Targeting Sites for Algae Biofuel Production Facilities in Arizona

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Projection: State Plane Arizona (NAD83)
Data Sources: Arizona State Land Department, National Resource Conservation Services, EPA, Shuttle Radar Topography Mission

WHY ALGAE?

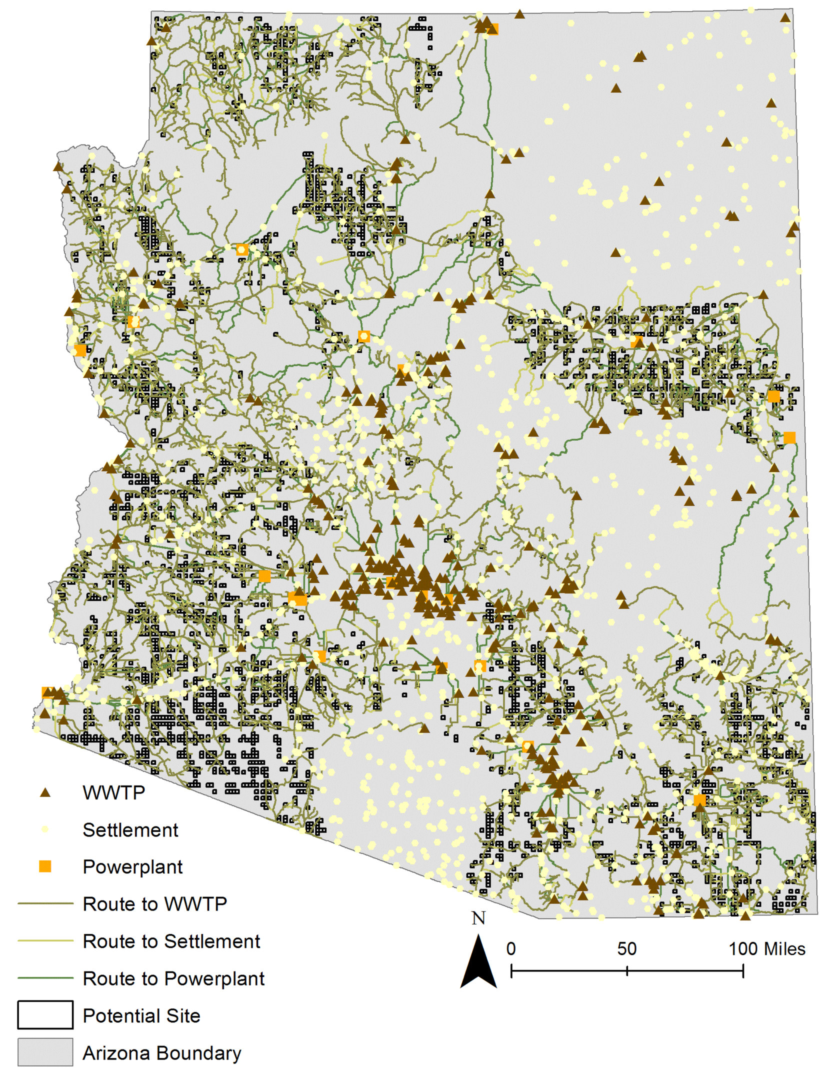
The global demand for energy continues to rise while available fossil fuel resources decline. Recent innovations in bioenergy production have led to substantial interest in the use of biofuels as a renewable energy solution. In particular, microalgae, grown in outdoor cultivation ponds, makes an especially promising energy crop, due to its high areal productivity and its ability to grow in harsh, arid climates. However, large-scale microalgae production facilities that are economically-viable have yet to emerge. This is largely due to the carbon dioxide and fertilizer input requirements. Anthropogenic sources, namely flue gas emissions from power utilities and municipal wastewater, could theoretically eliminate the energy and cost burdens of supplying carbon dioxide and nutrients to algae feedstocks. Coupling algae cultivation ponds with power utilities and wastewater treatment plants with flue gas and wastewater co-utilization (FWC) approach not only reduces upstream costs, but also provides a valuable service in wastewater treatment (Orfield 2014).

The state of Arizona has been identified as one of the most optimal locations for algae biofuel production, given its relatively high average solar radiation and land availability (Orfield 2014). This study utilized GIS tools to target sites for constructing algae biofuel production facilities based on an FWC approach in the state of Arizona. The parameters used to identify suitable areas involved physical suitability of the location and political availability of the land. Suitable areas were then considered for their spatial access to wastewater treatment plants (WWTPs), power plants, and settlements in a weighted additive models in order to identify sites that were most capable for algae biofuel production facility construction.

MEASURING ACCESS TO FACILITIES AND SETTLEMENTS

To develop a layer measuring access from suitable areas to WWTPs, power plants, and settlements, the distance from each 'suitable area' polygon to the nearest facility or settlement was calculated along a road network. Distance along a road network was more realistic in terms of access than simple overland distance because wastewater and CO_2 supplies would be transported to the facility via pipeline, and these pipelines could not be constructed through unsuitable areas. However, this analysis assumed pipelines would follow an existing road (constructed along the right of way). Proximity to settlements was also calculated along a road network

ROAD NETWORK ANALYSIS



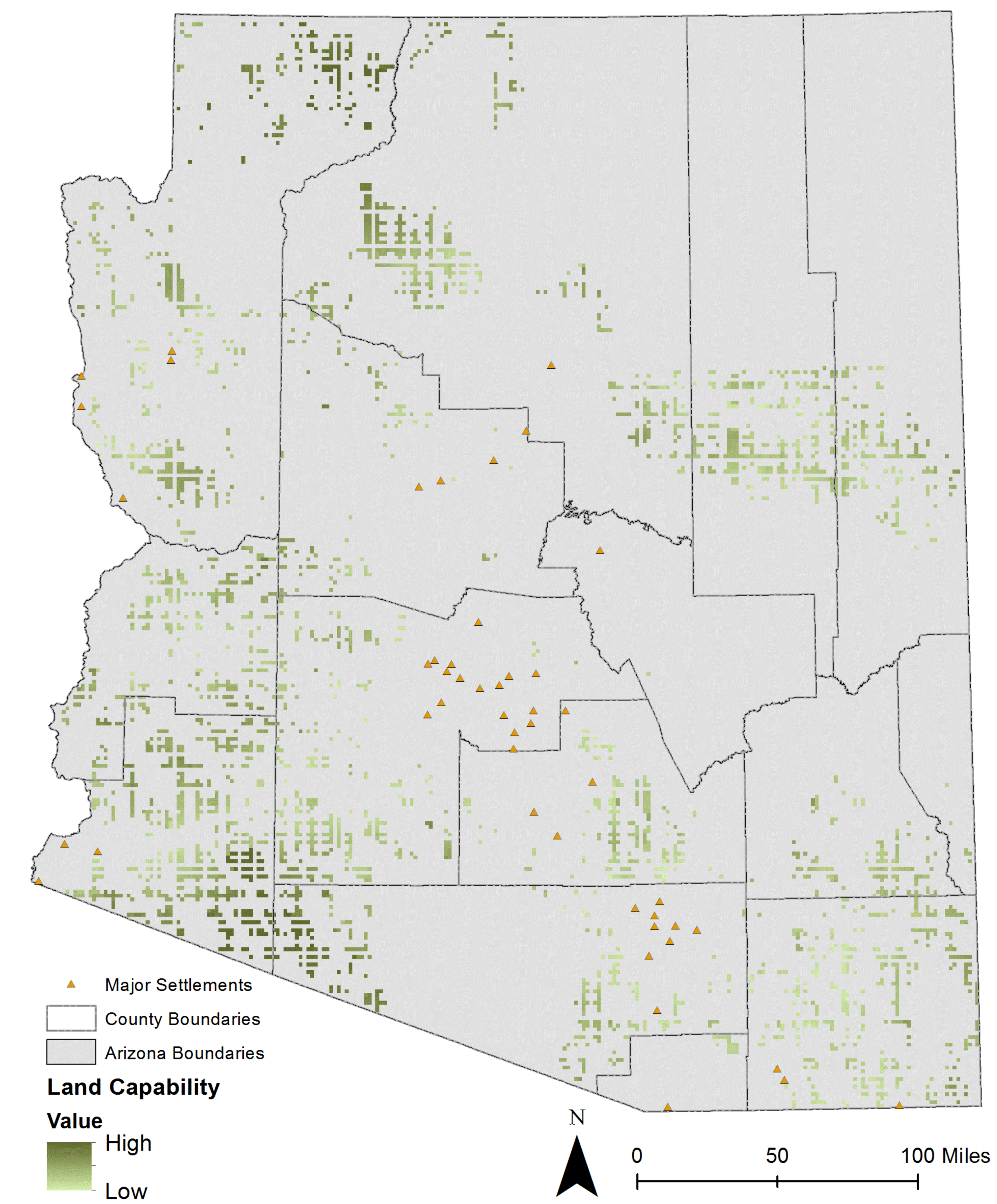
CREATING ADDITIVE LAND CAPABILITY MODEL

To develop An additive land capability model based on access to facilities or settlements, the resulting layers measuring distance from 'suitable areas' to WWTPs, Power plants, and Settlements were added. Although this analysis is centered on an FWC approach in biofuel production facility site targeting, in which access to WWTPs and power plants is considered most important, three different models were calculated, each corresponding to a different weighting of variables. The resulting additive layers for each model represent land capability from low to high of each area. Only the first model is featured, with access to WWTPs weighted the most heavily at 50%, access to power plants weighted at 30%, and access to settlements weighted at 20%.

CONCLUSIONS AND LIMITATIONS

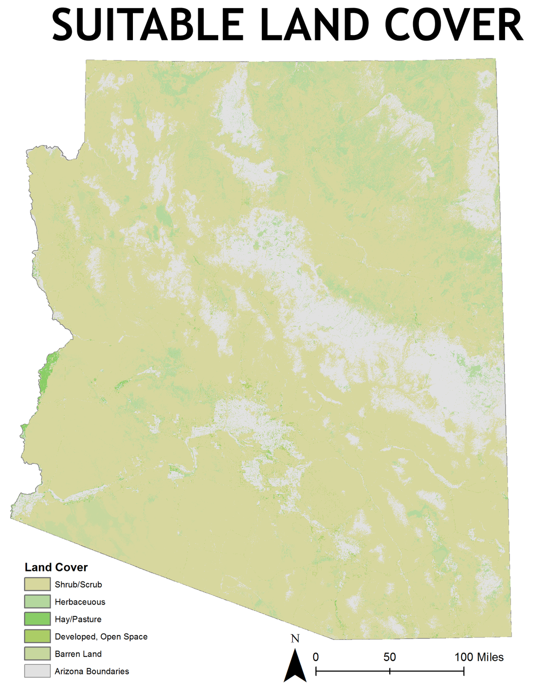
This analysis aimed to target sites in Arizona that could be used for algae biofuel production in the very near future. All of the additive models identified sites of high land capability in the southernmost and northernmost regions of Arizona. The first additive model for land capability, which prioritized access to wastewater treatments plants and power plants, was the primary focus of this analysis. This model identified 146,500 hectares of land in Arizona as high land capability for algae biofuel production facility construction. The production potential of these sites depends on a variety of parameters, including solar exposure, temperature, type of algae species, and type of facility constructed. A production potential estimate should be incorporated into future analyses.

ALGAE BIOFUEL CULTIVATION CAPABILITY



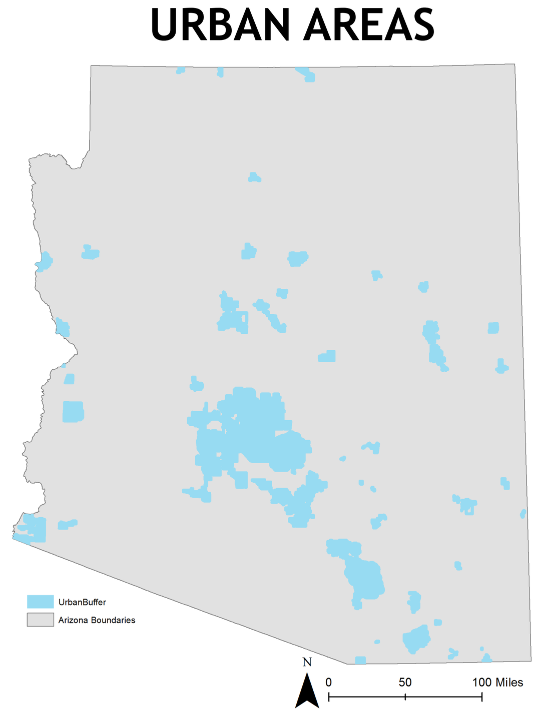
MODEL PARAMETERS

SUITABLE LAND COVER



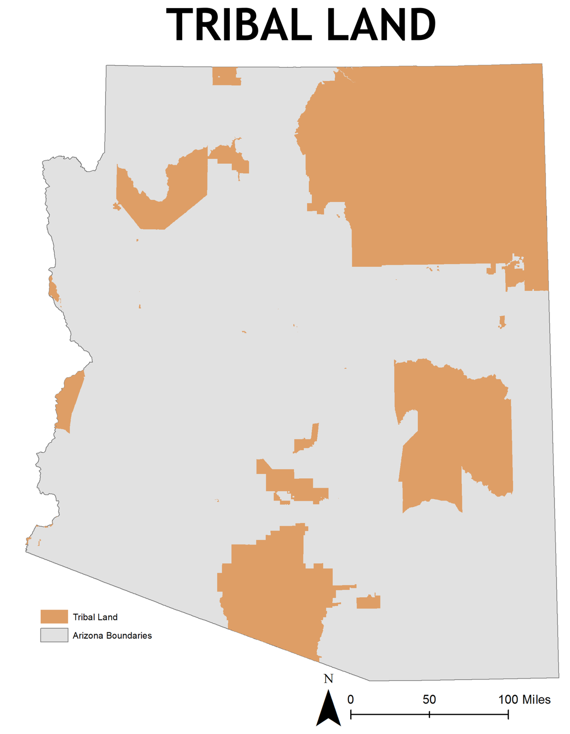
For this analysis, 'suitable' land cover was defined as Barren Land, Hay/Pasture, Herbaceous, Shrub/Scrub, and Developed, Open Space.

URBAN AREAS



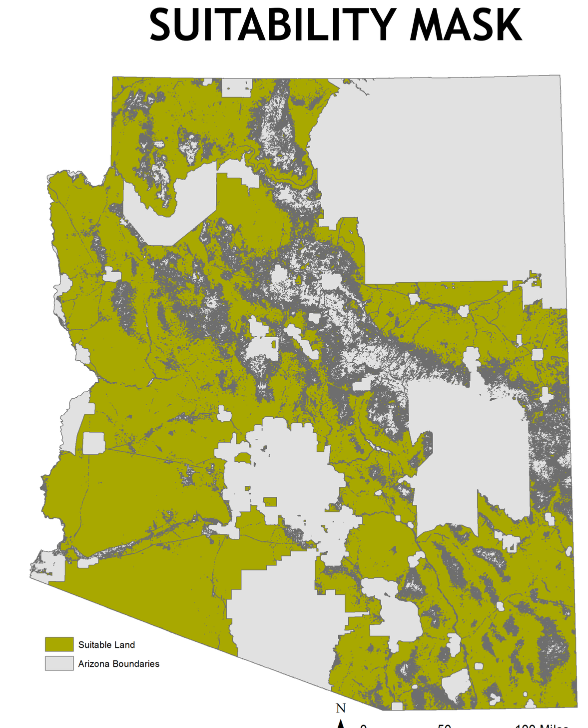
Urban areas were considered unsuitable for biofuel facility construction.

TRIBAL LAND



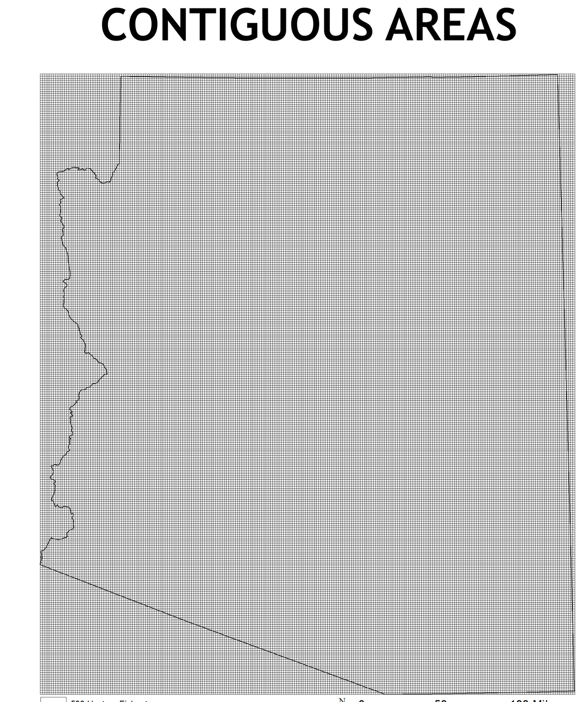
Tribal reservations and land trusts were considered unsuitable for biofuel facility construction.

SUITABILITY MASK



Land was determined suitable for construction if it was not urban area, tribal land, or unsuitable land-cover. A suitability mask was created from these variables.

CONTIGUOUS AREAS



To determine contiguous, 500 hectare, 'suitable' areas for biofuel production facility construction, the fishnet layer was intersected with the suitability mask to create 'suitable area' polygons, each with an area of 500 ha.

SUITABLE AREAS FOR ANALYSIS