



Dual Site Selection for a Combined Path Toward Carbon-Free Home Energy

GIS 5572—ArcGIS II, Spring 2018 |Galen Sjostrom — sjost044@umn.edu



Introduction

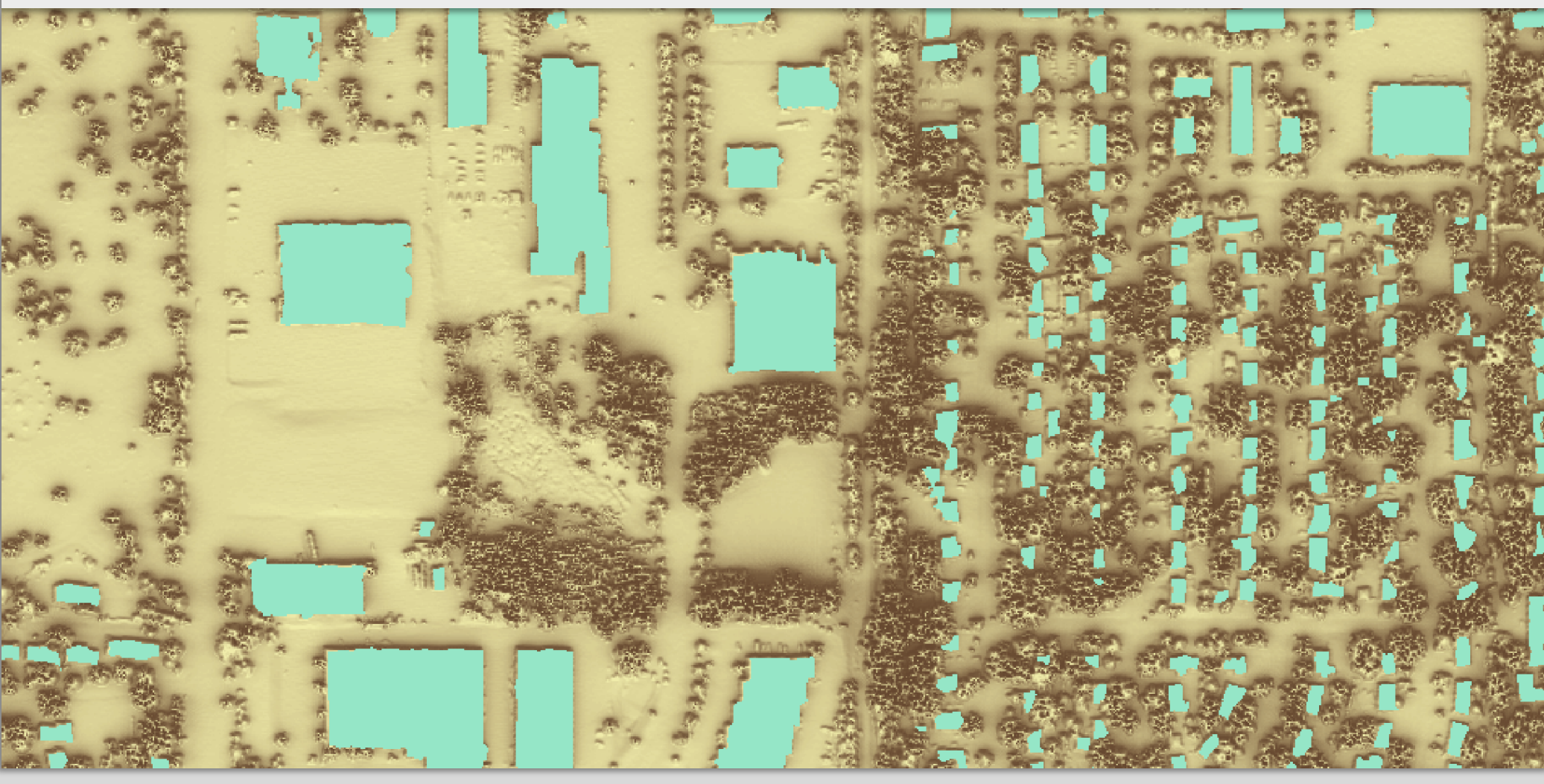
Objective: where in the Ramsey/Hennepin Counties sustainability-minded home owners might most effectively employ in-ground geothermal heating & cooling system (frequently shortened to “Geothermal Heat Pump”, or GHP) and on-roof solar panel arrays in tandem. Given the substantial up-front costs of installation for *either* type of system, this project limited its examination to environmental suitability only, and not cost effectiveness or cost recoup times.

Data & Methods: The primary input datasets were the solar insolation digital surface developed by the USpatial Institute for their solar suitability web app, and a soil suitability interpretation of SSURGO soil classifications based on a study conducted on Connecticut’s soils but generously re-calculated for Ramsey and Hennepin Counties’ soils by collaborating scientists at the USDA Natural Resources Conservation Service.

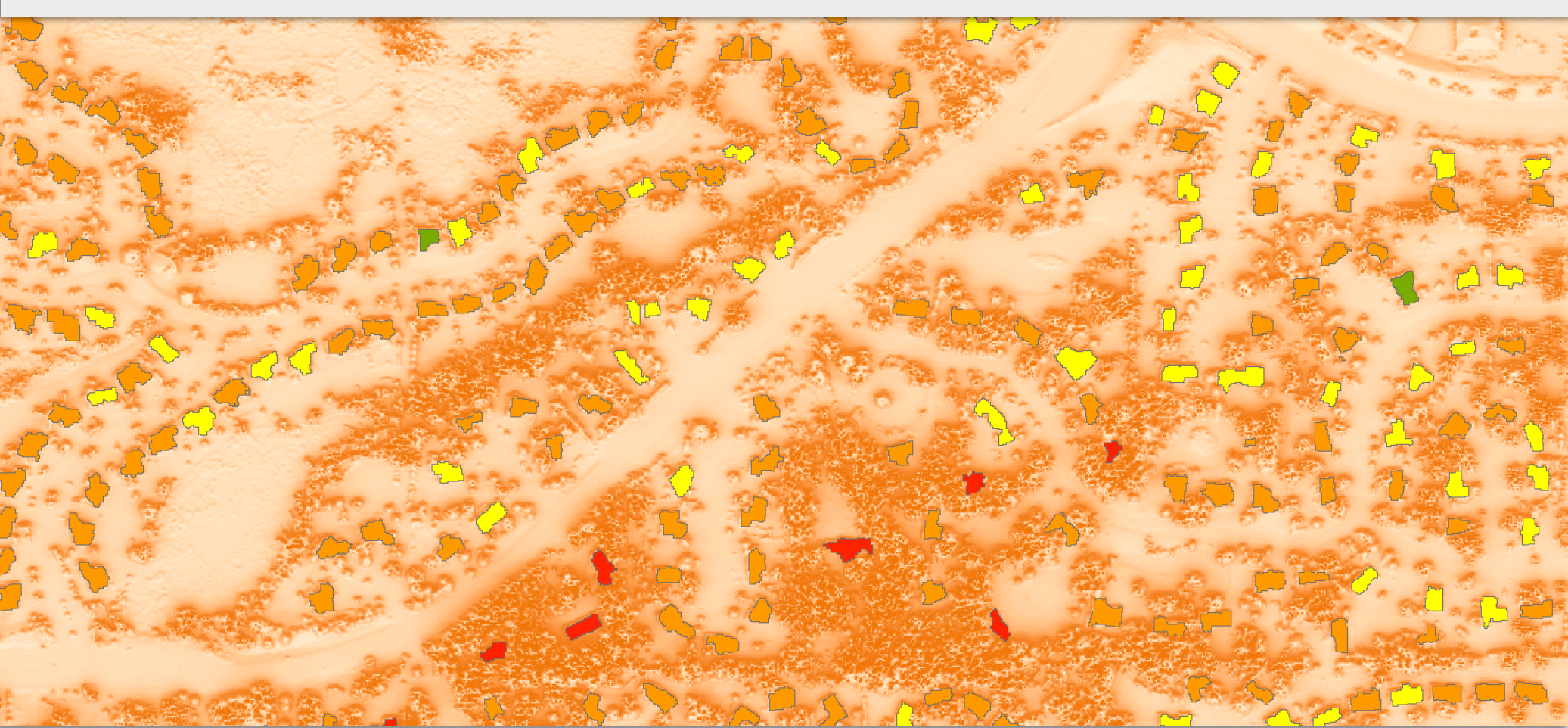
The two datasets were ultimately rasterized and summed to form a single 1-meter suitability surface which was then generalized by averaging per parcel.

Intermediate Outputs

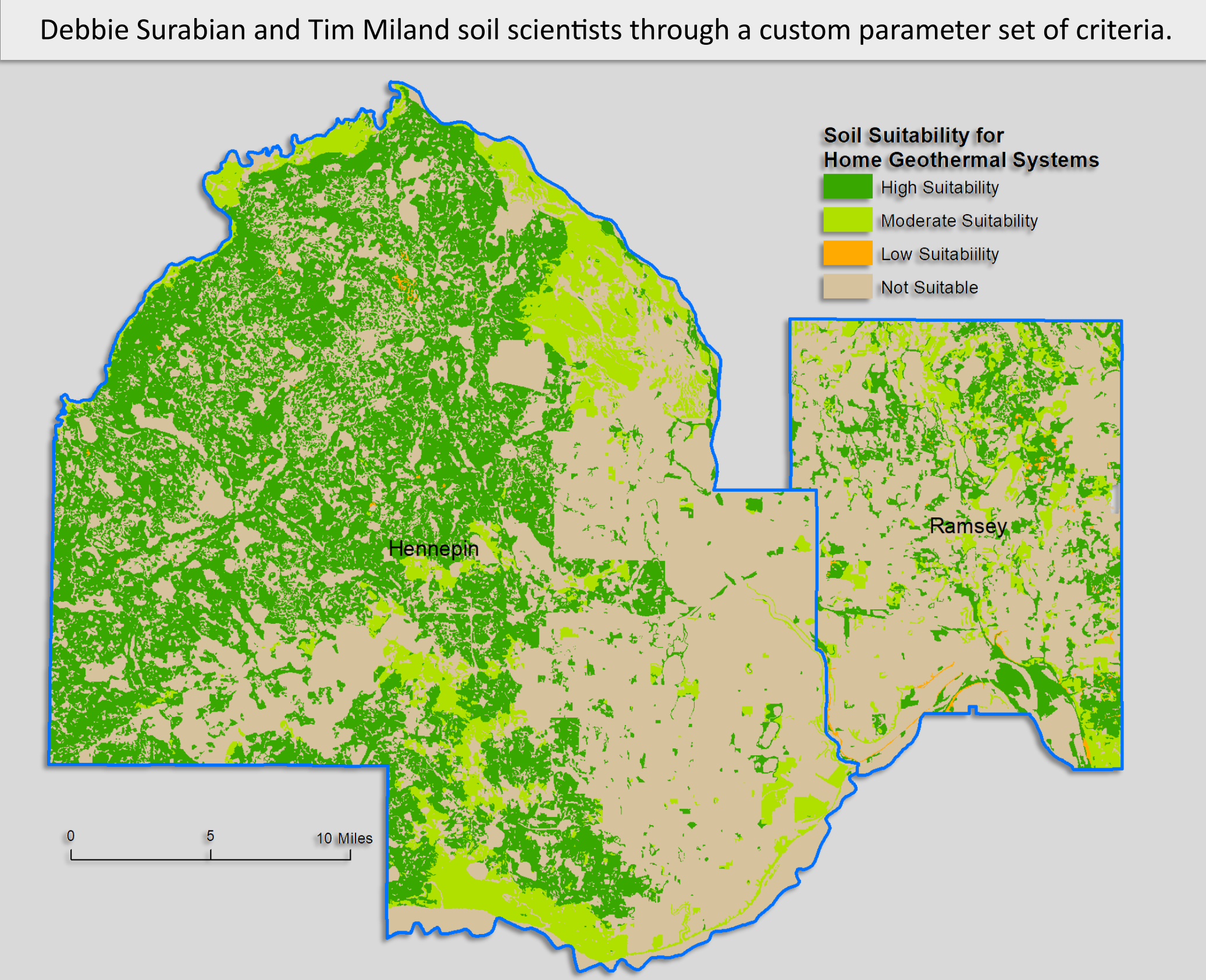
Large scale sample of the extracted insolation raster with building footprints layered on top. For subsequent calculations, CTUs that don’t record finished home sq. footage were excluded.



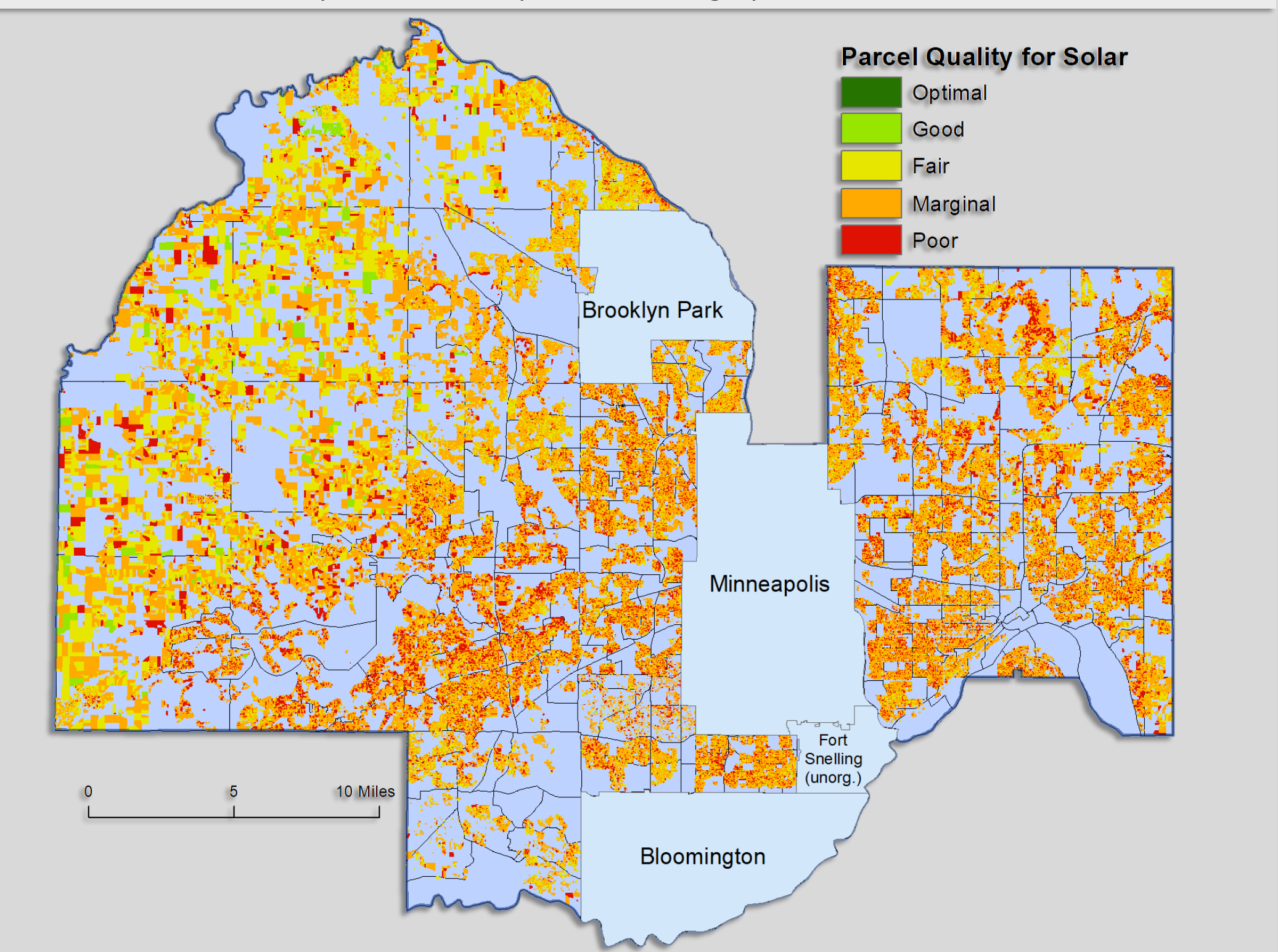
Close-up of building footprints classified for solar suitability based on average insolation values. Dark green = optimal, light green = good, yellow = fair, orange = marginal, and red = poor.



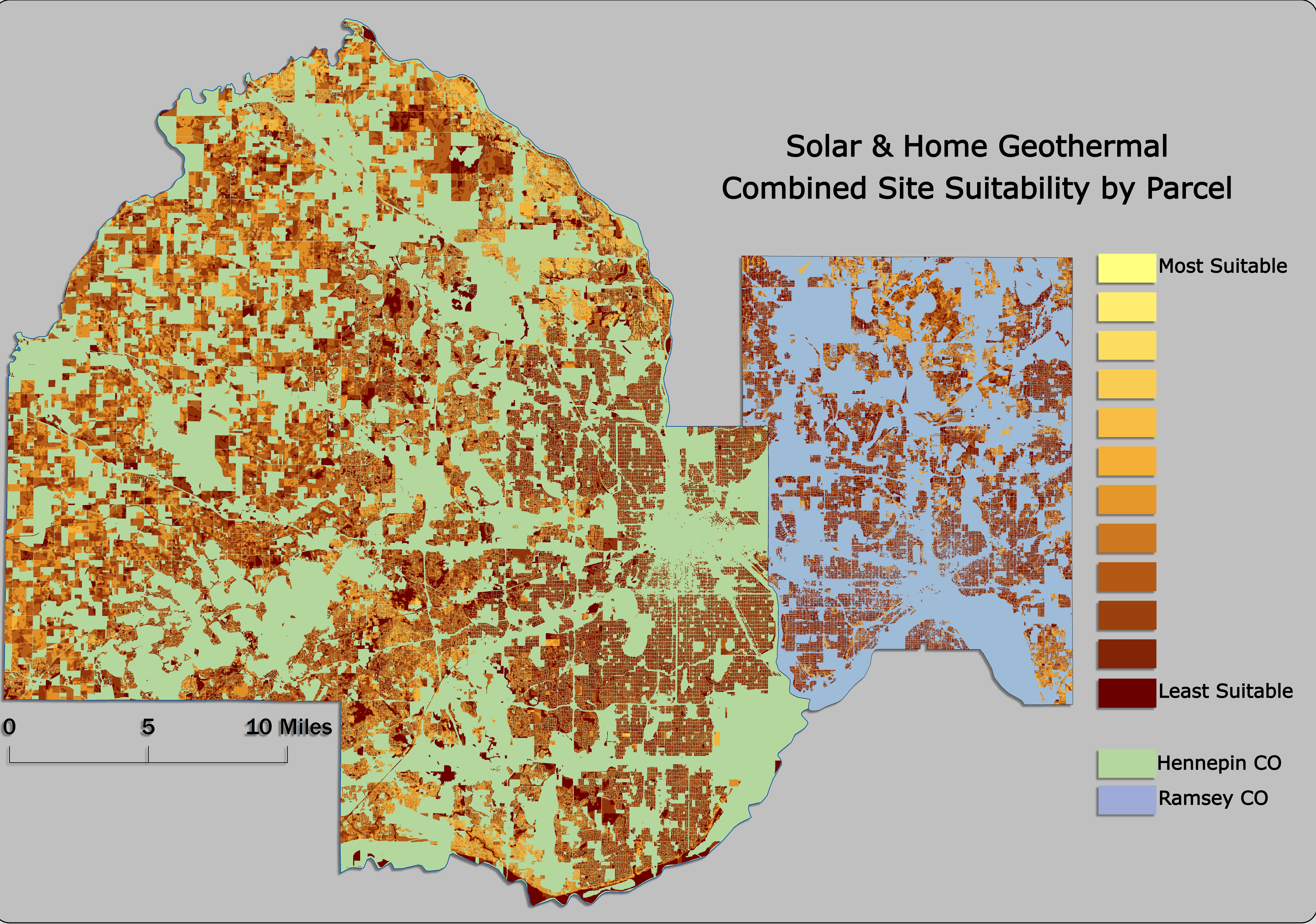
Soil suitability for home geothermal heating/cooling system, classified by NRCS Soil Scientists Debbie Surabian and Tim Miland soil scientists through a custom parameter set of criteria.



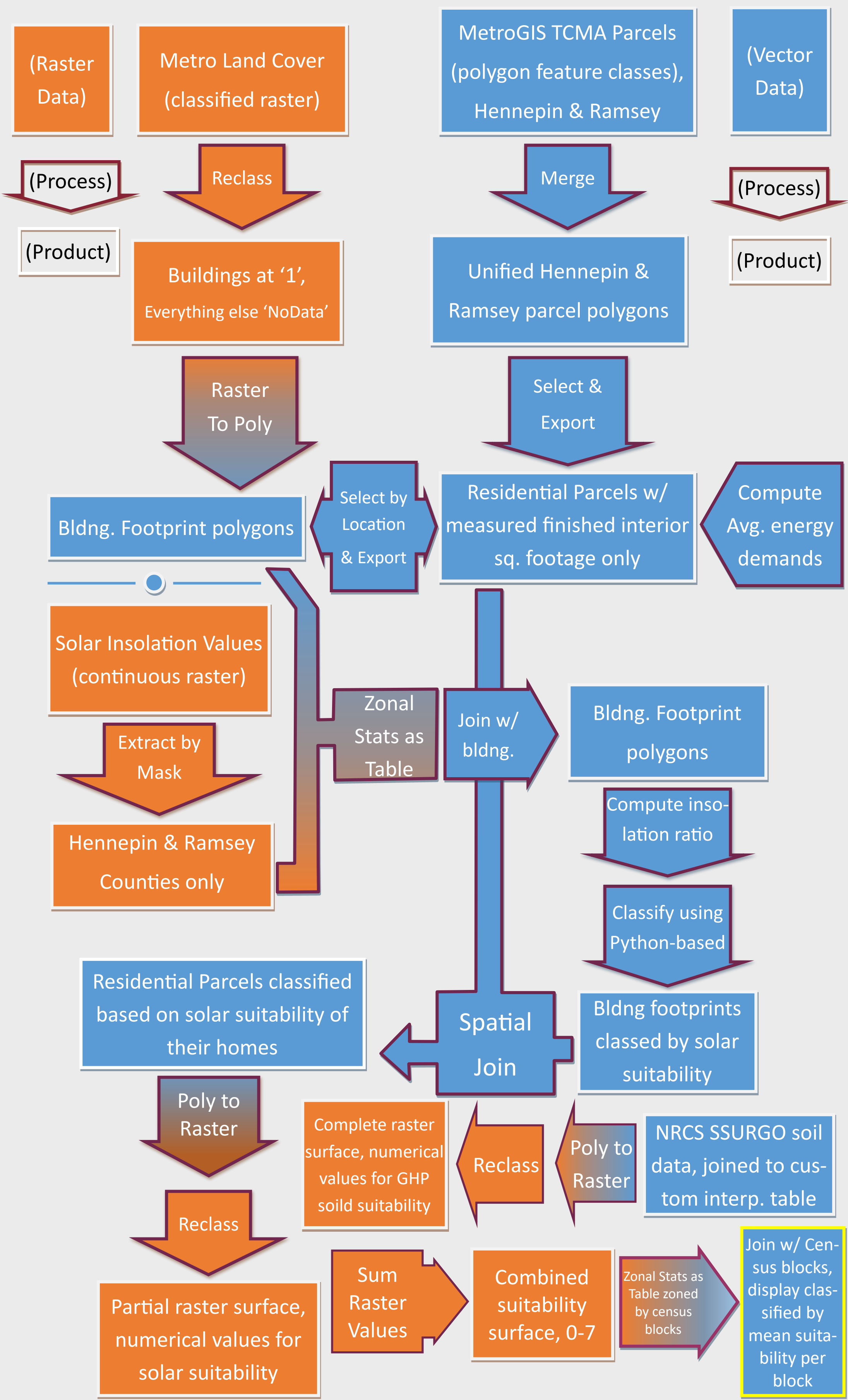
Per-parcel solar suitability, computed by ratio of anticipated kWh/m² against USpatial Solar Study-established optimum-through-poor classifications.



Solar & Home Geothermal Combined Site Suitability by Parcel



Spatial Workflow



Results & Conclusions

Unsurprisingly much of the least-suitable territory for this dual approach to sustainably sourced home energy was found in the most-developed urban areas surrounding Minneapolis and inside Saint Paul, primarily due to the high impermeability of the soils in those areas and the frequent abundance of shade trees which diminished the potential yield of most roof-top solar systems.

Numerically, solar yield ended up being the most limiting factor, with a significant majority of measured homes designated ‘marginal’ - meaning they only contributed 1 of a possible 4 points to that 1-meter cell’s combined suitability rating - and less than one percent designated ‘optimal’.

Future Research

Future research will include calculation of more precise estimates of per-household solar yield, balanced against similarly precise calculations of expected home energy needs (based on the average 800 kWh/month average household demands in Minnesota, adjusted for home geothermal implementation) in order to provide a rough estimate of how close each parcel’s dwelling can get to net-zero energy use with this combined approach.

Sources

Special thanks to NRCS soil scientists Debbie Surabian and Tim Miland for preparing the custom Hennepin & Ramsey county soil suitability interpretation.

For additional source information, scan below:

