Estimating Light Pollution in Suburban Areas with complex Topography

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1. Introduction

The aim of this paper is to examine techniques of addressing a computationally intensive calculation. This is the measure of the extent of light pollution in the suburbs of a populous town. Previous work (Chalkias et al., 2006) has provided a methodology for modelling light pollution using Geographical Information Systems (GIS) and Remote Sensing (RS) technology.

However, only one technique was attempted in this work based on a subset of the data by using the appropriate sampling. In this paper, we evaluate and compare different methodologies for light pollution calculation by altering the size of the dataset and the visibility analysis algorithm.

2. Background

The development of cities and towns in modern days along with the extended use of private and public lighting has resulted in a disturbance of the natural night lighting (Borg, 1996). Several studies had looked at the development of artificial light in the sky due to the human activity in the ground as well as its consequences to the human and natural environment (Albers and Duriscoe, 2001).

Furthermore, scientists have looked at the growth and modelling of artificial light (Chalkias et al., 2005; Cinzano and Elvidge, 2003; 2004; Kerola, 2006). There is also research on ways to improve artificial lights in order to reduce light pollution (Willis et al., 2005).

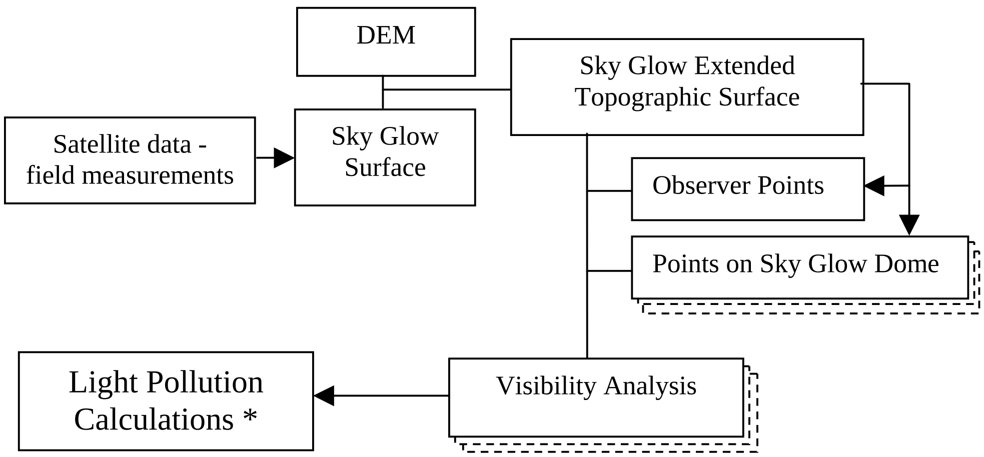
Although, there is substantial literature on the modelling of light pollution (Gerstang, 2000), mainly based on satellite images, there is little research in light pollution calculations in suburban areas with complex topography and related algorithm efficiency in terms of computational complexity and time. Here we attempt to propose ways of addressing these issues.

3. Data and methodology

The study area is the region of Attica, mainly the Athens Metropolitan area and its suburbs. The data used here, is the combination of the sky glow heights, estimated in

Chalkias et al. (2005) and the digital elevation model (DEM) of the study area. The output of this combination is a complex surface in which could be described as 'sky glow extended topographic surface'. This surface is the basis of the visibility analysis implementation.

In order to assess the light pollution, we perform a visibility analysis for every point in space representing a DEM cell. For each point of the study area, we measure the proportion of the cells of the sky glow surface that are visible. We assume full visibility for the points onto the sky glow. The output of the analysis is a grid that corresponds to the grade of light pollution in the cells of the study area.



* Based on Number of visible points on Sky Glow Dome from observer points

Figure 1. Diagram of the suggested methodology

One way to do this, is by producing a viewshed for every cell in the DEM and store the count of cells of the sky glow surface that are visible from this cell. Another way is to solve the same problem with a quicker generic algorithm using mathematical and geometrical theory. Both methods are time consuming and finding the most efficient is a challenge.

The steps of the suggested methodology are presented in a form of a diagram in fig. 1. The dashed rectangles in both "Points on Sky Glow Dome" and "Visibility Analysis" boxes suggested there are more than one approaches to each of these steps

4. Discussion

This work is in progress. Calculating the viewshed for every cell of the grid of the study areas takes several hours using standard commercial GIS (ESRI ArcGIS). We are using different approaches for defining the points on the Sky Glow Dome as well as testing different viewshed analysis algorithms aiming to identify the optimum one. We also attempt to develop our own alternative algorithm. In the full version of this paper we plan to provide comparative statistics of the different approaches we have tested.

5. References

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