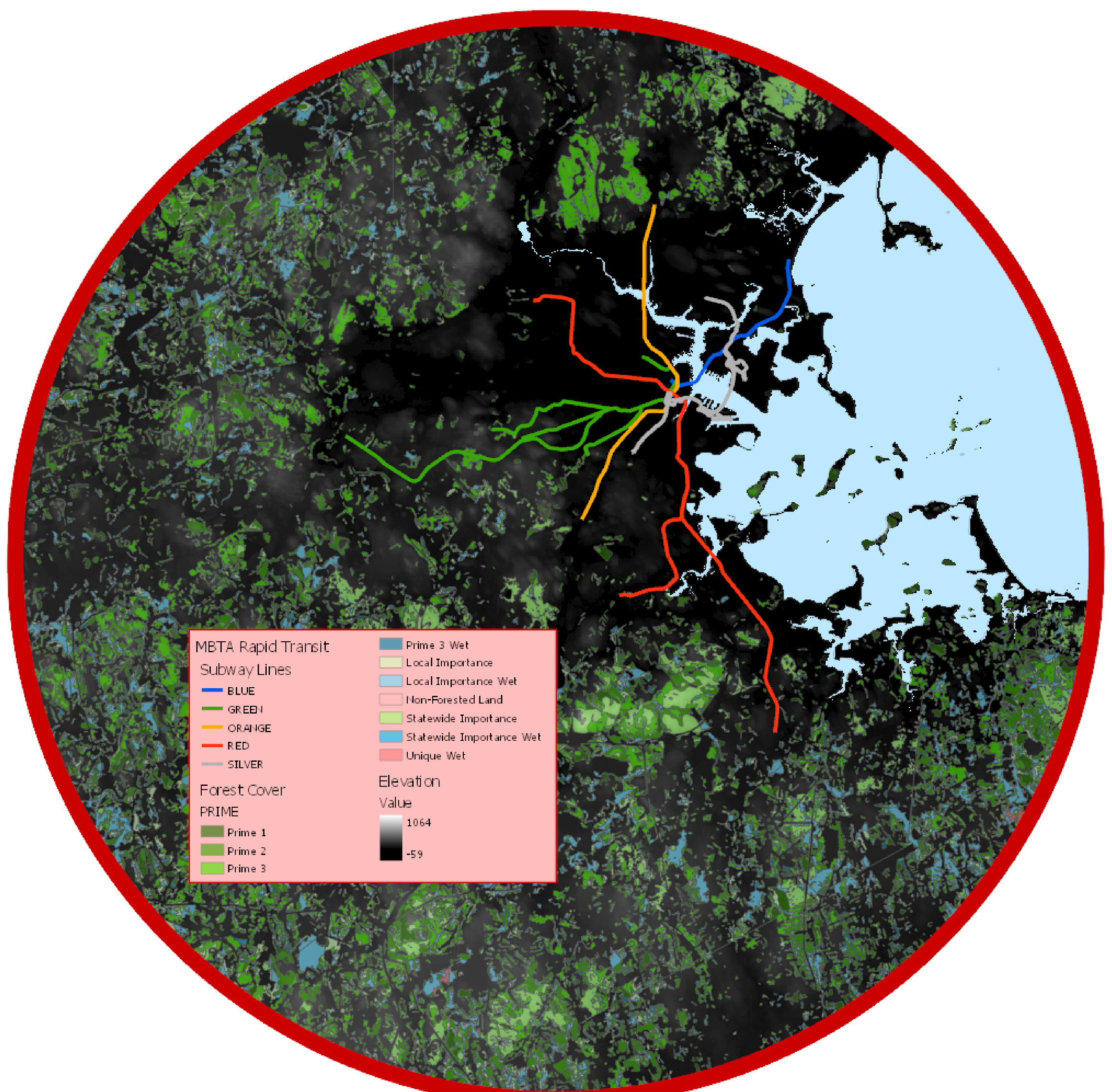
A Solar Suitability Analysis for the MBTA Red Line

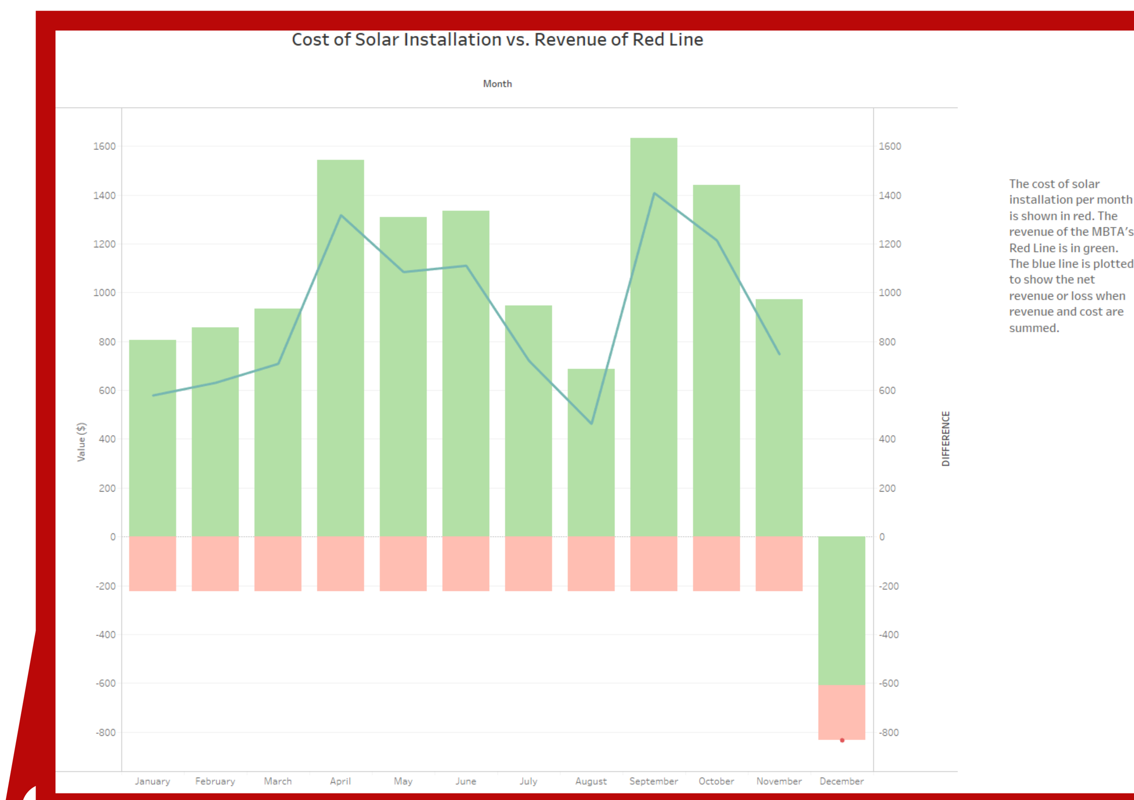


Background

More solar energy strikes our planet in one hour than our human population captures in an entire year (Lewis 798). As solar energy's availability and use has gained increasing attention, photovoltaic technologies have developed in parallel. Although just decades ago the capture of solar energy presented many seemingly unsolvable challenges, years of thought and research on the subject have illuminated the ways it can be harvested. Furthermore, better technology and increasing insight into photovoltaic technology have caused its cost to drop, desirability to surge, and accessibility to multiply.

Today, solar energy is used to power personal electronics, household utilities, commercial buildings, and more. However, there still seems to be a wide gap between the current amount of power generated from solar and the potential amount of power that could be generated from solar. Transportation often accounts for up to a third of a nation's energy consumption, and yet photovoltaics have only somewhat permeated that sector (Jaffery 271). Australia has deployed the first solar-powered train, but that was just one year ago. Countries like China and Uganda that are suffering from over-pollution are only now looking into solar buses.

Boston, MA is a prime location for investigation on solar suitability for the city's public transit network. The Massachusetts Bay Transportation Authority is an established subway system with steady revenue each year, which nominates the city as a candidate for solar integration.



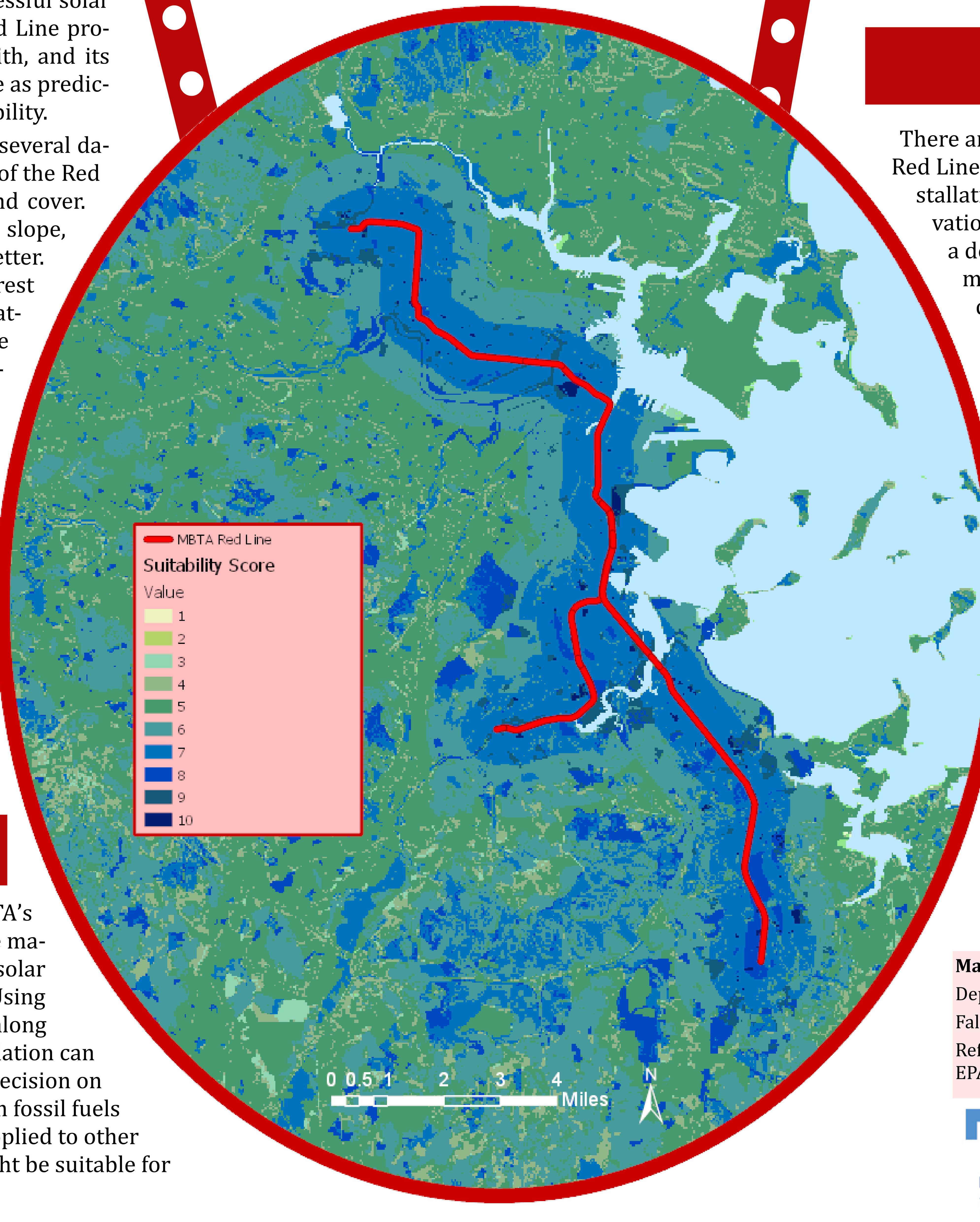
Methods I

To begin to determine the MBTA's solar suitability, it is important to narrow the target area before analyzing the factors that play into successful solar installation. Focusing on the MBTA's Red Line provides a smaller plot of land to work with, and its potential for using solar energy can serve as predictor of the other subway lines' solar suitability.

In order to calculate solar suitability, several data points must be obtained for the route of the Red Line. These are elevation, slope, and land cover. The higher the elevation, the flatter the slope, and the less land cover there is, the better. MassGIS provides an elevation and forest land map layer, but slope must be calculated. This is trivial in ArcGIS Pro — use the slope tool with a given raster of elevation. To calculate suitability from these three layers, reclassify the values in each of the layers to the same scale (in this case, a scale from 1-10 where 10 is the most suitable). Next, add buffers around the Red Line's route to account for the proximity of suitable solar land area. Lastly, using the raster calculator tool provided in ArcGIS Pro, sum the reclassified values of each of the map layers to accumulate a raw suitability score for each pixel, where each pixel represents 50 square meter of land.

Methods II

It is also important to consider the feasibility of integrating solar power with the Red Line. To determine whether or not the cost of installing PV cells would drastically exceed the revenue brought in by the Red Line, compare the monthly cost of solar installation versus the monthly revenue specific to the Red Line. Using annual financial reports published by the MBTA and sample solar costs, plot the two data sets against one another and calculate their sums. The sum represents the net monthly cost or revenue that would be accrued by MBTA from installing solar energy.



Results

There are several locations positioned around the Red Line route that would be suitable for solar installation. These spots provide a reasonable elevation, minimal slope, almost no land cover, and a decent proximity to the route itself. Furthermore, many of the suitable locations fall under the category of municipal or county owned land, meaning there would be few obstacles when converting this land to an energy generation site.

Using this suitability analysis for the Red Line, it is possible to extrapolate this data to other subway lines on the MBTA. Although the proximity factor would have to be recalculated for other lines, the slope, elevation, and land cover remain applicable.

Lastly, the cost analysis graph reveals that the costs of solar installation do not pose a financial set back for the MBTA. Given that the revenue brought in by the Red Line only far exceeds the monthly costs of installation, the MBTA would be able to maintain monthly profit even while bearing costs for this new project.

Conslusion

Assessing the solar suitability of the MBTA's Red Line involves taking into account the major factors that define successful uses of solar power: elevation, slope, and land cover. Using those factors to create a suitability map along with considering the costs of solar installation can provide a basis for the MBTA to make a decision on switching their energy consumption from fossil fuels to solar. Furthermore, this data can be applied to other subway lines to gauge whether solar might be suitable for those lines as well.

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References: MassGIS, (mass.gov), MBTA (mbta.com), EPA (edg.epa.gov) | Tools: Tableau, ArcGIS Pro

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