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# A rising risk to human health: assessment of light pollution on two dark sky regions of Portugal

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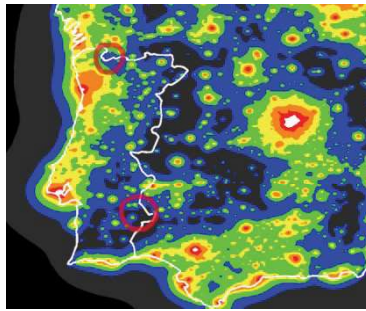
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## INTRODUCTION:

Bad public and private artificial light planning is the main cause for light pollution (LP). Night illumination is part of modern societies, reaching increasing levels with consequences on various fields that only recently began to be studied. Residents of large cities are almost totally deprived from a starry night. UNESCO, IAU and IAU's Declaration in Defence of the Night Sky and the Right to Starlight state that "an unpolluted night sky that allows the enjoyment and contemplation of the firmament should be considered an inalienable right equivalent to all other socio-cultural and environmental rights. Hence the progressive degradation of the night sky must be regarded as a fundamental loss" and that "the intelligent use of artificial lighting that minimizes sky glow and avoids obtrusive visual impact on both humans and wildlife should be promoted. This strategy would involve a more efficient use of energy so as to meet the wider commitments made on climate change, and for the protection of the environment"(Marín & Jafari, 2007). The observation and study of the night sky both at professional and casual or amateur levels is the first to be affected by light pollution thus being the primary reason to study LP until recently. However, other LP effects are already known to affect the human being such as modifications of the circadian rhythm(Stevens, 2006). More recent studies suggest LP as a risk factor for human breast and prostate cancer(Haim & Portnov, 2013). Other direct and indirect effects on the environment include natural resources consumption and effects on biodiversity, namely nocturnal fauna(Rich & Longcore, 2005). The creation of dark-skies protected areas is one form to preserve the night sky of some regions that still have a good dark sky quality. It is also a way to draw the attention of public and stakeholders to this growing problem. More than a local effect caused mainly by large urban centres, light pollution propagates to regions that are tens or more kilometres away from those populated regions, affecting places once with good night sky quality even a few years ago. Two examples of regions in Portugal that offer good dark skies are, at the north of the country, the Peneda-Gerês National Park and, at the south, the Alentejo's region of Alqueva, both commonly known to have good dark skies but that have not been previously measured. The latter got its classification as «dark sky reserve» based on the values of night sky brightness obtained for this work.

## OBJECTIVES:

Light pollution increases as a consequence of bad lighting planning and of the growth of cities(Walker, 1977). The creation of «dark sky preserves» is not sufficient unless other accompanying measures are taken to prevent the propagation of light pollution within those areas. The assessment of the places of study regarding sky brightness is then of the utmost importance in order to act both on the prevention side and on the improvement of the dark sky quality. Being recognized as a source of pollution with effects beyond astronomy, namely on human health, a permanent record of the night sky darkness becomes a necessity to trace the evolution of LP. This work is part of an ongoing PhD thesis and quantifies the sky darkness of two large areas of Portugal (Fig. 1), aiming to be a starting point to a permanent record of light pollution levels at those places. In Galiza (Spain) a similar work has effectively started where several stations register on a permanent basis the brightness of local night sky (Salvador Bará, personal communication, March 6, 2014. Also URL: <http://webspersoais.usc.es/persoais/salva.bara/GalicianNSBnetwork.html>).



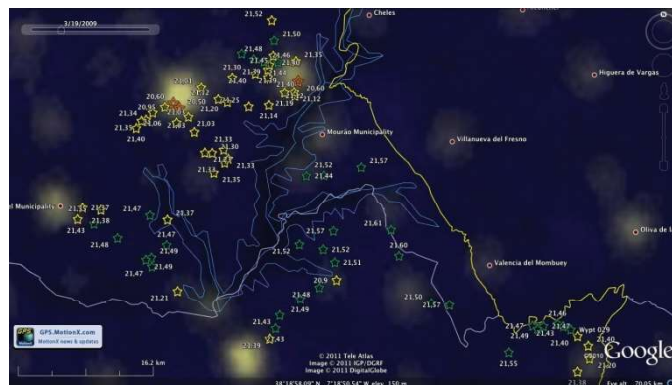
**Fig. 1** - Areas of study superimposed on night sky brightness map (PNPG, red circle above, Alqueva, red circle below).  
Adapted from Cinzano P, Falchi F, Elvidge CD (2001) The first World Atlas of the artificial night sky brightness.  
Mon Not R AstronSoc 328:689-707

## MATERIALS AND METHODS:

The measurements were obtained at the zenith on moonless nights, between dusk and dawn astronomical crepuscules to minimize natural light contribution and to guarantee that only artificial light contribution was being measured against natural dark sky brightness. We used a portable Unihedron® Sky Quality Meter-L and an iPhone unit with a GPS application (MotionX-GPS v21.1) for georeferentiation mostly along the roads that cross both regions. The campaigns started in 2010 and the next campaign is due to the next summer (2014).

## RESULTS AND DISCUSSION:

The Dark Sky® Alqueva Reserve has a large area (around 3000 sq. km) of almost continuous good quality night sky darkness, negatively affected only at regions close to its main populated areas, namely Reguengos de Monsaraz (pop. 7261 inh.; source: INE 2011) (Fig. 2).



**Fig. 2** - Sample of results for Alqueva from one of the campaigns. All values in mag/arcsec<sup>2</sup>.

The smaller (c. 710 sq. km) and loosely populated Peneda-Gerês' National Park (PNPG) is mostly affected by LP at its south and south western most parts, where many small but highly concentrated populated areas prevail. Light pollution contribution here therefore is mainly from those sources. We have had readings above 21,8 mag/arcsec<sup>2</sup> on some places on both regions, consistent with excellent dark sky quality. These are the first results obtained from the ground for both regions. The results for all the region of Alqueva were used to apply for classification as Starlight Tourism Destination from the Starlight Foundation (UNESCO/United Nations World Tourism Organization/Instituto de Astrofísica de Canarias). The Dark Sky® Reserve was the first site in the world to achieve this certification (December 2011). The first results for Peneda-Gerês National Park from this work were also used for the application for regulation regarding light pollution within the Park, which became effective with the Park's latest Management Plan.

We found that the main contribution to light pollution in the PNPG comes from regions outside the Park extending for kilometers away (Comunidades Intermunicipais of Alto Minho, Cávado, Alto Tâmega, Ave and Grande Porto), whereas the main source to light pollution in the Reserva Dark Sky® Alqueva comes from small towns within and at the borders of the Reserva (namely Reguengos de Monsaraz). On both areas the

small towns contribution is almost negligible except from within those towns, where glare from bad lighting blocks the vision of all but the brightest stars. A few hundred meters away from those localities the sky darkness is again of very good quality.

#### **CONCLUSION:**

We have analysed the sky brightness on two regions in Portugal known to be of good quality regarding darkness, in order to quantify and assess the major sources of light pollution to that areas. We present the first results of the night sky brightness for those two regions. The night sky on both Alqueva and Peneda-Gerês, albeit being regions with different characteristics, has exceptional quality that urges to be preserved. Being a growing menace to human health, we emphasise the necessity of continuous monitoring of light pollution to reduce it where possible, namely on populated cities and avoid propagation to well preserved places.

#### **REFERENCES:**

1. Haim, A., & Portnov, B. A. (2013). Light Pollution as a New Risk Factor for Human Breast and Prostate Cancers, 1-165.
2. Marín, C., & Jafari, J. (2007). Starlight - A common heritage. *Starlight Initiative - Instituto de Astrofísica de Canarias (IAC)*, 1-497.
3. Rich, C., & Longcore, T. (2005). *Ecological Consequences of Artificial Night Lighting* (pp. 1-480).
4. Stevens, R. G. (2006). Artificial Lighting in the Industrialized World: Circadian Disruption and Breast Cancer. *Cancer Causes Control*, 17(4), 501-507. doi:DOI 10.1007/s10552-005-9001-x
5. Walker, M. P. (1977). The Effects of Urban Lighting on the Brightness of the Night Sky. *Publications of the Astronomical Society of the Pacific*, 89, 405-409.