



## 2. Underpinning Research

Light pollution is a form of environmental degradation caused by excessive artificial outdoor lightings, such as street lamps, neon signs and illuminated signboards, which affect the natural environment and the ecosystem. Poorly designed outdoor lighting not only wastes energy, money, and valuable earth resources, but also deprives everyone of the beautiful night sky. The electricity that might be saved with less improper outdoor lighting would also mean less air pollution, which could in turn reduce global warming caused by the power generation process.

As revealed by satellite imagery of the Earth at night, it is obvious that light pollution is fast growing to be a global environmental problem. Dr Jason Pun, Principal Lecturer in the Department of Physics, first studied this issue in 2003 using traditional astronomical techniques (telescope and camera), which was the first scientific research of this problem in Hong Kong. To increase the geographical and time coverage of the survey, Dr Pun obtained a grant under the Environment and Conservation Fund (ECF) in 2007 to initiate the project *A Survey of Light Pollution in Hong Kong*, which was the first ever ECF grant on the topic. It was designed to be a citizen science project, with over 170 participants coming from different walks of life: amateur astronomers, campsite managers, and secondary school teachers and students.

At the end of this 18-month survey, 2,000 individual readings of the night sky conditions were recorded in over 199 distinct locations, forming the basis of the report submitted to the Environmental Protection Department. It was found that light pollution in Hong Kong was severe, with the night sky in the worst polluted urban areas being a few hundred times brighter than in some less polluted rural areas.

Building on the success of the previous survey, Dr Pun received another ECF grant in 2009 to conduct the project *Hong Kong Night Sky Brightness Monitoring Network* (NSN). Automatic night sky measuring stations were established at 18 sites all around Hong Kong to continuously monitor the quality of the night skies. Over 5 million night sky brightness data points were collected, making the NSN the largest long-term single database on night sky brightness ever developed in the world. Results from this 2-year study clearly revealed that artificial exterior lighting is the main source of light pollution in Hong Kong, with the night sky changing sharply near the top of the hour at 11pm, 12am, and 1am, matching the timing patterns of surrounding public and commercial lightings. The urban night sky is on average 15 times brighter than the rural sites, further demonstrating the damaging effects of man-made lightings. Moreover, the Hong Kong urban night sky was found to be 100 to 1,000 times brighter than the international dark sky standard between 8:30-11:00pm, making it one of the most light-polluted cities in the world. Results from this project had been submitted to the government to facilitate consideration of further regulations on the use of outdoor lightings.

### 3. References to the Research

#### Key peer-reviewed publications:

1. **Pun, C. S. J., & So, C. W.** 2011, “Night-sky Brightness Monitoring in Hong Kong: A city wide assessment”, *Environmental Monitoring and Assessment*, 184, 2537  
DOI: 10.1007/s10661-011-2136-1
2. **Pun, C. S. J., So, C. W., Leung, W. Y., Wong, C. F.** 2014, “Contributions of artificial lighting sources on light pollution in Hong Kong measured through a night sky brightness monitoring network”, *Journal of Quantitative Spectroscopy and Radiative Transfer*, 139, 90 – 108; DOI: 10.1016/j.jqsrt.2013.12.014

#### Selected external grant funding:

1. A Survey of Light Pollution in Hong Kong (ECF 2007-01)  
 Funding Scheme: Environment and Conservation Fund (ECF) of the HKSAR Government  
 Principal Investigator: Dr Jason C S Pun  
 Period: 2007 – 2009  
 Amount Awarded: HK\$148,000
2. Hong Kong Night Sky Brightness Monitoring Network (ECF 2009-10)  
 Funding Scheme: ECF  
 Principal Investigator: Dr Jason C S Pun  
 Period: 2010 – 2012  
 Amount Awarded: HK\$499,970

### 4. Details of the Impact or Benefit

It is a huge challenge to change public perception on light pollution because traditionally the general public is proud of Hong Kong being the “bright” Pearl of the Orient. In order to promote public awareness of the damage caused by light pollution to the natural environment, Dr Pun’s team has adopted a multifaceted approach in community engagement.

#### *Impact on the General Public*

- Light pollution was a topic that received scant attention before the first survey conducted by Dr Pun in 2003. Since 2005, the work of Dr Pun and his team has been covered in over 50 newspaper articles related to light pollution, including

international news agencies such as the *Wall Street Journal* and CNN. In addition, his team has also made a total of 18 local and international television appearances to advocate for the issue. Increasing public interest and changing public perception can be seen as a result. For example, the press release issued in June 2009 on the results of the first ECF project gave rise to a total of 14 articles from 11 newspapers, including the editorial of *South China Morning Post*. This indicated a gradual change in public opinion from questioning why it was even necessary to talk about dimming the bright Pearl of the Orient to becoming concerned about the damaging effects of abusive outdoor lightings.

- A dedicated website (<http://nightsky.physics.hku.hk/>) was set up to communicate real-time readings from the survey to the public. It serves as an educational resource center for the general public on all issues related to light pollution, attracting over 30,000 unique visitors and 220,000 pageviews since its launch in October 2011. A mobile version of the website (<http://nightsky.physics.hku.hk/m/>) has also been developed for people to access the night sky conditions from their mobile devices.
- In support of the *Earth Hour* organized by the World Wide Fund for Nature (WWF), Dr Pun's team held the *Light Pollution Science Roadshow* on March 23, 2013 at the Avenue of Stars, Tsim Sha Tsui, to promote the HKU light pollution research results and the importance of dark sky and energy conservation to the public. The interactive exhibition attracted thousands of visitors to participate in real-time light pollution measurements.
- The "Light Pollution Photography Competition 2014" organized by Dr Pun provides another indication of the increasingly critical view of the public on light pollution. The competition attracted 154 entries, many of which focused on the impacts of light pollution on our living and ecological environments.

#### *Impact on the Decision-Makers*

- The long-term reduction of light pollution in Hong Kong could not take place without the participation of the government and business communities which are responsible for the design, procurement, and deployment of outdoor lightings. Dr Pun met with Miss Choi Man-ye Katherine, then Principal Assistant Secretary of the Environment Bureau, together with the representatives of advocacy groups, Friends of the Earth and the Ho Koon Nature Education cum Astronomical Centre, in May 2009 to discuss results of the HKU survey and propose possible guidelines, rules and regulations to tackle the issue.
- Based partly on the results from Dr Pun's first ECF project, the Environment Bureau issued the *Guidelines on Industry Best Practices for External Lighting Installations* in January 2012 with a view to alleviating the worsening conditions. This document provides a reference for the trade and relevant parties in planning external lighting projects and their daily operation.
- Dr Pun has delivered a series of talks related to lighting use and design for various professional bodies, including the Hong Kong Institution of Engineers, Housing Authority, the Society of Operations Engineers (Hong Kong Region), Hong Kong Institute of Housing, and Hong Kong Institute of Surveyors, etc. He also organized a

course on light pollution for staff of Henderson Land Development Company Ltd in August 2008. Valuable discussions took place on how light pollution could be reduced by good industry practices.

#### *Impact on Schools*

- Engagement of young people is a high priority in this knowledge exchange project. A total of 148 students from 28 schools participated in the first ECF project. They not only contributed data to the database but also experienced the light pollution situation in person.
- Dr Pun has conducted light pollution workshops in secondary schools. Special measuring meters were loaned to the students for them to conduct their own light pollution studies (e.g. night sky brightness as a function of time, or as a function of location).
- The “Light Pollution Project Competition 2014” was organized to engage secondary school students to investigate problems of light pollution by carrying out a research project about their own environment. The competition attracted applications from 42 teams, involving 138 secondary school students from 17 schools. The best 9 teams were shortlisted for oral presentation at HKU held in May to compete for the prizes. The outstanding research projects together with the winning photographs from the “Light Pollution Photography Competition 2014” are on display at a special exhibition at the Hong Kong Space Museum from July 9 to August 11, 2014 to further spread the message of night sky preservation in Hong Kong to the public.
- Dr Pun’s team now acts as the leading source of information for the general public on light pollution. They received over 50 student requests for information in the past two years, some related to potential projects for Independent Enquiry Studies (IES) under the Liberal Studies curriculum.

## 5. References to the Corroboration of Impact or Benefit

- The *Hong Kong Night Sky Brightness Monitoring Network (NSN)* website (<http://nightsky.physics.hku.hk/>) ranks first among Google searches for keywords “light pollution Hong Kong”. Starting from October 2011, there were over 30,000 unique visitors to the website, with over 220,000 pageviews.
- To expand the reach of the NSN, the *Weather Information for Astronomical Observation* webpage ([http://www.hko.gov.hk/gts/astronomy/astro\\_portal.html](http://www.hko.gov.hk/gts/astronomy/astro_portal.html)), jointly organized by the HKU Department of Physics, Hong Kong Observatory and Hong Kong Space Museum, was launched in early 2014. This webpage provides star maps, sky brightness and weather information for star watchers among the general public.
- The press releases, “Measuring the Night Sky Brightness to understand the problem

of Light Pollution in Hong Kong” (June 12, 2009) and “Hong Kong Night Sky Brightness Monitoring Network Confirms manmade lighting is the dominant cause of light pollution” (March 18, 2013), were extensively covered by the media.

- Feedback from participants and judges of the two competitions mentioned above is available for corroboration purpose.