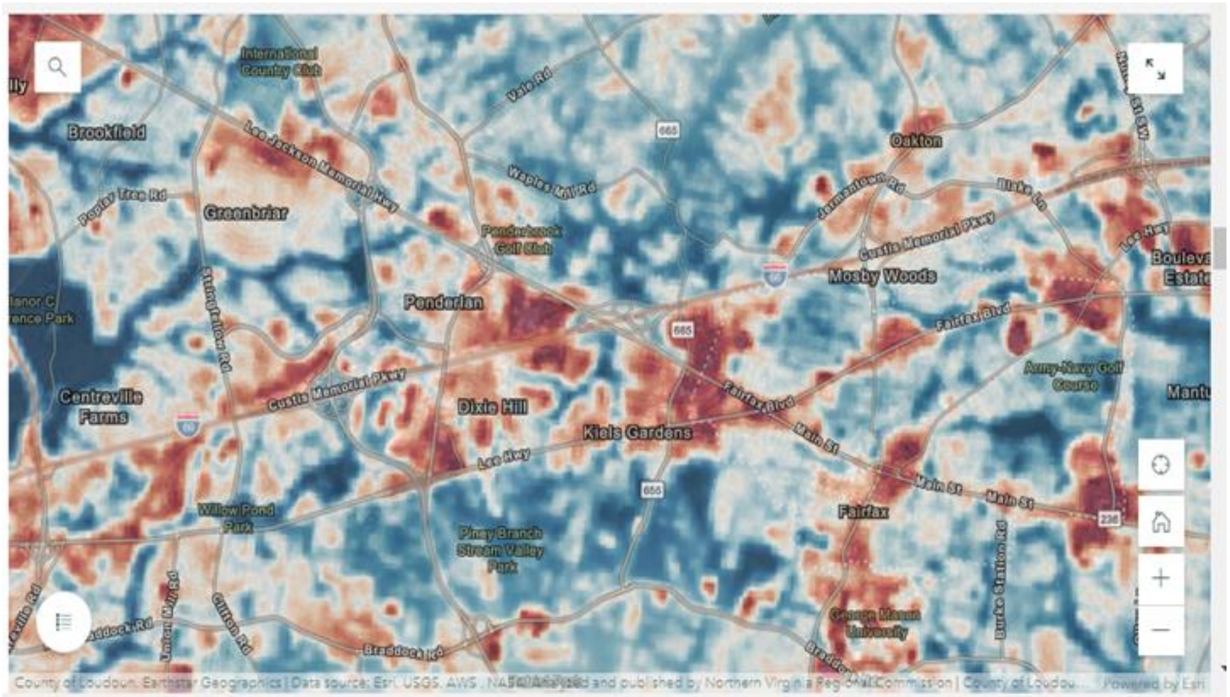

Regional Collaboration to Build Community Resilience in Northern Virginia

FY19 FINAL REPORT

Northern Virginia Regional Commission
February 2021 FY19 Task 83 Final Report to VACZMP

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1 Introduction

The Intergovernmental Panel on Climate Change projects that the southeast region of the US, which includes Northern Virginia, will experience an increase in extreme precipitation events, more frequent and longer heat waves, and increased flooding from sea level rise and storm surge. These stressors combined with continued population growth and conversion of land from open to urban throughout the region, pose a risk for vulnerable people, assets, economies and ecosystems. The economic consequences of extreme climate events make resiliency planning at the regional level imperative and urgent.

In response to these acute and chronic challenges raised above, NVRC formed the “Northern Virginia Climate Resiliency Team” (NVCRT) in November 2016 with funding from a FY16 grant from the Virginia Coastal Zone Management Program. The purpose of the grant and team was to develop *“Resilient Critical Infrastructure: A Roadmap for Northern Virginia”*. The “Roadmap” identified the primary climate-related stressors facing the region, a series of objectives aimed at building resilience for critical infrastructure and a set of corresponding strategies that could be implemented to achieve the objectives.

The work conducted under this FY19 grant allowed NVRC to continue this important work by sustaining the Northern Virginia Climate Resiliency Team for another year to explore innovations that we can learn from each other as well as other countries.

The following paragraphs summarize the outcomes from each product associated with this grant.

2 Deliverables

2.1 Product #1: NOVA Climate Resiliency Team Meetings

During this reporting period, NVRC staff coordinated five meetings of the resiliency team. Due to the COVID-19 pandemic and state limitations on gatherings, all meetings were held as virtual webinars and were recorded. Recordings[1] are loaded to YouTube and links are provided in the table below. The topics included an overview of flood mitigation strategies in Northern VA, how insurance and risk reduction can build resilience, nature based urban heat island mitigation strategies, and building public spaces that utilize green infrastructure. Participants represented staff from local jurisdictions, non-profit organizations, academia, state, and federal agencies, as well as DOD agencies. The major outcomes of these meetings were the sharing of information regarding how to tie these topics together as part of an overall resiliency strategy regarding flooding, urban heat island and stormwater.

[1] The recording for Tim Beatley’s presentation on Biophilic Cities is not available but information about Biophilic Cities is provided in the link.

Table 1. Meetings of the Northern VA Climate Resiliency Team

Date	Topic	Number of Participants
3/4/2020	Biophilic Cities and Section 309 5-year Coastal Hazards Strategy	32
7/29/20	Nature Based Urban Heat Island Mitigation: Ideas from Germany	82
9/15/20	Public "Play Spaces" That Integrate Natural Systems	69
9/29/20	Flood Response Strategies in Northern Virginia: An Overview	58
10/6/20	The Role of Insurance and Risk Reduction to Build Infrastructure Resilience	53

In addition to the aforementioned meetings, NVRC staff gave presentations about the work conducted under this grant to the NVRC Board of Directors as well as the Northern Virginia Faith Alliance for Climate Solutions (a regional non-profit organization).

2.2 Product #2: Downscaled Precipitation and Runoff Study

NVRC staff partnered with staff and students at George Mason University (GMU) to participate in an "Investigation of Precipitation Trends Across Northern Virginia". The following is an abstract of the study.

"[2]Investigating regional vulnerability to extreme hydroclimatic events (e.g., flooding and droughts) poses a challenge to the scientific community and highly depends on our ability to provide reliable precipitation estimates. The primary objective of this research is to investigate trends in precipitation in a fast-growing region, like Norther Virginia (NOVA) at scales (1km) that can help increase regional sustainability and optimize stormwater management planning. A downscaling framework is applied to a set of atmospheric variables from the North American Land Data Assimilation (NLDAS) to 1 km using a combination of physically-based techniques

[2] Ishrat Jahan Dollan , Viviana Maggioni , Tasnuva Rouf and Yiwen Mei , (1)George Mason University, Sid and Reva Dewberry Dept. of Civil, Environmental & Infrastructure Engineering, Fairfax, VA, United States.

and a machine learning algorithm. Specifically, topographic and lapse rate corrections are chosen to downscale air temperature, pressure, humidity, surface downward longwave and shortwave radiation, and wind velocity. A random forest (RF) algorithm combines the previously downscaled atmospheric forcing (1 km), terrain topography (SRTM-DEM), and vegetation information (from MODIS land cover) to predict precipitation. The relevant predictors for precipitation derived from a recursive feature elimination method are used to train the RF classifcation (rain/no rain) and the regression model. The proposed project applies these novel downscaling techniques to serve as regional level planning for future demands on stormwater infrastructure."

The researchers are planning to release the findings from their study in Spring 2021 and NVRC staff will continue to coordinate with the GMU team to communicate the results to our local jurisdictions.

2.3 Product #3: Pilot Scale Heat Vulnerability Assessment

An increase in extreme heat days and heat waves are climate stressors that communities in Northern Virginia should monitor and plan for because of the effects on human health, ecosystems and the built environment. Extreme heat events and prolonged exposure to heat can lead to a wide range of heat stress conditions and illnesses or even death, particularly for vulnerable populations. In large urban centers, both the effects on human health and the magnitude of extreme heat may be greater because of the urban heat island effect.

To determine locations and populations that are vulnerable to extreme heat, a map depicting the land surface temperature on July 13, 2020, when the air temperature exceeded 95 degrees Fahrenheit was created. Methodology

The heat islands map was created by calculating surface temperature on July 13, 2020 derived from Multispectral Landsat 8 imagery. The Landsat 8 imagery includes eight multispectral bands from the Operational Land Imager (OLI) and two bands from the Thermal Infrared Sensor (TIRS). The two TIRS bands (Bands 10 and 11) were used to calculate the degrees Fahrenheit above or below the average temperature in the surrounding 5 kilometers.

Steps to calculate surface temperature:

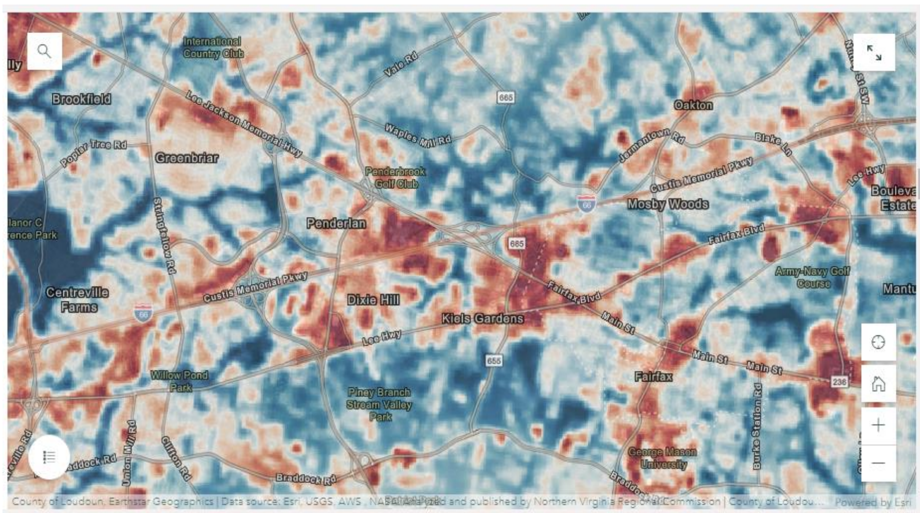
1. Calculate the average of band 10 and band 11 raster layers on a cell-by-cell basis.
2. Use focal statistics tool to calculate mean statistics in the surrounding 5 kilometers.
3. Subtract the focal statistics results from the calculated average in step 1.
4. Apply a stretch of +/- 20 to the raster output to improve visual contrast to show the urban heat island effect.

In urban areas, much of the land is covered with development. Since buildings and roads absorb more heat than trees and greenery, this causes urban areas to have higher surface temperatures than surrounding areas. Areas where this occurs are referred to as "heat islands." Heat islands can refer to temperature differences between cities and their surrounding areas as well as temperature differences in different areas in a city or region.

Figure 1 shows the land surface temperature above or below the average temperature on July 13, 2020 compared to the surrounding area. The red colors show areas that are hotter than the average temperature and the blue colors show areas that are cooler than the average temperature. The white color in the middle represents 0 degrees F. This means that white colors show areas that are the same as the average temperature.

As you can see there are specific areas in the center of the map that are dark red. These are areas that are up to 20 degrees F hotter than the average temperature in the surrounding area on July 13, 2020.

Figure 1. Land Surface Temperature on July 13, 2020



If we zoom in further on a dark red spot, we notice that the hottest areas occur over shopping centers and malls. Figure 2 shows the urban heat island effect in action. Areas that are highly developed with buildings and parking lots are significantly hotter than surrounding areas.

Figure 2. Example of an urban heat island shown in red

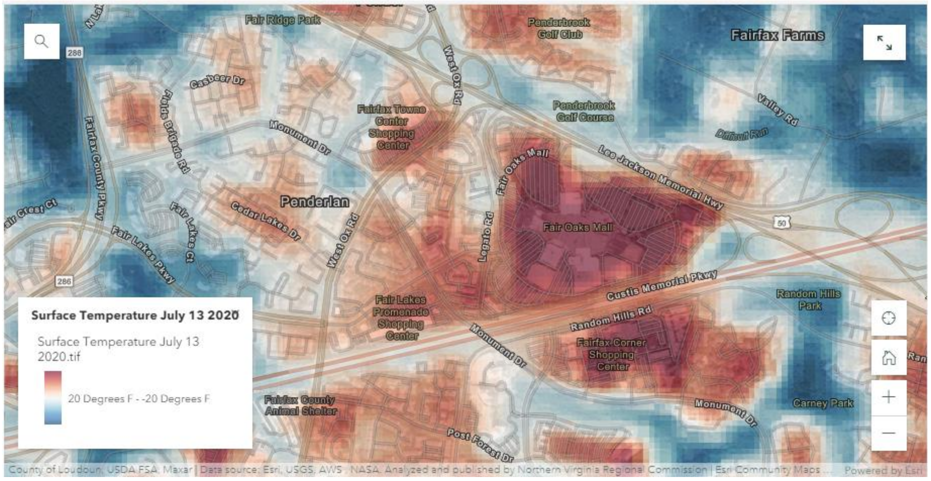
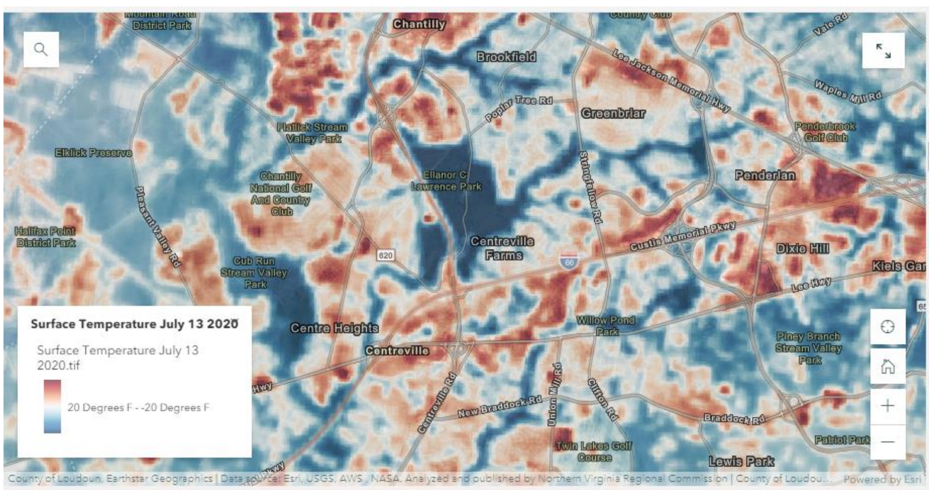


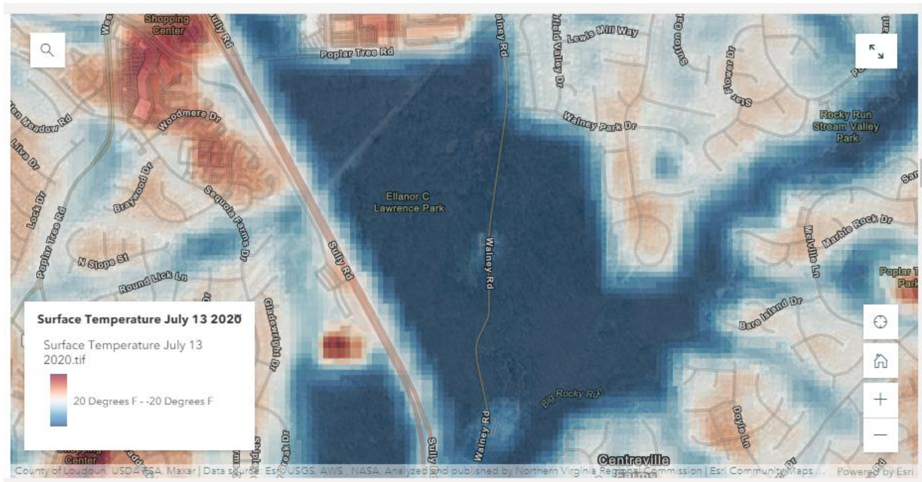
Figure 3 is an example of a cool spot. As you can see there is an area in the center of the map that is dark blue. This is an area that is up to 20 degrees F cooler than the average temperature in the surrounding area on July 13, 2020.

Figure 3. Example of an urban cool island shown in blue



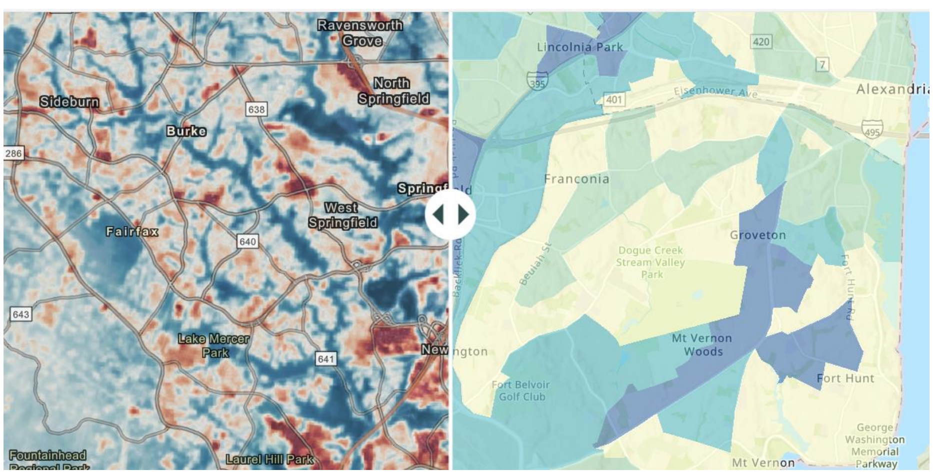
If we zoom in further on the dark blue spot labeled Ellanor C Lawrence Park, we notice that the cool spot is in a forested park. Figure 4 shows that areas that are undeveloped with high percentage of intact forest canopy are significantly cooler than surrounding areas.

Figure 4. Zoomed in cool spot showing forest canopy



To see where extremely hot areas are in relation to vulnerable populations, the 2018 Virginia CDC social vulnerability index layer was added to the land surface temperature map. The social vulnerability index consists of five layers including overall social vulnerability, socioeconomic, household composition/disability, minority/language, and housing/transportation. On the interactive story map, you can swipe the arrows left and right to observe the relationship between social vulnerability and heat islands. Figure 5 shows the Virginia CDC's social vulnerability index in 2018 overlaid on urban heat islands. Areas with high social vulnerability may have more heat islands.

Figure 5. Land Surface Temperature overlayed with CDC social vulnerability index



2.4 Product #4: Coordination with Chief Resilience Officer

Governor Northam issued Executive Order Number 24 on November 2, 2018. This executive order provides a pathway to increase resilience to sea level rise and other hazards in the Commonwealth and includes a provision for the Commonwealth's first Coastal Resilience Master Plan (CRMP).

The development of the Virginia Coastal Resilience Master Plan is the responsibility of the Commonwealth's Chief Resilience Officer (The Secretary of Natural Resources), with the Assistance of the Special Assistant to the Governor for Coastal Adaptation and Protection, in consultation with stakeholders at all levels - including but not limited to: local governments, state agencies, Regional Planning District Commissions, the Secure and Resilient Commonwealth Panel, federal partners, the Virginia Institute of Marine Science, partner universities in the Virginia Sea Grant Program and the Commonwealth Center for Recurrent Flooding.

NVRC staff has been actively coordinating with the Chief Resilience Officer and the Special Assistant to the Governor for Coastal Adaptation and Protection to assist in the development of the Virginia Coastal Resilience Master Planning Framework that was published in Oct. 2020. The framework outlines the guiding principles, goals, and actions necessary to create a full Master Plan.

In addition, Governor Northam's Executive Order 71 convened a Technical Advisory Committee to assist with creating a full Master Plan by developing and implementing protocols for evaluation of projects and strategy proposals. EO 71 formally directed NVRC to appoint a representative. NVRC staff participated in the first meeting of the TAC on Thursday, November 12, 2020 and plans to participate in other meetings, as necessary.

2.5 Product #5: Resilience Digital Dashboard

Predicting future climate conditions is a complex undertaking based on several interacting models and assumptions. The way humans behave now will influence the rate of climate change in coming decades. Therefore, the Intergovernmental Panel on Climate Change (IPCC), publishes projections for changes in temperature or precipitation based on the "Relative Concentration Pathways," or the level of emissions that may be introduced into the atmosphere over time.

For example, if governments do not adopt policy changes to reduce emissions and continue to rely heavily on fossil fuels, this would lead to a "High Emissions" scenario or RCP 8.5. If governments strive to meet ambitious targets to lower fossil fuel consumption, increase renewable energy use, and maintain a lower energy consumption worldwide, this will lead to a "Low Emissions" scenario or RCP 2.5.

An on-line informational dashboard offers an interactive visual representation of data in multiple formats. This type of dashboard allows different scenarios of climate data projections to be easily consumed and quickly compared.

NVRC staff created an on-line [Climate Resilience Dashboard] that provides information on existing and future climate-related stressors impacting Northern Virginia to enable users to improve their resilience, compare and analyze existing data as well as modeled future projections of three climate indicators affecting Northern Virginia: heat, precipitation, and sea level rise. It aims to support policymakers, planners, and the public to examine variables that affect potential climate hazards so that we can take action to protect vulnerable people, infrastructure, and assets.

Over time, additional information can be added such as resilience indicators and progress towards specific goals.