**Cheat Water Resources**

*Assessing Climatology and Land Cover Trends and Evaluating Flood Risk of the Cheat River*

**Project Team**

***Project Team:***

Sabine Nix (Project Lead)

McKenna Brahler

Mary Everett Fuller

Alex Rowland

***Advisors & Mentors:***

Dr. Robert Griffin (The University of Alabama Huntsville)

Dr. Jeffrey Luvall (NASA Marshall Space Flight Center)

***Team POC:*** Sabine Nix, nixs@sas.upenn.edu

***Partner POC:*** Madison Ball, madison@cheat.org

**Project Overview**

***Project Synopsis:***

The Cheat River experiences frequent flooding events that cause harm to human as well as ecological communities and threaten to reverse years of restoration work aimed at reducing contamination due to acid mine drainage (AMD). In partnership with the Friends of the Cheat (FOC), the team utilized NASA Earth observations to create a flood vulnerability map and conduct a time series analysis of climate trends in the region to better understand future flood potential. FOC will be able to incorporate these end products into their decision-making process as they proactively mitigate flooding in at-risk areas and build community resilience.

***Abstract:***

The Cheat River, primarily located in northeast West Virginia, experiences major flooding events that negatively impact nearby communities. Poor water quality due to acid mine drainage and excess sediment loads during flood events threaten the health of communities and numerous animal species who depend on the Cheat as a primary water source. Communities in the Cheat River watershed are confronted with floods that can destroy housing, key infrastructure, and crops, and also further pollute the river. A warming climate is predicted to increase precipitation and storm severity in the region, which could increase flood frequency in the watershed. The team partnered with the Friends of the Cheat (FOC), an organization that has historically focused on mitigating acid mine drainage in the river and has recently begun to focus on proactive flood mitigation. Utilizing Landsat 5 Thematic Mapper (TM), Landsat 8 Operational Land Imager (OLI), and Shuttle Radar Topography Mission (SRTM) data, the team conducted a climatology time series analysis, monitored changes in land use and land cover change, and created flood risk and vulnerability maps to improve FOC’s flood mitigation efforts. To calculate the change in precipitation and temperature, the team used the equations of the linear trend lines based on annual averages of Preston and Tucker counties and averaged the results. These results indicated that temperature has increased by about 1.5°C and precipitation has increased by 4.2 inches between 1970 and 2020, while monthly river discharge has become more variable. At the same time, there were no detectable trends in land cover at the county level. Communities near Parsons, Masontown, Reedsville, and Eglon are among the most vulnerable to flood events based on the flood vulnerability analysis.

***Key Terms:***

flood resilience, flood mitigation, remote sensing, Landsat, time series analysis, SRTM, climate, fuzzy logic

***National Application Area Addressed:*** Water Resources

***Study Location:*** Preston County and Tucker County, WV

***Study Period:*** January 1950 to December 2020

***Community Concerns:***

* Towns in the region are often located within the river’s floodplain, putting them at increased risk for property damage and economic disruption due to flooding.
* Warming climate and increased precipitation contribute to increased flooding.
* Flood events can lead to worsened water quality due to acid mine drainage and increased turbidity, affecting the ecology of the river and human health.

***Project Objectives:***

* Identify long-term trends in precipitation, temperature, and river discharge
* Quantify recent changes in land cover to better assess flood risk
* Map flood vulnerability and identify areas in which to target mitigation efforts

**Partner Overview**

***Partner Organization:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **Friends of the Cheat** | Madison Ball, Restoration Program Manager | End User | Yes |

***Decision-Making Practices & Policies:***

Since 1995, FOC has been instrumental in the restoration of the Cheat River watershed and the remediation of AMD within the region. FOC has routinely employed several passive remediation strategies to combat AMD to include natural wetlands, limestone beds and channels. FOC also maintains active water treatment systems to neutralize highly acidic water consisting mainly of silos with lime added to acidic water to balance pH levels. Over the years, FOC has collaborated with several local and federal organizations and institutions to aid in the restoration of the Cheat River watershed. Current field observation strategies consist mainly of water sampling for pH levels with the help of their Cheat Aquatic Pollution and BaseLine Ecological (CAPABLE) Monitoring Program. FOC’s present capacity for GIS and remote sensing is minimal with only one active member having knowledge of GIS and its applications.

**Earth Observations & End Products Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter** | **Use** |
| **Landsat 5 TM** | Surface reflectance | The team used Landsat 5 TM classify land cover between 1990 and 2011. |
| **Landsat 8 OLI** | Surface reflectance | The team used Landsat 8 OLI to classify land cover between 2011 and 2020, and to calculate the Normalized Difference Water Index (NDWI).  |
| **SRTM** | Elevation | The team used SRTM elevation data in the flood risk and flood vulnerability maps. |

***Ancillary Datasets:***

* National Climate Data Center (NCDC), National Oceanic and Atmospheric Administration (NOAA) – Climate data used in time series analysis of precipitation and temperature
* Parsons Stream Gauge Data, United States Geological Survey (USGS) – Stream gauge data used in a comparative analysis with precipitation and temperature time series
* Multi-Resolution Land Characteristics National Land Cover Database (NLCD) – Data used to train the supervised land cover classifier in the land cover time series analysis
* Global 30m Height Above Nearest Drainage (HAND) - Data used to identify areas at risk for flooding in the flood risk map
* Federal Emergency Management Agency (FEMA) Statewide Floodplain Polygons – 100 and 500-year FEMA Floodplains used to identify areas at risk for flooding in flood risk map
* Roads, U.S. Census Bureau – Data used to determine road vulnerability to flooding
* Abandoned Mines, Friends of the Cheat – Data used to determine mine vulnerability to flooding
* Population, U.S. Census Blocks TIGER, U.S. Census Bureau – Data used to determine where population density contributed to increased flood vulnerability

***Software & Scripting:***

* Google Earth Engine API – Data Acquisition and manipulation, image processing, land cover classification
* ArcGIS Pro v2.5 - Raster manipulation, map generation, and flood vulnerability assessment

***End Product(s):***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Earth Observations Used**  | **Partner Benefit & Use** | **Software Release Category** |
| **Climatology Time Series** | N/A | This climatology analysis highlighted the changes in precipitation, temperature, and river discharge over the study period. This time series can be utilized to understand future flood conditions. | N/A |
| **Land Cover Time Series** | Landsat 5 TM, Landsat 8 OLI | This analysis determined land cover trends throughout the study period to understand the potential relationships between land cover change and worsened flood risk. The 2020 land cover map was also included in the flood risk analysis to account for variable flood impacts due to different land cover types.  | I |
| **Flood Risk and Vulnerability Maps** | Landsat 5 TM, Landsat 8 OLI, SRTM | This map highlighted areas of the Cheat River watershed that are susceptible to flood damage. These maps assessed vulnerability variables such as road infrastructure, mining contamination and population density. | I |
| **Cheat Water Resource Video** | Landsat 5 TM, Landsat 8 OLI, SRTM | This video will be utilized as a tool to educate the local community about areas vulnerable to flood events due, in part, to changing climatic conditions and land cover.  | N/A |

***Product Benefit to End User:***

The climatology time series will give FOC insight into how precipitation, temperature, and river discharge have changed in Preston and Tucker Counties in West Virginia over the last 40 years. Having these data will allow FOC to develop mitigation plans to better prepare for future flood events. The land cover time series analysis will be used to identify trends that impact flood vulnerability within the watershed and inform proactive flood mitigation. Using elevation, height above nearest drainage, historical flood extent, land cover types, key infrastructure, and population density, the flood vulnerability map will provide FOC a map of the areas that are most vulnerable to flooding, allowing FOC to better target their flood mitigation efforts to these areas. The team provided a video aimed at increasing public understanding of flood vulnerability and its relation to changing climate and land use.

**References**

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Wang, X, & Xie, H. (2018). A review on applications of remote sensing and geographic information systems (GIS) in water resources and flood risk management. *Water, 10*(5), 608.  https://doi.org/10.3390/w10050608