North Norfolk Dark Sky Survey
"Norfolk Nightscape"

Survey Results

Phase 2, October 2010 to May 2011.
The work continues to be carried out by members of the NNAS with some financial support for 2010/11 from the Norfolk Coast Partnership.
Members associated with Survey for this period, J.Prockter, C.Hards, M.Lawton, AD. Prockter

Introduction

The purpose of the Survey is to establish a database of the quality of the night sky in North Norfolk. The survey is being carried out across all of North Norfolk but in greater detail at the coastal areas that correspond with the Area of Outstanding Natural Beauty along the north Norfolk coast, using Unihedron Sky Quality Meters (SQM).

Some benefits of the survey are:-

1. The final results will provide an indicator of the levels and sources of light pollution but also the areas of best dark sky quality (DSQ). It can also be used to monitor future changes in DSQ.
2. It can be used to retain the quality of the existing night-time sky. In other parts of the UK this type of survey has contributed to the establishment of the first Dark Sky Park at Galloway in Scotland. Exmoor National Park is also seeking IDA International Dark Sky Reserve status in respect of the IDA Dark Sky Places initiative.

3. It can be used by planning organisations to monitor the effects of changes resulting from urban and industrial development.

4. It is of use as a measure of environmental quality relating to nocturnal wildlife, it can aid tourism when accompanying advertising campaigns and is especially useful to astronomy organisations and visiting astronomers.

5. It is available to local communities to create awareness of their local night environment and it encourages them to protect it.

Comparisons

There are alternative methods of providing DSQ information. The Campaign to Protect Rural England, CPRE, through it's organisation Night Blight has published contour maps of light pollution although these are now probably out of date. They rely on the use of satellite images, which are inward looking rather than measuring what the observer sees from the ground. Also, there is no information available about the timing, level of cloud cover and whether the images were taken at the same time or are a compilation of many satellite passes over many weeks.
There are now also available a lot of DSQ data readings (using similar equipment to ours) taken across the country and posted on websites. But there is no overall quality standard applied to these readings so they cannot be directly compared with other locations. Also, no data is available about

the conditions prevailing at the time they were taken.

Astronomers use a variety of criteria to establish the DSQ, mostly using star counting methods. Though useful, these only give a subjective measure.

Equipment

We continue to use the hand-held Unihedron SQM for localised readings in built up areas, but we now have two sets of SQM that can be linked to laptop computers so that, using gps technology we can drive to pre-arranged locations and record the required series of readings for later analysis. We continue to use standard Ordnance Survey (OS) maps.

Method

Our method is a development of that described in our **Phase 1** report of last year. The emphasis has been on improving the planning of the activity. The changes we have adopted are:-

1. We use two scales for the density of readings
   a) the centre (or as near as we can get) of a standard 4km by 4km OS grid box
   b) the centre of a 2km by 2km OS grid box
   The 4 x 4 box covers an area of 16 sq km and the 2 x 2 box covers an area of 4 sq km. The 4 x 4 box is used to cover most of the survey territory while the 2 x 2 box is used to get more detail, for example around and within towns.

2. We use Google Earth to identify the desired locations and obtain their Latitude and Longitude.
   This information is used in a "sat.nav" to allow us to drive to the required series of locations. Typically, between 10 and 20 locations can be surveyed in a 3hr period but it is important to carefully plan the route. As all of the surveying takes place at night, 3hrs proves a suitable period, especially when the vehicle mounted SQM is used as there is normally no need to leave the vehicle.

3. When we arrive at the location the SQM readings are downloaded along with a gps reading (used as a check on location) and an averaged SQM reading is stored in a laptop computer file along with other data. This data is later added to a master database.

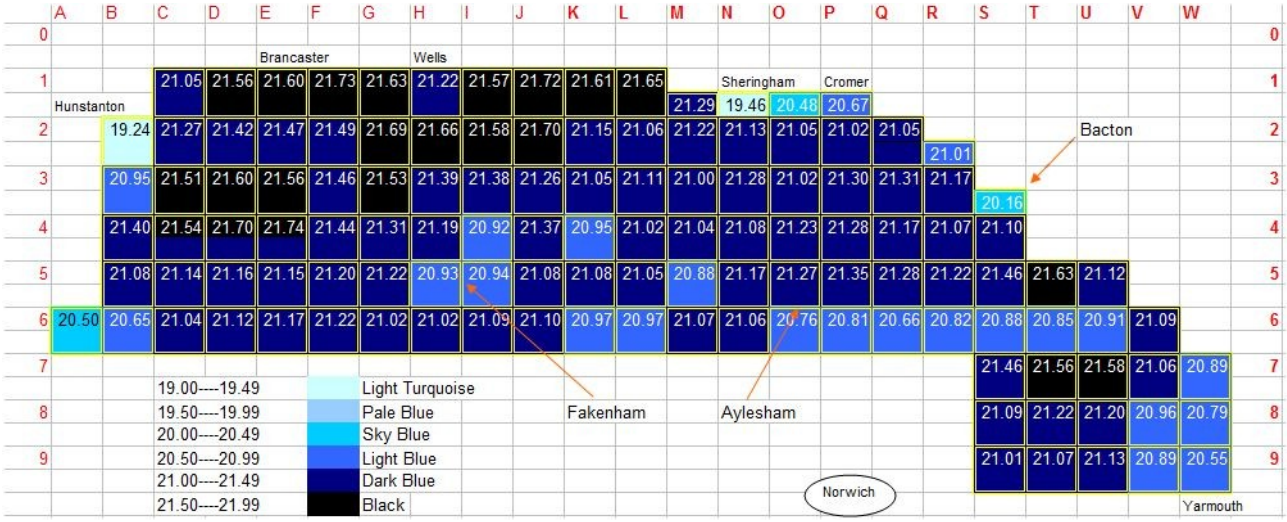
4. We now pay greater attention to prevailing weather conditions and the following rules are applied.
   a) No moon, no twilight.
   b) No cloud, either at the start or predicted for the period of the survey. The use of www.metoffice.gov.uk has proved very effective for planning this.

5. The use of a static SQM operating at a fixed, good NSQ location has been used as a comparison during the survey run.

6. Hand-held SQM use is restricted to a manual recording system, using pre-printed maps with identifiable survey locations. The data is subsequently manually loaded onto the database.

Presentation

This remains the biggest problem. Creating a database of readings and accompanying information is relatively easy. Putting that information into a format that is accessible by people outside the survey is not! Various ways of presentation have been tried but so far, tessellation (tiling) has proved the simplest. It may be possible to create a contour presentation in the future but it also may prove there is too low a density of readings to do this effectively.



The above illustration is obtained by using a spreadsheet (Excel) where each box (or tile) represents a 16sq km rectangle on the Ordnance Survey map. Some half height tiles are shown along the coastline.

In fact, we have taken readings at a greater detail in urban areas, 4 sq km and less, and these can also be introduced in the map to show the lighting effects in towns. However, this results in the spreadsheet becoming very large and the operation time-consuming. Further work will be done here this year and will be published on our website www.nnas.org.

It should also be noted that there are known errors in the data displayed above. The original purpose of the survey could be worded as "how dark is North Norfolk" and some of the light blue rectangles in row 6 are probably darker than the readings suggest. This is almost certainly due to atmospheric and operating conditions that we have now learnt to avoid. It is intended to re-visit these suspect sites and re-measure.

Also, a lot of the dark blue tile readings have borderline results with black ones. This suggests that the scales are too broad and the range of colours used may be insufficient. For example, the darkest region (black) could have a range of 21.75 to 21.99, the next darkest (dark blue) 21.5 to 21.74 and so on. This would increase the accuracy of the presentation but double the palette of colours required.

An interpretation of the above picture is that the Western Coast, going inland to the A148 is a very dark area. This probably relates to the small size of the coastal towns and the lack of industrial development. In the east, apart from the Sheringham, Cromer and Bacton effect, the quality is very good but affected by some light pollution from larger towns with some industry, ie North Walsham and Aylesham. As we travel along the eastern coast, the quality reduces further as we approach Yarmouth.

A similar reduction in quality is seen around Fakenham. This town has been surveyed in greater depth but the results are not yet incorporated. Typically, readings in a town with street lighting are in the order of 17.0 to 18.5 and when incorporated will probably show on the map as yellow/red areas. It will also be interesting to see the changes in light quality levels as major housing and industrial developments are made in Fakenham over the coming decade at the Clipbush Business Park and how far outward the pollution spreads. Dereham is another town that has been surveyed in

similar detail.
In fact, readings have been taken further south and around Kings Lynn but do not yet show in the above illustration. It is also likely that by co-operation with other Astronomy Societies we can expand the survey across most of Norfolk so that a complete darkness map can be achieved.

Photographic Images

As a part of this survey we originally planned to make a photographic record of light pollution sources from high points. This continues but at a slower rate than planned.

The above picture was taken from the top of the tower of Langham church using a fish-eye lens. It shows light pollution sources at the circular horizon. (the arrow is a wind-vane on top of the flagpole and Polaris, the North Star is just to the right of the arrow feather). Apart from the rather dramatic demonstration of pollution, we have yet to find a method of incorporating the data this type of picture provides into our database.

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Notes

The Unihedron SQM

The SQM records the light from the night sky and is calibrated to give a reading from1 to 23. 1 is total light while 23 would be no light. Normal night conditions will range from about 15 in a town to 21 or more in a very dark open area. The units of measurement are magnitudes per square arcsecond. The method used is to point the meter straight upwards and press a button to take a reading. The reading is prominently displayed and written down on a record sheet. Eight readings are taken at each location, the highest and lowest are discarded and the remaining six are averaged to obtain a final reading for the site. Alternatively, a type of SQM is now available that has a usb connector so that the reading is downloaded onto a laptop computer where the computations are completed and the result is stored in a file.

Details of the SQM is at http://unihedron.com/

2010/11 Phase 1 Report is available at http://nightscape.nnas.org/

International Dark Sky organisation http://www.darksky.org/

CPRE Night Blight www.cpre.org.uk/resources/countryside/dark-skies/

The Campaign for Dark Skies www.britastro.org/dark-skies/