Position Paper from the User Community Earth Observation of Nighttime Lighting

July 4, 2011

The User Community Earth Observation of Nighttime Lighting consists of 24 members from 8 different European countries and 2 non-European countries, see annex A. For further contact, please refer to the person who send you this paper, or to the address you'll find at the end of this paper.

Introduction

Artificial night lighting is a unique sign of human activity. Pictures from space show us beautifully and strikingly how we illuminate our planet. Light emission (and low-light reflection) data can aid research in numerous fields, from socio-economic studies, via light pollution, to emergency response. The only instrument currently capable of measuring nighttime lights from space is the Defense Meteorological Satellite Program – Operational Linescan System (DMSP-OLS). Although this unique dataset was the first to allow analysis of our nighttime activities, it has many shortcomings, such as rather coarse spatial resolution (2.5 km ground sampling distance), only panchromatic visible spectral information and no visible band calibration, 6-bit quantification, saturation and overglow. By the end of 2011, a new instrument will be launched, the Visible-Infrared Imager-Radiometer Suite (VIIRS) onboard the NPOESS[1] Preparatory Project (NPP) satellite. This instrument remedies some of the shortcomings of the DMSP-OLS instrument, but it still is not designed for earth observation of nighttime lighting and lacks many specifications we advocate here. On June 10th 2011, the High Sensitivity Camera (HSC) onboard the Aquarius/SAC-D satellite was launched successfully. This instrument has a panchromatic band (450 – 610 nm) and a resolution of 200-300 meters. The foreseen products and other characteristics are yet unknown to the authors.

Users – Research fields

The breadth of research fields in which light emission (and low-light reflection) data can be of aid are numerous. We outline the research fields identified so far in table 1, but we are certain new fields will emerge when products from measurements of nighttime lighting become more detailed, numerous, and dedicated.

Table 1: Research fields in which light emission (and low-light reflection) data can be of aid.

Research field	Description
Socio-Economic	Light emission data as proxy for socio-economic statistics. Assessing power access, i.e. 'electrification rates'. Population estimation. Land-use mapping.
Light Pollution	Monitoring trends in light emission; intensity and spectral composition. Lighting as proxy for human influence. Ecological studies regarding Light-at-Night.
Risk Assessment	Human health risk assessment regarding Light-at-Night. Ecological risk assessment regarding Light-at-Night.
Emergency Response	Detection of power outages (monitoring post-disaster recovery), fires, lightning, icebergs. Mapping dust storms.
Climate/Environmental	Mapping/Monitoring snow cover, sea ice.

[1] National Polar Orbiting Environmental Satellite System

	Nighttime cloud/aerosol detection, classification and characterization. CO_2 output assessments.
Tracking Human Activity	Tracking fisheries and nocturnal maritime activities. Estimating gas flaring volumes.
Policy Aid	Monitoring effects of policy measures regarding outdoor lighting.
Social/Tourism	Identification of star gazing sites, dark sky parks. Certification of dark sky parks.
Other	Aurora studies, bioluminescence studies, polar stratospheric cloud studies.

Specifications

The specifications of a dedicated instrument vary depending on the application, and additional research is needed in this area. Quite some work on a nighttime lights imaging mission has already been performed by C.D. Elvidge et al[2]. Some of the general requirements are outlined in table 2, subject to the need for repeated calibration of the sensor.

Table 2: Some general requirements for a nighttime imaging mission.

Parameter	Specification
Spatial Coverage	Global for most applications
Spatial Resolution	10-100 meter
Spectral Channels	Multispectral ranging from 400 nm to 1000 nm
Detection Limit	5E-9 – 1E-8 W/cm2/sr/µm
Overpass Time	9:30 pm – 12:00 pm

Contact information:

Please refer to the person who send you this paper, or to:

D.E. Lolkema
National Institute for Public Health and the Environment
P.O. Box 1
3720 BA Bilthoven
The Netherlands
T +31 (0)30 274 4258
F +31 (0)30 288 7531
E dorien.lolkema@rivm.nl

[2] C.D. Elvidge, P. Cinzano, D.R. Pettit, J. Arvesen, P. Sutton, C. Small, R. Nemani, T. Longcore, C. Rich, J. Safran, J. Weeks and S. Ebener, The Nightsat mission concept, *International Journal of Remote Sensing*, Vol. 28, No. 12, 20 June 2007, 2645-2670.

Annex A: Members of the User Community Earth Observation of Nighttime Lighting

(in alphabetic order)

Christoph Aubrecht, Research Associate Scientist, AIT Austrian Institute of Technology GmbH, Austria

Christopher Baddiley, Committee member of the British Astronomical Association Campaign for Dark Skies, United Kingdom

Nicolas Bessolaz, Vice-president of the association LICORNESS Light Control Brightness Night Environment Sky Survey, France

Michel Bonavitacola, LICORNESS Light Control Brightness Night Environment Sky Survey, France

Phil Cameron, President at STELA Space Travel Law Association, USA

Stefano Dietrich, Head of Satellite Meteorology at CNR-ISAC Institute of Atmospheric Sciences and Climate of the Italian National Research Council, Italy

Jurgen Fischer, Head of the Institute for Space Sciences, Freie Universität Berlin, Germany

Andreas Hänel, Museum am Schölerberg, Planetarium Director, Osnabrück, Germany

Franz Hölker, Project leader 'Verlust der Nacht', Leibniz Institute of Freshwater Ecology and Inland Fisheries, Germany

Sukhad S. Keshkamat, Ph.D candidate, Scale and sustainability assessments of linear infrastructure, Faculty of Geoinformation science and Earth observation, University of Twente, The Netherlands

Matthijs Krijger, Senior Scientist, SRON Netherlands Institute for Space Research, The Netherlands

Christopher Kyba, Freie Universität Berlin, Department of Earth Sciences, Institute for Space Sciences, Germany

Alain Le Gue, Secretary of LICORNESS Light Control Brightness Night Envrionment Sky Survey, Member of IDA International Dark-Sky Association, Member of Association Nationale pour la Protection du Ciel et de l'Environnement Nocturne, France

Dorien Lolkema, Project leader 'Light Pollution and the Absence of Darkness', National Institute for Public Health and the Environment, The Netherlands

Travis Longcore, Research Associate Professor, Spatial Sciences Institute, University of Southern California, USA

Christian Luginbuhl, Astronomer, U.S. Naval Observatory Flagstaff Station, USA

Jolanta Michulec, Scientist, TNO Netherlands Organization for Applied Scientific Research, The Netherlands

Martin Morgan-Taylor, Board Member of IDA International Dark-Sky Association, Principal Lecturer, DeMontfort University, Leicester, United Kingdom

Alexei Pace, IDA Malta, President of The Astronomical Society of Malta, Malta

Friedel Pas, European Liaison Officer International Dark-Sky Association, Belgium

Rahul Ratnam, Birla Institute of Technology, Mesra, Ranchi, India

Wim Schmidt, Director at Sotto le Stelle, The Netherlands

Henk Spoelstra, Director at Lumineux Consult, The Netherlands

Tuong Thuy Vu, Assistant Professor, School of Geography, University of Nottingham, Malaysia campus