**NASA DEVELOP National Program**



Wise County Clerk of Court’s Office

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Wise County Disasters

Identifying the past and future extent of flooding throughout Wise County, Virginia.

 **Technical Report**

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# I. Abstract

Wise County, located in the Appalachian Mountains of Southwest Virginia, was once a very large contributor to the coal industry. Mountainous terrain and strip mines increase the amount of runoff in local drainage basins. This project determined areas that are more susceptible to flooding using ArcGIS and The Coupled Routing and Excess Storage (CREST) model to analyze data collected from Landsat 5 TM, Landsat 8 OLI, Aqua and Terra MODIS, and Shuttle Radar Topography Mission (SRTM). These sensors collected data on rainfall, elevation, and land use change from 2000-2014. Comparison of the modeled flooding data to historical floods yielded XX% confidence in our flood predictions. Maps created from the flood models have been handed off to the Wise County Emergency Operations Center for use in planning for future flood events.

**Keywords**

Flooding, Snowmelt, Surface Runoff, CREST

# II. Introduction

Wise County is located in southwest Virginia and is home to more than 40,000 people, thousands of which live near streams and rivers. Factors that may contribute to destructive flooding in this area include the high volume of strip mining which increases runoff due to hardened soil, low capacity thresholds of the many stream networks, and high rainfall rates associated with strong storm systems. In recent years, Wise County has sustained several million dollars in flood damage. Knowing which areas are prone to severe flooding will improve how county officials and first responders prepare for these events.

This project’s study area surrounds Wise County, Virginia and encompasses the neighboring counties of Dickenson, Russell, Scott and Lee Counties in Virginia, and Harlan County Kentucky. This project aims to help the Wise County Board of Supervisors and officials from surrounding counties better understand the watersheds in Wise County, and how they affect the individuals of the county.

The flood hazard was calculated usingthe Coupled Routing and Excess Storage (CREST) model from The University of Oklahoma. The model requires in-situ and remotely sensed data. The outputs from the CREST model, which include flood maps, will be delivered to the project partners, the Wise County Office of Emergency Management. Remotely sensed data was collected from Landsat 5 TM, Landsat 8 OLI, Aqua and Terra MODIS, Tropical Rainfall Measuring Mission (TRMM), Global Precipitation Model (GPM), and Shuttle Radar Topography Mission (SRTM) data from the years 2000-2014. Flood hazard maps generated by CREST will be compared to historical flood data as well as Federal Emergency Management Agency (FEMA) flood maps to assess how accurate the CREST model’s predictions are.

# III. Methodology

**Data Acquisition**

Shuttle Radar Topography Mission (SRTM) data was obtained from the United States Geological Survey’s (USGS) Earth Explorer website, which provided the team with a 30-meter digital elevation model (DEM) of the study area. Other ancillary data utilized in this project include a boundary shapefile provided by Wise County.

GPM and TRMM data was collected for precipitation totals using the Giovanni data acquisition tool. Giovanni allowed a polygon to be drawn over the study area on an interactive web map. Once the desired area was found data was requested by running the“Merged satellite-gauge precipitation estimate - Final Run (recommended for general use)” for precipitation in units of mm/month. After plotting the data and confirming the study area was fully covered, the data was downloaded in NetCDF format. Using conversion tools present in ArcMAP, the data was converted from NetCDF to Raster format.

Soil data needed for the CREST model, including, soil type, hydraulic conductivity, and water capacity was gathered using the Web Soil Survey Map from United States Department of Agriculture (USDA) Natural Resource Conservation Service. The soil data for the counties were downloaded as shapefiles and then merged and clipped to the study area. Soil characteristics needed for the CREST model were exported as raster files.

The CREST model was processed in Flood Event (FE) Mode instead of Regular Mode. The FE Model was chosen because it only models outputs within the period of the flood events specified in the control file. The FE Model can be used in both simulation and calibration style and saves computational time since it skips the non-flood event periods ([Shen](http://hydro.ou.edu/research/crest/), 2014). All of CREST files are saved in a single folder called the Project Folder. There are five files, or collections of data, needed to run the CREST models; the Control File, Basic Folder, Parameters (Params) Folder, Rains Folder, and the Evapotranspiration (PET) Folder.

The Control File is saved stored in the root of the project folder. It contains the model options and path variables for all other data files needed by CREST. The variable paths were assigned to the computer's operating system to bind the input parameters to the model. The Basic Folder contains the DEM, FDR (Flow Direction) file, and FAC (Flow Accumulation) file. There are also optional files in the Basic Folder such as the Mask file, GridArea file, Area Fact file, Stream file, Slope file, and LakeMask file. The optional files for slope and streams data was included in this project. The Parameters file contains information on the physical characteristics such as soil moisture, hydraulic conductivity, overland runoff velocity, overland flow speed, and river cell threshold. The Rains Folder contains precipitation data in the form of rasters over the entire study area. The PET Folder contains the potential evaporation data ([Shen](http://hydro.ou.edu/research/crest/), 2014).

The CREST model requires a Calibration file to control the extreme values of the results. The calibrations are entered as a text file that CREST reads the constraints of the data points to restrain the model to improve accuracy. Figure 1 from the CREST User Manual (Shen, 2014) shows the required inputs for the calibration file.



Figure 1. Image of the Calibration.txt File inputs and descriptions from (Shen, 2014)

Once the model has successfully executed, the outputs are located in the Results Folder. This will contain hydrographs, output variables, and calibration results in various formats.

# IV. Results & Discussion

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Things to discuss:

* Analysis of Results: What can you tell from your graphs, images, etc? What does this mean for your project?
* Errors & Uncertainty: What factors could you not account for, what things didn’t work out like you expected they would, etc.
* Future Work: If this project was to be selected for another term, what would be the focus? What other areas would be of interest?

# V. Conclusions

Final conclusions. Word count: 200-600 (~a page).

# VI. Acknowledgments

The Wise County Disasters team would like to thank the mentors and partners who provided their time and support to make this project possible:

Mentors/ Science Advisors

* Dr. Kenton Ross
* Dr. DeWayne Cecil
* Bob VanGundy

Partners

* Wise County Board of Supervisors (End-user, Boundary Organization)
* POC: Bob Adkins (Director of Emergency Management)

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# VII. References

Insert references here. Only include articles/content cited in the body of text above. It’s great if you read many other articles, but they should not all be listed here unless they are being cited in this report.

[Shen, X. S., Hong, Y. (2014). *CREST: Coupled Routing and Excess Storage User Manual.* Unpublished manuscript. University of Oklahoma, Norman, OK.](http://hydro.ou.edu/research/crest/)

Willson, W. (2015). *The* [*Coupled Routing and Excess Storage* *(CREST) Hydrologic Model.* Unpublished manuscript. NASA DEVELOP National Program.](http://hydro.ou.edu/research/crest/)

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# IV. Appendices

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