Delineating Subwatersheds within the Monongahela National Forest: The Implications of a Watershed Approach on Forest Planning

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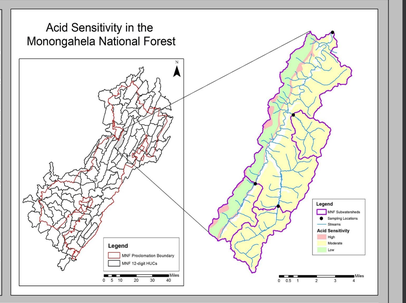
Abstract

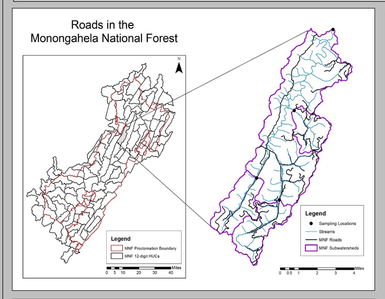
The Monongahela National Forest comprises over 900,000 acres of biologically diverse land in West Virginia. It is the largest tract of public land within the state, and it attracts anglers, hunters, and other outdoor enthusiasts to the region. It is important to maintain the health and beauty of the forest as it plays a major role in the socioeconomic well-being of the state. One important aspect of improving forest management practices is to create an ecological classification system to characterize its watersheds. For this classification to be successful and useable for modifying the Forest Management Plan, smaller watersheds are required. This project was designed using a Geographic Information System and elevation and stream data to create subwatersheds for water quality sampling locations within the Monongahela National Forest. Nearly two hundred subwatersheds were created for use in this classification system. The methodology has been converted into a How to Guide to allow replication for additional sampling locations within the Forest, in other National Forests, as well as future student projects at Virginia Tech. Additionally, application examples were provided to demonstrate the convenience of using the subwatersheds with land use planning, which can then be used to update the Forest Management Plan.

Application Examples

Acid Sensitivity in the Forest

Acid sensitivity is the ability of soils to buffer acids. As shown in the image to the right, the geomorphology may change several times in a watershed. These subwatersheds can be used to identify the factors driving the acidity levels, which is important for the local flora and fauna. Liming Stations are scattered throughout the forest to reduce acidity. Station locations can be prioritized, and pollution sources can be identified.



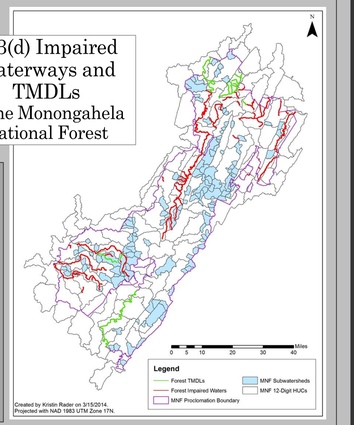


Watershed Forest Management Information System

This is an extension of ArcGIS that can be used by forests to look at the impacts on watersheds caused by nonpoint source pollution, road systems, and silviculture in a forest. Conservation areas can be prioritized, current and potential problems associated with roads can be identified, and timber harvesting schedules can be changed to best suit the watershed. As shown to the left, most of the roads in the watersheds cross or are directly beside of a stream.

Watershed Characterization and Modeling System

An extension of ArcGIS used by the WV DEP for water quality management. Uses a large-scale watershed approach with limited data availability. Subwatersheds in the forest could act as a case study for improvements to the program, which could then be replicated in West Virginia.



TMDL Planning

TMDLs are typically based on water quality data taken from sampling points in streams, which can have a lag time. Using ecosystem functions of a watershed for prioritization and proactive planning could result in more successful TMDL plans. This can be applied with the subwatersheds in the forest, as TMDLs currently exist there. It would also be useful for nested watersheds and very large watersheds like the Chesapeake Bay's TMDL Plan.

Methods

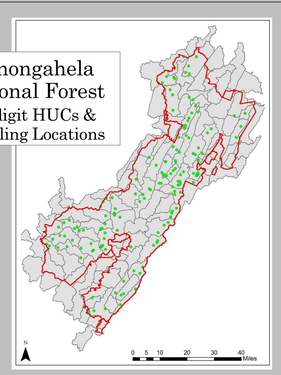
Designed for ESRI ArcGIS 10.1 and the Spatial Analyst Toolbox

Data Used:

- 3 meter elevation data
- MNF boundary shapefiles
- MNF stream reach points
- National Hydrologic Dataset shapefile
- National Watershed Boundary Dataset 12-digit HUCs

Created a How to Guide for replication

*All subwatersheds were not delineated due to lack of data, which may have been caused by simply not having access to the files or there was no monitoring taking place in that location



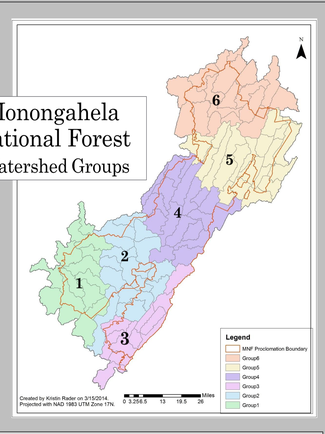
Forest was divided into groups for faster processing time. Methods were repeated for each group, then files were merged.

Elevation Data

- Downloaded elevation grids
- Mosaic
- Project (UTM NAD 1983 17N)
- Fills

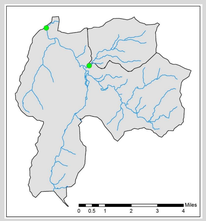
Watersheds

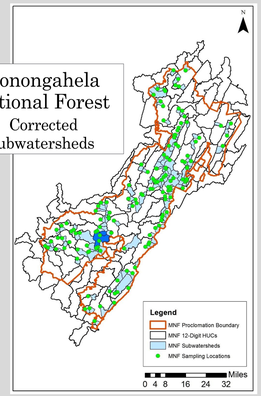
- Flow Direction
- Flow Accumulation
- Snapped Pour Points - Distance = 60
- Flow Network - Threshold = 1500



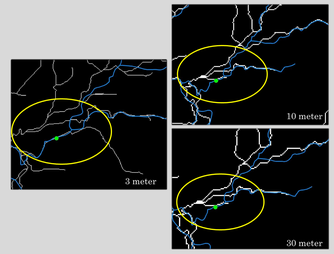
Watershed Correction

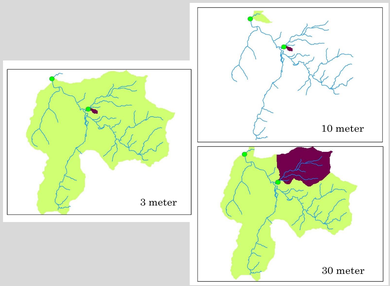
While error checking the final subwatersheds, there were two subwatersheds in Group 2 that were incorrect, highlighted in dark blue in the image to the right. Below are the final delineations of those subwatersheds used in this project





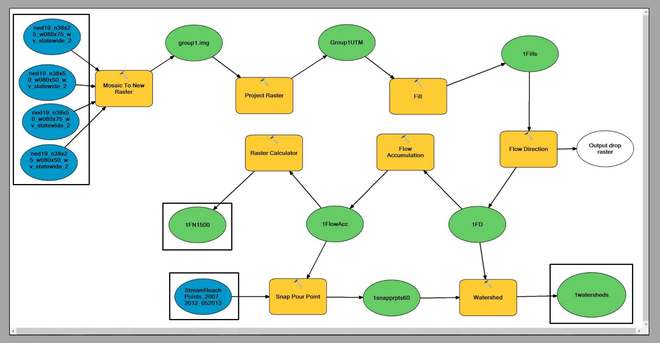
Below is an image of the subwatershed delineations using 3 meter, 10 meter, and 30 meter elevation data. The 30 meter subwatersheds were used in this project only for these two subwatersheds.





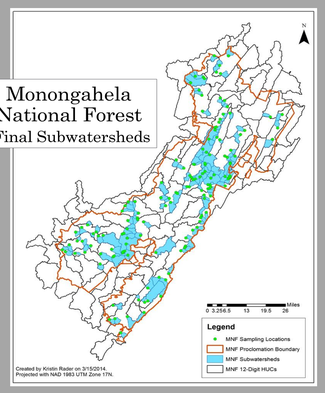
After examining the watersheds further, it was determined that the flow networks (white) did not match the NHD stream data (blue), as shown above. An aerial image of the location showed dense forest, an open flat area, a braided stream, and some development. that the stream is braided.

Model Builder



Conclusion

Overall, 145 subwatersheds were delineated, which are currently being used by the Forest Service. Major limitations of funding, time, and knowledge of technical skills have been addressed by using free data, a model, and creating an instruction manual for replication. The classification system can be completed after a 10 year delay, and the Forest Plan can be improved.



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