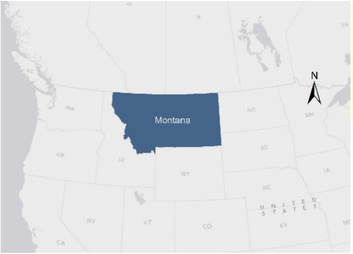

Siting Geothermal Facilities in Montana: A Suitability Analysis

Background

Coal-fired power plants accounted for nearly 45 percent of electricity generation in the United States in 2009. Renowned climate scientist James Hansen has described the future of coal bluntly: "coal emissions must be phased out as rapidly as possible or global climate disaster will be a dead certainty."[1] This project spatially examines geothermal energy as an alternative to coal production in Montana. Geothermal energy is a source of base-load power, and thus could be a viable alternative to coal generation in the state. According to 2009 statistics from the Energy Information Administration, coal accounts for nearly 60 percent of power generated in Montana.

The goal of this project is to examine suitability for geothermal facility siting using a GIS overlay analysis in the context of factors beyond resource availability. Because the availability of geothermal energy does not always imply its accessibility, additional spatial analysis of factors such as land use, transmission line locations, and electricity demand centers is necessary.

Methodology

Data layers used in this analysis include geothermal resource potential, transmission line locations, population centers, percent slope of terrain, highways, conservation lands, and flood plain locations. Ideal areas for geothermal siting would meet the following criteria:

Suitability Criteria:

- Intersecting areas with geothermal resources
- Close to existing transmission lines
- Close to population centers
- Intersecting flat terrain
- Close to major roads
- Not in conservation lands
- Not in a flood plain

Spatial analysis tools were used to 'score' each 1-km section of the state of Montana based on the criteria for each layer listed above. Scores were calculated such that a score of 1 indicates an area is unsuitable; 4 indicates it is most suitable. The seven smaller maps located below show the results of this process.

Each of the maps below were then overlaid, and scores across all layers were combined or summarized. Regions with the highest score represent the most suitable areas for geothermal development. (The lowest raw score possible is 7 and the maximum is 28.) Since all criteria are not equally as important, scores for each set of criteria were weighted relative to one another, with proximity to geothermal resources and transmission lines being the most important.

The map at the right shows the results of this weighted overlay analysis for geothermal suitability.

Tufts UNIVERSITY

Created by Samantha Weaver
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Results

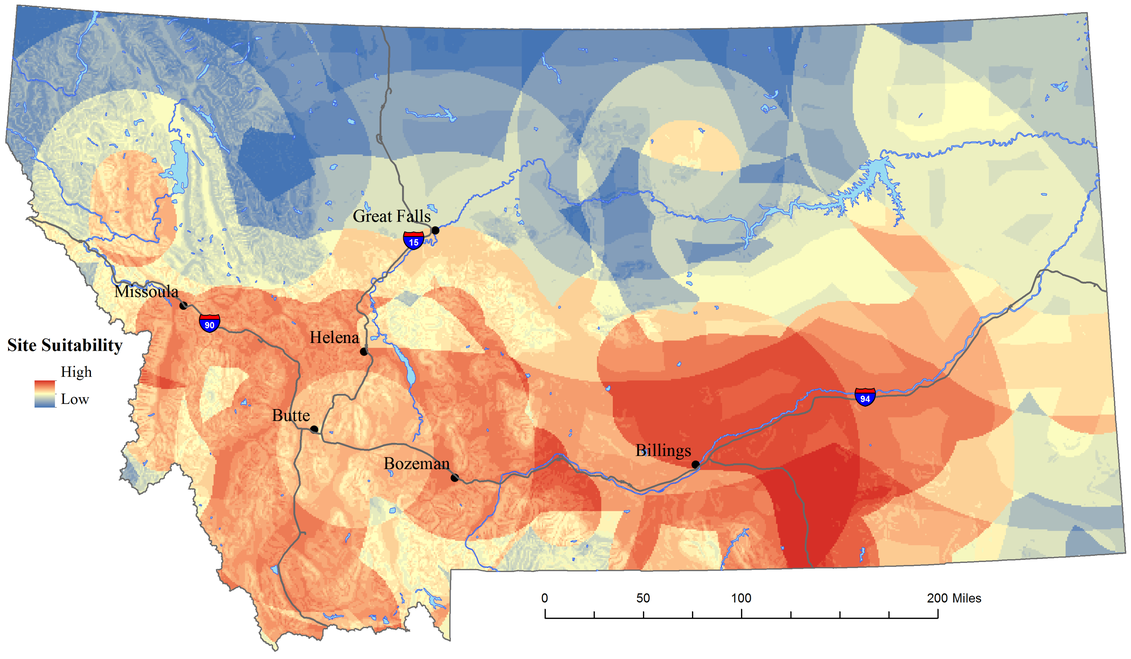
Analysis shows that a number of regions in southwestern Montana could be considered further for geothermal facility siting. An additional factor that makes these areas ideal is their proximity to the western state border, which could allow for exports of energy to other states with high demand for renewable energy, including California.

More than anything, this analysis confirms that more work should be done to determine ideal siting for geothermal power production facilities. Future studies should examine each of these high-suitability areas in more detail, perhaps at the county level. Additional criteria to overlay might include geology, temperatures of hot springs at known geothermal sites, and county-level land use patterns. Since perceived site suitability depends greatly on the criteria chosen and relative weights applied, studies done at higher resolution might yield different results.

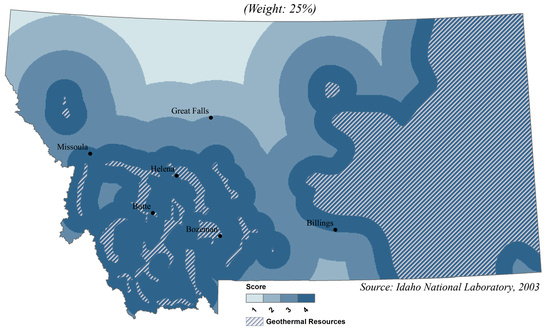
Limitations

Data related to geothermal resource availability and transmission line locations are most important in this analysis, but are outdated. Geothermal resource data are not difficult to obtain, but were last updated in 2003. Recent information about transmission line locations and voltages, on the other hand, is difficult to obtain publicly. While the work completed here is not invalid, since it is likely that transmission lines sited in 1993 are still active, information about newer projects is critical. Studies such as this one would benefit greatly from more open information related to transmission.

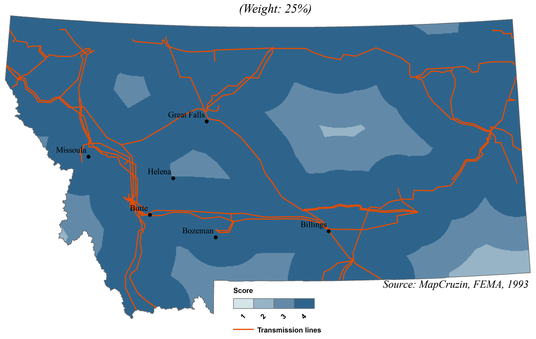
1. Hansen, James. 2009. *Storms of My Grandchildren: The Truth about the Coming Climate Catastrophe and Our Last Chance to Save Humanity*. New York, New York: Bloomsbury USA. P. 172



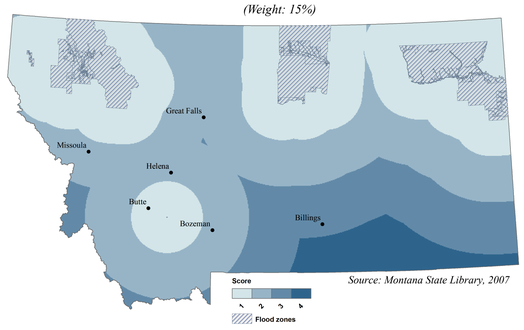
Proximity to Geothermal Resources
(Weight: 25%)



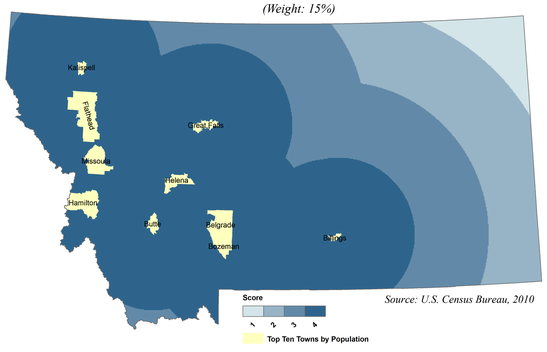
Proximity to Transmission Lines
(Weight: 25%)



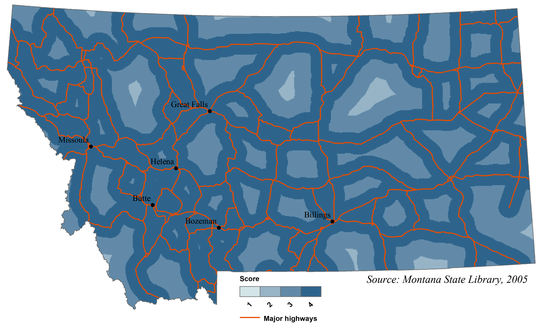
Distance from Flood Zones
(Weight: 15%)



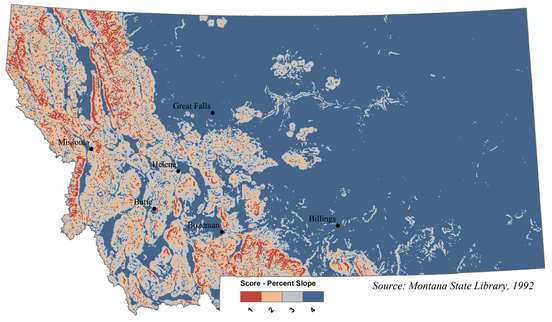
Distance to Population Centers
(Weight: 15%)



Proximity to Major Highways
(Weight: 6.67%)



Proximity to Flat Terrain
(Weight: 6.67%)



Distance from Conservation Lands
(Weight: 6.67%)