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A view of London at night from the International Space Station, orbiting at a height of 360 km. You may be able to spot two large parks, just west of the city centre, and the M25 orbital motorway to the south. Heathrow and Gatwick airports are also brightly lit

NASA/SPL

Seeing stars

GCSE key words
Electromagnetic spectrum
Light pollution
Reflection
Refraction

Go outside on a dark night, and look up at the sky. What do you see? The Moon, stars, the odd planet? Or a dim light across the sky, making it difficult to discern anything of interest? Astronomers, amateur and professional, aren't happy about this. It's light pollution, and it makes it difficult for them to observe the night sky. But you don't have to be an astronomer to be affected.

'Over great cities, towns and even small villages, light pollution robs us, in the last millisecond of its journey, of light which may have travelled for hundreds, thousands or even millions of years to reach our planet.' Bob Mizon of the Campaign for Dark Skies.

You may have been on holiday to a place where the night sky is clear. The sight of thousands of stars can be a breathtaking experience. In such a place you may see the Milky Way, the broad band of stars which is our galaxy, or a comet.

In the UK such experiences are increasingly rare. Light pollution is caused by too much light, from street lighting and other sources, illuminating the night sky. Any dust or water droplets in the atmosphere reflect light back down to us, and this makes it harder to see the stars. Towns are much worse for light pollution than rural areas, but there is growing concern that the countryside is becoming more urbanised, with more lighting. The difference between town and country is decreasing.

Stars are faint objects. Bright moonlight is about one-millionth of the brightness of a summer's day, and stars are much fainter than that. To see faint objects, your eyes need to be accustomed to the dark. It takes a few seconds for the pupils to widen, to let in maximum light on a dark night. After a few minutes, the light-sensitive chemicals in the rod cells in your retina reach maximum sensitivity. But if the stars are lost in a faint haze of light pollution, you simply won't see them.

Floodlighting of sports grounds is one source of light pollution

Bob Mizon/CfDS

Frank Zullo/SPL

Above: *These street lights minimise light pollution. The mist in the air shows how all the light is directed downwards*

Astronomers up in arms

Astronomers are unhappy about light pollution, to say the least. It can interfere with their own observations, if they are looking at starlight in the visible part of the electromagnetic spectrum. In addition, it makes it difficult for amateur astronomers, most of whom live in towns, to make any observations at all.

This isn't just spoiling someone's hobby — amateur astronomers have always made important contributions to the development of astronomy. Earlier this year, Jay McNeil spotted a new star in the constellation of Orion. Using his 3-inch telescope, he had noticed a rare event — the birth of a new star. Within hours, the giant UK/US Gemini telescope, in Hawaii, was observing the same event. Professional astronomers value the part played by amateurs on occasions like this, and the two communities share information freely.

Light pollution is getting worse, despite growing awareness of the problem. In an attempt to turn back the tide, the British Astronomical Association has set up the Campaign for Dark Skies. Its head, Bob Mizon, explains why he thinks it's an important campaign:

> The night sky is by its very nature a 'site of special scientific interest' and an 'area of outstanding natural beauty'. It has been quietly and gradually taken away, over the last 50 years, from those dwelling in towns and urban fringe areas, throughout the developed world. Sky-glow and obtrusive wasted upward lighting also detract from the character of the night-time scene and are detrimental to local amenity, not just for astronomers, but for the public in general.

The campaign doesn't want to turn off all street-lights, but it does want to see more controlled lighting, with great reductions in the wasted light which spills upwards from poorly designed fittings.

- **Try to imagine what it would be like if we lived on a planet where we could only see the Sun and Moon in the sky. Would we ever have discovered the true extent of the universe?**

- **There are many Sites of Special Scientific Interest (SSSIs) on the ground in Britain. Use a search engine to find out why a place is declared an SSSI.**

- **The first Area of Outstanding Natural Beauty was the Gower peninsula in south Wales. Where is the nearest one to your home?**

Better lighting

Most street lighting in the UK makes use of sodium lamps, in which an electric current passes through a tube containing sodium vapour. The sodium atoms gain energy from the current and glow when they release it as light.

Low-pressure sodium lamps glow orange, the colour you may be familiar with from flame tests. Roughly 35% of street lights are low-pressure sodium. The remainder are nearly all high-pressure sodium, which give white light. These tend to waste more energy than the low-pressure variety.

A well-designed lamp will direct its light where it is needed. This can be done in a variety of ways.

- High-pressure sodium lamps usually have a reflector above the tube, to re-direct light downwards.
- Low-pressure sodium lamps make use of 'refractor optics' — light from the tube shines through a thick glass cover which acts as a lens, concentrating the light where it is needed.

The UK Highways Agency has a 'good practice' policy on street-lighting, to encourage local authorities to use energy-efficient, environmentally-friendly lighting (Figure 1). However, lights have a long life, and badly-designed lights may be around for a long time before they are changed.

At the same time, sources of light pollution are growing. More people are fitting 'security lights', and more public buildings are being floodlit. The skies are getting lighter.

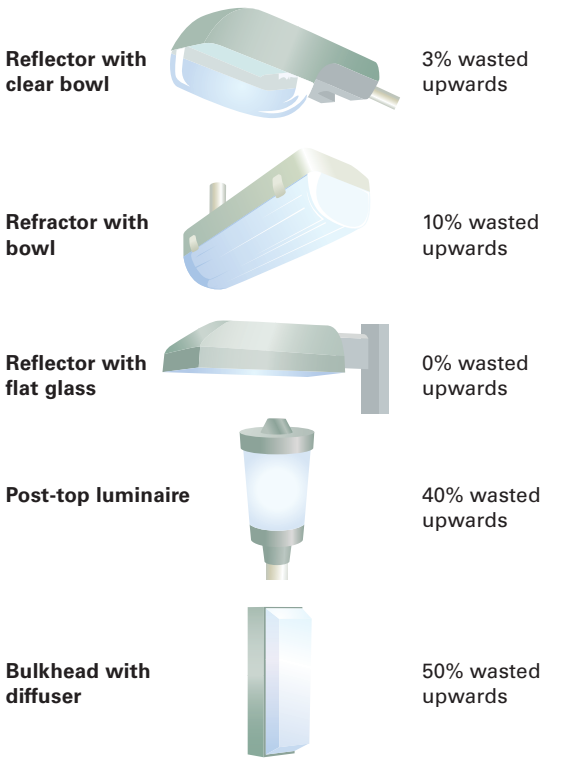

Figure 1 *Types of street light. Some waste as much as 50% of their light*

Box 1 Looking at the statistics

Case 1

Traders in Birmingham's Rag Market were worried about thefts. They installed new lighting in late 1983.

Figure 2 compares the numbers of thefts in the Rag Market with the numbers in two other markets nearby (the Open Market and the Market Hall). Unfortunately, the number of thefts in the Rag Market was already falling, so the data can't be said to show that lighting was effective.

Case 2

In Bristol, new lighting was introduced in some areas in the late 1980s. The upper line on Figure 3 shows the number of crimes on the relevant police beats over intervals of 6 months.

The control data are for other beats where no changes were made to the lighting. Can you see a pattern?

You might guess that there is a slight downward trend in the upper line, but a proper statistical analysis shows that this is insignificant. Paul Marchant says, 'The up-and-down variations are what is known as "noise". They are simply random variations from one year to the next, and don't show any convincing evidence for the effectiveness of increased street lighting in the fight against crime.'

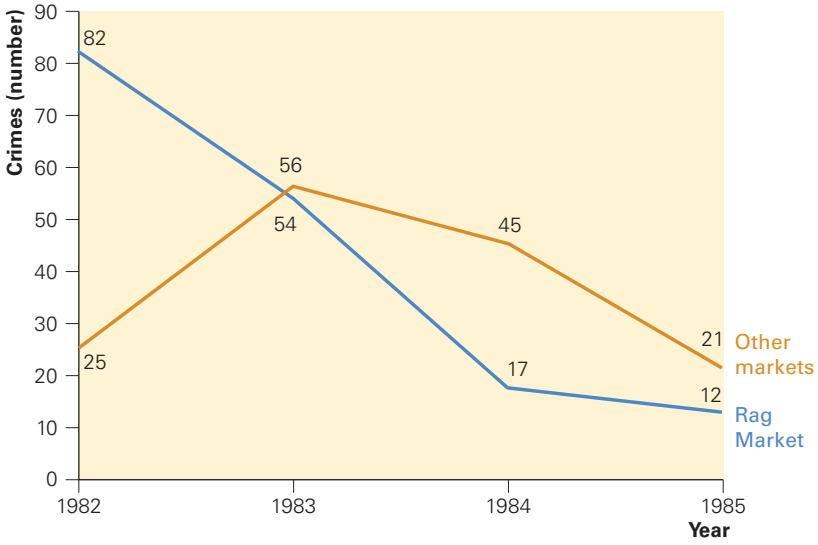

Figure 2 *Number of crimes in Birmingham markets. New lighting was introduced at Rag Market in late 1983*

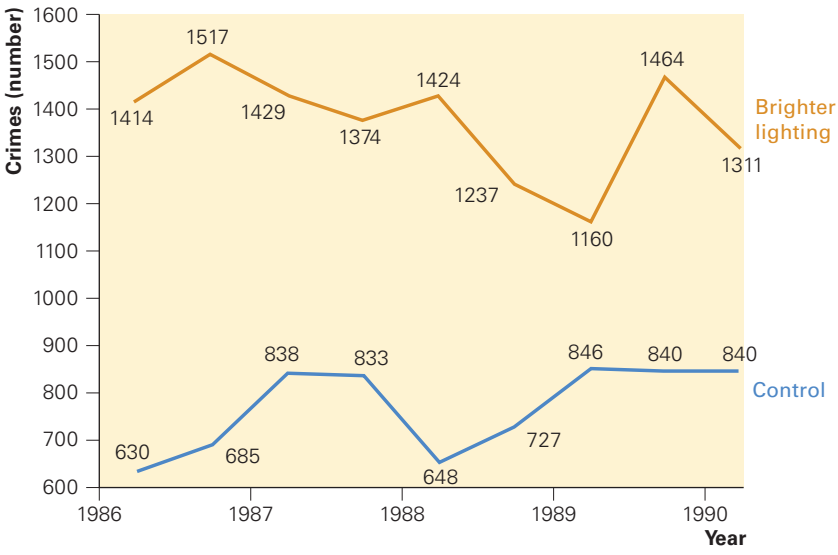

Figure 3 *Number of crimes reported (in 6-month periods). New lighting was introduced from July 1987 to March 1989*

Keeping crime at bay

People are increasingly fearful of crime. They worry that their houses may be broken into, or that they will be mugged in the street at night. So they fit exterior lights in their gardens, and local authorities increase the level of street lighting as a deterrent to crime. It seems sensible, doesn't it?

Not necessarily, according to Paul Marchant, a statistician at Leeds Metropolitan University, and an amateur astronomer:

> It may seem obvious that crime will go down with better lighting. However, we do not have the evidence to prove it.
>
> Most crimes are committed during the day. At night, burglars need light, too. In some parts of the USA, schools have turned off their lighting at night, and they get less vandalism.
>
> The light fittings which many people attach to their homes are too bright; the glare they give off makes it difficult to see what is going on in the shadows. Try replacing a 150 W lamp with a 15 W one and you'll see the difference.

Paul is not convinced by the data used to argue for more lighting (see Box 1). 'There haven't been any scientifically-designed studies into the effects of increased lighting. Meanwhile light pollution has substantial environmental consequences. If any decision is taken to increase lighting, it needs to be taken on the best possible evidence.'

Darker nights

Astronomers make use of all regions of the electromagnetic spectrum to study the skies. They have agreements with governments not to permit the use of certain wavelengths for radio communications, so that radio telescopes don't suffer from interference. At the same time, the evidence is that light pollution has increased over the last 10 years, and our view of the stars is fading fast.

David Sang *writes textbooks and is an editor of* CATALYST.

The Campaign for Dark Skies is run by the British Astronomical Association: http://www.dark-skies.org/main.shtm

- **The Campaign to Protect Rural England is concerned about light pollution. Go to http://www.cpre.org.uk/campaigns and click on *Light pollution* where you can download maps for your area for 1993 and 2003.**