Solar Radiation Tool within ArcGIS For Identifying Areas Prone to Snow Phenomena

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1. Background

Road travel is nowadays an essential part of our society. Road users expect to travel no matter the season or the weather conditions. Mainly during the winter, unfavourable weather conditions may have serious consequences for safety, and less important on delays. According to *John E. Thornes et.al* from the University of Birmingham, the benefits of winter maintenance have been estimated to be about eight times the cost.

The increasing role of GIS technologies as part of the road winter maintenance programs (developed in part by Highway Agency in UK) and Road Weather Information Systems (RWIS) (MetOffice Road Weather Forecasting in UK) has improved these systems results. Between the analysed factors for these RWIS, a sky view component has been demonstrated as highly relevant (Lee Chapman and J.E.Thornes).
Thus, the Solar Radiation tools available within the ArcGIS software package have been tested to check their suitability with a trial prediction model for snow phenomena for the Lincolnshire road network.

2. Aims and Objectives

Aims

✓Assess the value of the solar radiation tools for identifying "at risk" areas in bad weather.

Objectives

✓Develop a data driven approach to select areas prone to snow events.

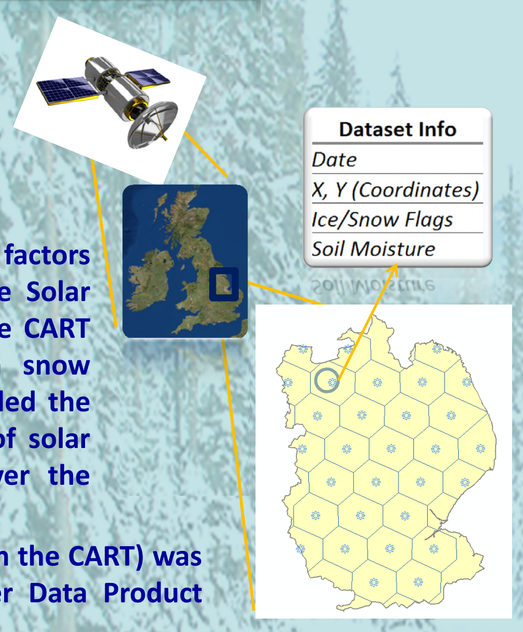
✓Assess the suitability of the solar radiation tool as a complement for the analysis and identification of these areas

✓Analyse possible relationships between areas with a longer duration of direct insolation, higher direct incoming solar radiation and spatial snow melting patterns.

3. Approach and Methodology

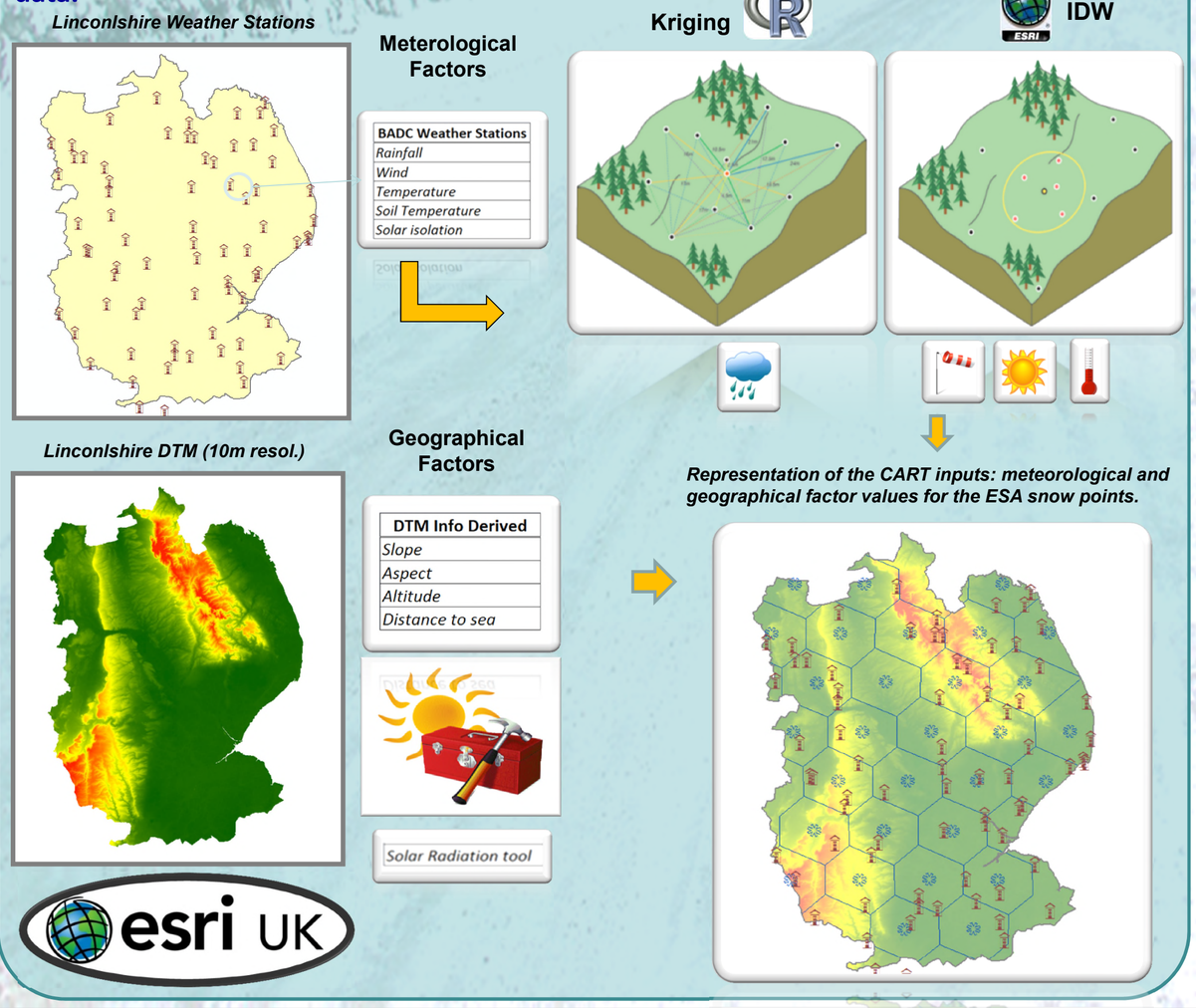
The research approach of this project is based on the use of Classification and Regression Trees (CART). This technique is used to predict variable values based on relationships between different datasets, by the development of a classification based on thresholds.

Thus, a set of meteorological and geographical factors were selected together with the outputs of the Solar Radiation tools (all of which were treated as the CART inputs), to investigate their relationship with snow events. Solar Radiation tools from ArcGIS enabled the quantification (and inclusion within the CART) of solar insolation and insolation hours parameters over the study area.



The snow spatio-temporal data required (output in the CART) was extracted from the SMOS L2 Soil Moisture User Data Product (MIR_SMUDP2) for the grid points.

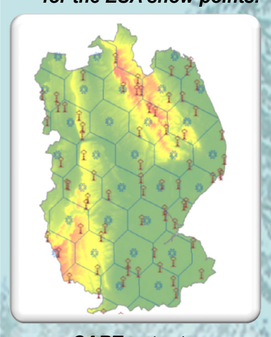
Meteorological data were obtained from the British Atmospheric Data Centre weather stations. In order to obtain the same spatial data for these points (data available only for the weather station locations), Kriging and IDW geostatistic techniques were applied. The kriging technique used was Ordinary Kriging with a block support to better fit into the ESA data.



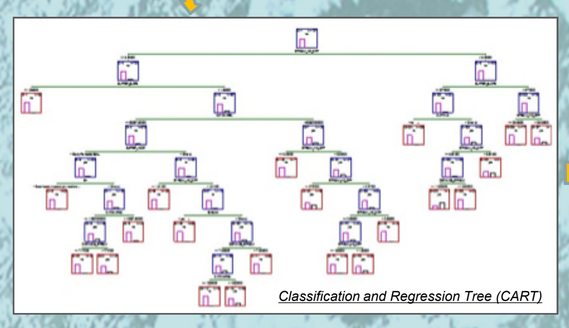
Representation of the CART inputs: meteorological and geographical factor values for the ESA snow points.

4.- Findings and Recommendations

CART inputs: meteorological and geographical factor values for the ESA snow points.



CART outputs: ESA snow locations.



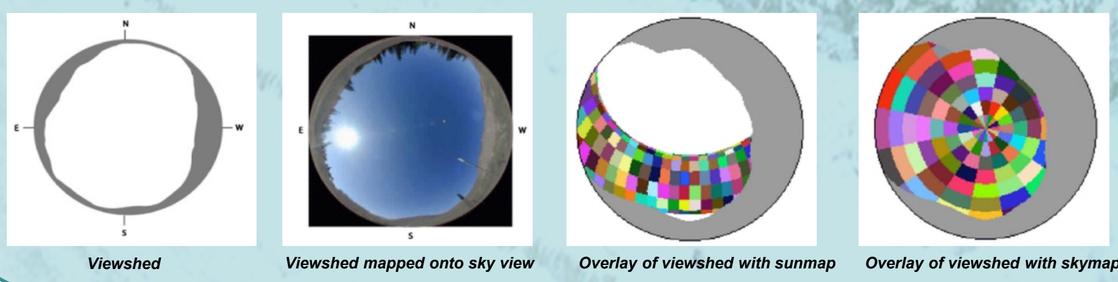
✓Kriging predictions of rainfall values were satisfactory as there was a considerable number of sampling points (BADC stations). Block kriging was demonstrated to be a suitable support for this study taking into account the ESA datasets, as shown on the cross validation results.

✓IDW results were very useful taking into account the sampling size limitations for the other meteorological factors.

✓The CART model performed well even though the size of the input dataset (in relation to the task to be done). Meteorological and geographical factors identified as important by the literature were also identified by the CART.

✓CART outputs allowed a correlation analysis between the spatial location of the snow phenomena and the Solar Radiation tool outputs. Results from this analysis were overlaid with the current gritting routes of the Lincolnshire road network as the final step for the conclusion extraction.

Solar Radiation tool map types: SUNMAP for the representation of the sun position over a defined period of time and SKYMAP, which depicts the sky sectors influencing the quantity of insolation (incoming solar radiation).



Viewshed | *Viewshed mapped onto sky view* | *Overlay of viewshed with sunmap* | *Overlay of viewshed with skymap*

5. Conclusions

✓The results of the approach taken in this research may be further improved in an extended time frame. It would allow the use of other geostatistical techniques such as CoKriging or MonteCarlo simulations, which could potentially lead into the development of a risk map. Another important constraint was found in the availability of spatio-temporal datasets regarding weather and snow phenomena, which will improve the CART performance and thus the assessment of the Solar Radiation tools suitability.

✓As in the consulted literature, the sky view factor was demonstrated to be an important driven factor, which is a positive feedback for a further use of the Solar Radiation tools for similar purposes.

✓There was a slight relationship between areas with a longer duration of direct insolation, higher direct incoming solar radiation and spatial snow melting patterns

✓ As an overall conclusion the depth of research here developed is not enough to assess the suitability of these tools. However this methodology can be improved with the above suggestions and at different scales, which will allow the extraction of further conclusions.

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