Campus Streetlight Illumination Modeling for Furman University

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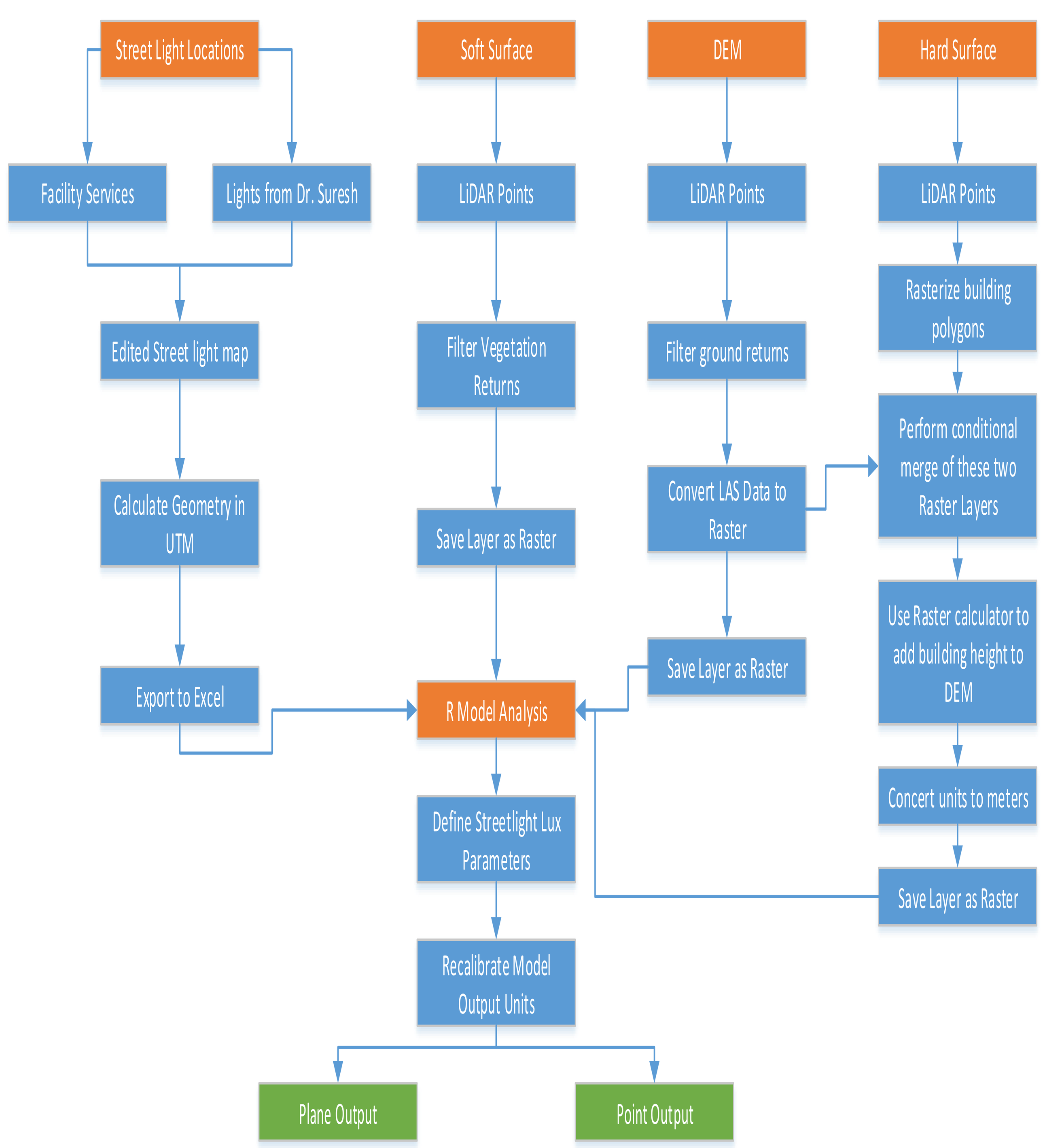
Abstract

Street lights are commonplace in urban areas. These lights increase night-time visibility and allow for safe human movement after hours. It is assumed that street lights decrease local crime rates after dark through two factors; increased surveillance by community members or law enforcement and they act as a deterrent for those who may commit a crime (Farrington et al. 2002). This is good news for the well-being of the lit communities. There are, though, several drawbacks to streetlight illumination during the night. As prospering urban centers around the world are erecting light fixtures to ensure the safety of their citizens, wildlife is suffering as a result. The constant illumination is disorienting to animals. Several behavioral patterns such as foraging, predation, reproduction, and communication are being disturbed (Longcore et al. 2004). This then leads to the purpose of this project. The purpose is to create a map of Furman University's light glow. I utilized the model created by Bennie et al. (2014) which employs the R-program. Using LiDAR data and building footprints, with the help of Dr. Suresh, we created an elevation model that included the hard surfaces (ground and buildings) and the soft surfaces (vegetation). With this I developed a 3-D visual representation of Furman University's light pollution. The light model that was created is relevant to reference height of 1.7 meters, human height. A 1.7 meter object would view the light intensity as produced in the Results section. With this I hope to highlight any areas of interest that show excessive light intensity on surrounding ecological environments

Methods



Results

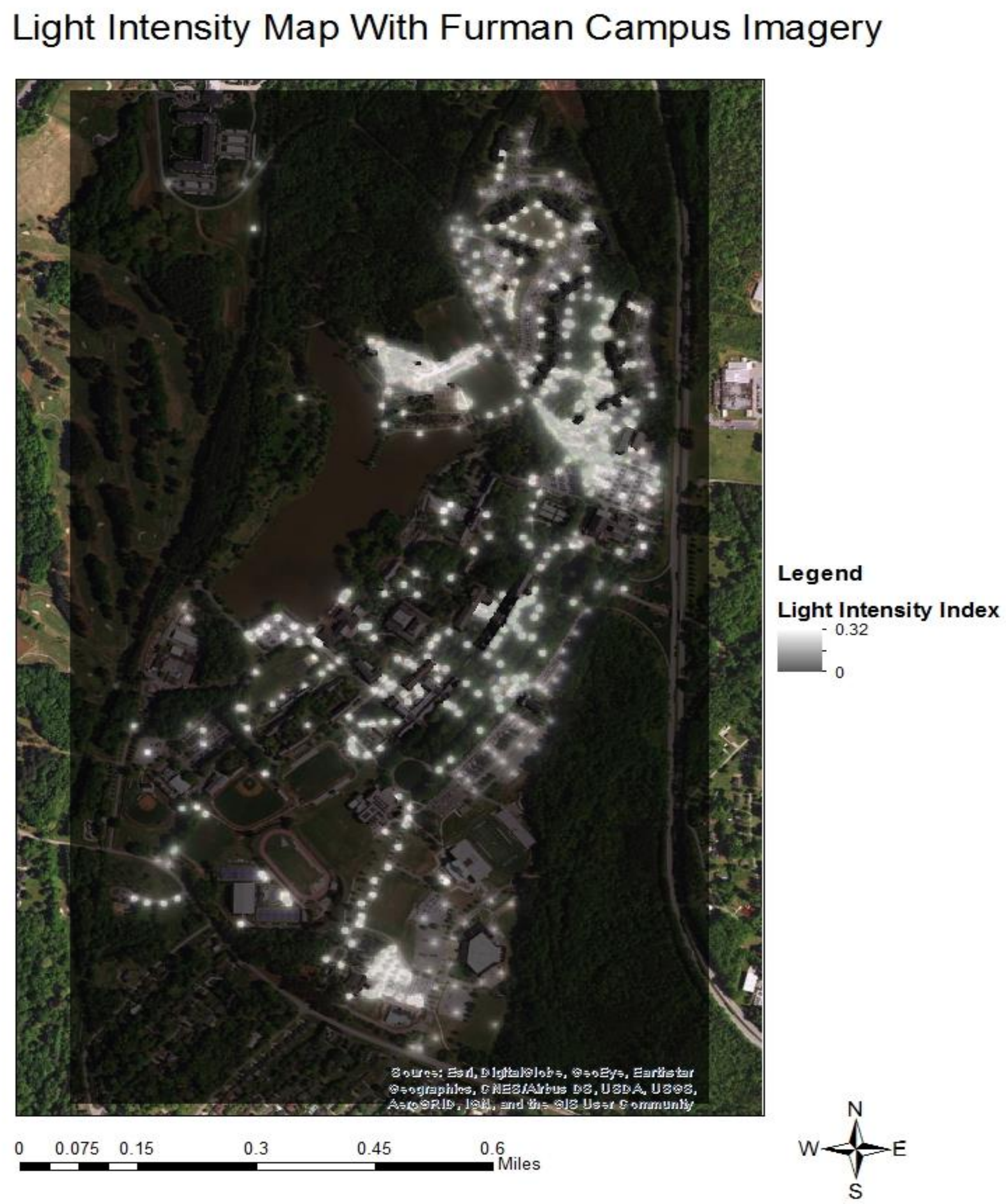


Fig. 1 Light map showing the light intensities (Lux) around Furman University's campus.

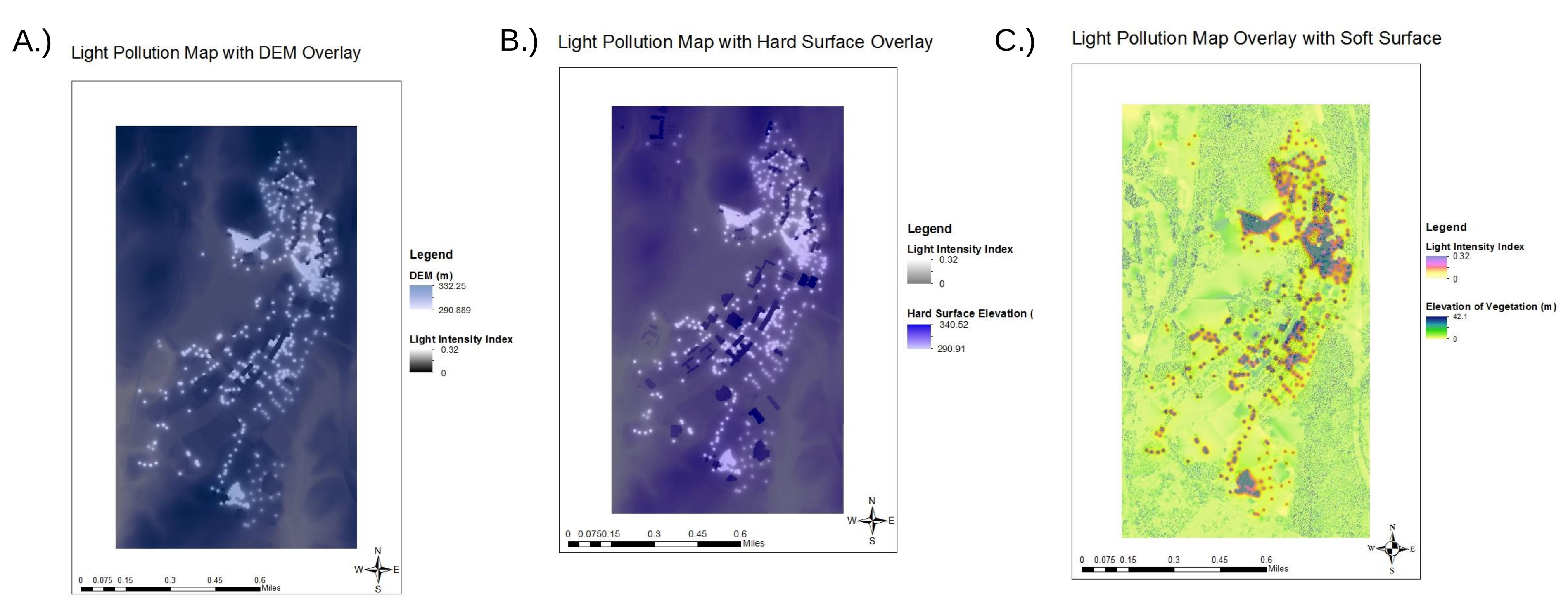


Fig. 2 A.) Light intensities (Lux) with Digital Elevation Model of Furman University. This includes only ground level elevation B.) Light intensities (Lux) with hard surface overlay represents light interactions with hard surfaces. Building polygons are added to the DEM to determine the absolute elevation of the hard surfaces. The light does not move through the surfaces. C.) Light intensities (Lux) with elevation of vegetation. Values of vegetation are determined as the difference between the top of the vegetation and the DEM.

Conclusion

Densely populated areas, such as Furman's Campus, produce a large light glow due in large part to street lights. It is argued that these street lights are necessary to deter crime at night in otherwise poorly lit areas. There is no denying these claims are true, (Farrington et al. 2002) but there are things we can do to limit the light pollution we emit to surrounding ecological environments. Being conscious of how lights are oriented can help local areas remain unaffected. In areas near rivers or other aquatic habitats, lights should be oriented upwards, away from asphalt. Polarotactic insects may mistake a damp, light asphalt for water and then mistakenly lay their eggs, leaving them for dead when the damp surface dries up. Directing lights away from vegetation cover will allow local bird communities to properly communicate, nest, and forage. Selecting rough surfaces, which have lower reflective values, for building surfaces will limit excess dispersion of the light source (Horvath et al. 2009).

Now that we have a map of Furman University's light pollution, it is possible for us to identify areas of issue. Areas that are not light efficiently, too much light in one area, can be damaging to local habitats and are unnecessary. Carefully choosing street light locations and placing them only poorly lit areas will not only protect surrounding ecological environments but will potentially cut energy costs. Three inefficiently lit areas that are easy to see, Fig. 1, include the amphitheater, around McAlister auditorium, and the Younts conference center. These areas should consider reducing the amount of light fixtures in order to more efficiently light the area.

Further Research is possible with simple editing of this model. In a few years' time Furman will have all street lights switched to LED bulbs. This means the model can be run again with increased lux values. This can also be run concurrently with a sound model. Collecting sounds at certain points around campus at specific times, then running the sound through a similar R model will produce a raster layer map. This map, alongside the light pollution map may highlight more areas of focus that would require furthering editing of the Furman street light system.

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Data Sources

1. Furman Facilities and Services
2. Suresh Muthukrishnan
3. Bennie, et al. R code for light dispersion and intensity
4. Greenville County LiDAR Dataset 2014

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