Relic charcoal hearths geomorphology and hydrology in mid-Appalachian region of Pennsylvania

Samuel Bayuzick¹, Patrick Drohan², Thomas Raab³, Florian Hirsch⁴, Alexander Bonhage⁵, Marc McDill⁶, and Duane Diefenbach⁷

¹The Pennsylvania State University, Ecosys. Sci Mgmt, State College, United States of America (samuelbayuzick@gmail.com)
²The Pennsylvania State University, Ecosys. Sci Mgmt, State College, United States of America (pjd7@psu.edu)
³Brandenburg University of Technology Cottbus-Senftenberg (BTU), Geopedology and Landscape Development, Cottbus, Germany (raab@b-tu.de)
⁴Brandenburg University of Technology Cottbus-Senftenberg (BTU), Geopedology and Landscape Development, Cottbus, Germany (florian.hirsch@b-tu.de)
⁵Brandenburg University of Technology Cottbus-Senftenberg (BTU), Geopedology and Landscape Development, Cottbus, Germany (Alexander.Bonhage@b-tu.de)
⁶The Pennsylvania State University, Ecosys. Sci Mgmt, State College, United States of America (mmcdill@psu.edu)
⁷The Pennsylvania State University, Ecosys. Sci Mgmt, State College, United States of America (drd11@psu.edu)

Throughout the northeastern United States and Europe, relic charcoal hearths (RCHs) are more regularly being discovered in proximity to furnaces used for iron or quick-lime production; charcoal was used as a primary fuel source in the furnaces. RCHs have been found across parts of Europe and Connecticut, USA in different hillslope positions, on vary degrees of slope and aspect, all of which can be a factor affecting the shape of the RCH. Their usage for charcoal production varied with the time period, furnaces were in operation with some hearths being used once and older ones (such as in Europe) being used multiple times. RCHs across the northcentral Appalachians, USA have been minimally investigated, thus determining where they occur on the landscape, their shape, and their morphologic positions will be useful in discerning their effect on surface hydrology and soil development. Our study focuses on developing a repeatable process for: finding RCHs and quantifying how RCHs may alter surface hydrology.

We used a combination of processed LiDAR data to create hillshades, and slope gradients to visualize RCHs. A total of 6,758 hearths have been digitized across three study areas that reflect different historical time periods of construction and environments. We hypothesize that the construction of RCHs can alter the surface hydrology of their surrounding environments. To fully quantify the landscape-level effects of RCHs, a subset of the total was created to fully digitize the RCHs’ area. The RCH was broken into their rim and platform components. A topographic wetness index (TWI), and SAGA wetness index (SWI) was created for two study areas in order to quantify surface hydrology effects. We found that RCH platforms have a significantly higher TWI and SWI than the rim counterparts indicating that the platform is wetter than the RCH outer rims. Geomorphic position was found to not effect wetness. Using field measured volumetric water content, we found that as distance from the center of the hearth increases, the drier the soil
becomes. Using a combination of GIS flow path analysis, and RCH geometry, standardized ellipses using the axis of local RCHs and the mean area of the total RCHs were created to understand the upslope (control) and downslope (experiment) effects of hearths on the surface hydrology. Preliminary analysis indicates that downslope positions from RCHs are drier than upslope positions and that there is a significant difference in the relationship between slope position and distance from an RCH and the corresponding TWI and SWI values. Future research will address the effect of slope position and distance to quantify the effect of RHCs on surface hydrology. Furthermore, the soil chemical changes from RCH creation and the increase moisture may increase the habitat for rare species of both plants and animals that otherwise would not be present. Understanding the extent of the impact human activity can have on various ecosystems can help forest managers, conservationists, pedologists, and climatologists better adapt their management or research pursuits within a specific environment to prepare for future changes, natural or anthropogenic.