Astronomy in Focus, Volume 1, Focus Meeting 2
XXIXth IAU General Assembly, August 2015
Piero Benvenuti, ed.

doi:10.1017/S1743921316002568

Protection of SAAO observing site against light and dust pollution

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Abstract. The South African Astronomical Observatory (SAAO) observing station near Sutherland, Northern Cape in South Africa, is one of the darkest sites in the world for optical and IR astronomy. The SAAO hosts and operates several facilities, including the Southern African Large Telescope (SALT) and a number of international robotic telescopes. To ensure that the conditions remain optimal for astronomy, legislation called the Astronomy Geographic Advantage (AGA) Act, of 2007, was enacted. The Act empowers the Department of Science and Technology (DST) to regulate issues that pose a threat to optical and/or radio astronomy in areas declared Astronomy Advantage Areas in South Africa. For optical astronomy, the main challenges are those posed by light and dust pollution as result of wind energy developments, and petroleum gas and oil exploration/exploitation in the area. We give an update of possible threats to the quality of the night skies at SAAO, and the challenges relating to the AGA Act implementation and enforcement. We discuss measures that are put in place to protect the Observatory, including a study to quantify the threat by a planned wind energy facility.

Keywords. Protection, telescopes, sites, light pollution, AGA Act.

1. Introduction and Background

The SAAO observing site at Sutherland is among the best astronomical sites in the world for optical and Infrared astronomy, and is recognised as one of the few regions in the Southern Hemisphere that are suitable for large 10-m class telescopes. Indeed, Sutherland hosts SALT, the largest single telescope in the Southern Hemisphere. The site is very dark at night, and relatively dust-free due to its location in the arid Karoo, far away from major cities and industrial activities. Measurements done at SAAO indicate a V-band zenith sky-brightness, at Solar minimum, to be close to 22.0 mag arcsec^{-2}, i.e. at the level of the darkest observatories on the planet (e.g. Benn & Ellison 1998). It is mostly clear and atmospherically stable, with 70% observable nights in the year. As well as SALT and other SAAO telescopes, a number of robotic international telescopes are hosted at Sutherland†, including LCOGT (USA), KMTNet (South Korea), MASTER (Russia), KELT (USA), SuperWASP (UK), Solaris (Poland), Monet (Germany) and IRSF (Japan).

These wonderful conditions for optical astronomy, that attracted so many international facilities, are at risk due to developments geared towards addressing energy problems in South Africa (see e.g. Sefako 2012). The planned developments include solar energy, wind farms and petroleum gas and oil exploration, some of which may impact negatively on the high quality observing site due to light and dust pollution that will be generated either during their construction or operation.

† Details on SAAO and hosted telescope facilities: http://www.saao.ac.za/science/facilities/telescopes/

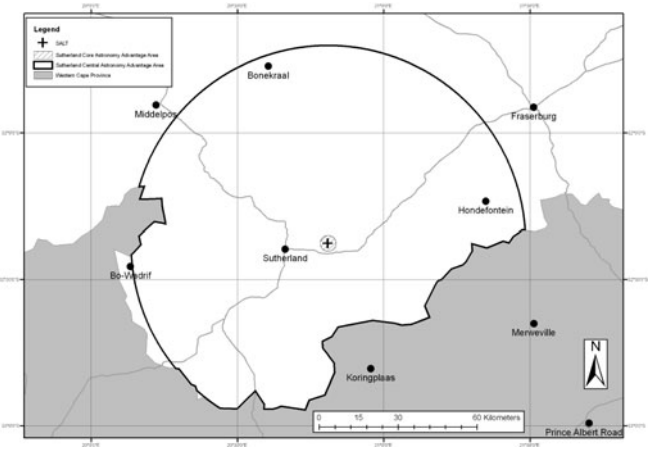

Figure 1. The Astronomy Advantage Areas for optical astronomy around the SAAO site.

To address the challenges, the South African government enacted the AGA Act No. 21 of 2007, which makes provision for the minister of DST to declare Astronomy Advantage Areas (AAAs) within which activities detrimental to astronomy may be controlled or restricted. The DST's Astronomy Management Authority (AMA) is charged with monitoring and ensuring that the AAAs are complied with. The AAA for optical astronomy is divided into to three areas with differing levels of protection (Figure 1). The **Core** is the physical area of the observatory covering about 3 km radius from SALT; the **Central AAA** extends to 75 km from SALT in the Northern Cape surrounding the Core AAA (Figure 1). The **Coordinated Area**, which has the least regulated restrictions, surrounds the Central Area and extends to 250 km radius from SALT.

2. Current status and challenges

A number of proposals around the Sutherland area are currently considered, including shale gas extraction, wind energy and solar power. Some or all of these energy developments are likely to cause light or dust pollution during construction or operation. There is on-going discussions between the SAAO, AMA and energy developers on ways in which light and dust pollution can be controlled or reduced during construction and/or during operation of the facilities.

The Civil Aviation Authority (CAA) has also been engaged given their requirement that structures taller than 45m must have aircraft warning lights (The Aviation Act of 1962). The CAA recognise both the need for renewable energy and importance of astronomy in the country, and has considered helpful options, such as Pilot Activated Lighting (PAL; lights on a specific wind farm would be activated by the aircraft pilot when flying lower than specified height above the facility) and Automatic Primary Radar Sensors, capable of detecting aircraft and activating the lighting (at the wind farm) for the period of the aircraft operating within the sensor range. Either of these methods will efficiently reduce the light pollution compared to having permanent lighting structures on wind turbines within the 75 km of the Observatory.

Other current activities include light pollution modelling for one of the proposed wind energy facilities (WEF) called Gunsfontein. The results show that wind turbines that do *not* have direct lines of sight to the telescopes 20 to 25 km away will not have significant effect to the general night sky brightness, as seen if Figure 2 showing modelling by the

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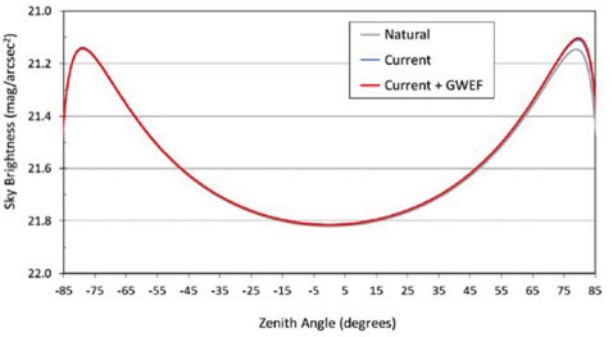

Figure 2. Sky brightness at SALT along the great semicircle beginning at the horizon opposite the Gunsfontein WEF (labelled GWEF) and ending at the horizon between SALT and GWEF, resulting from DSP modelling.

Dark Sky Partners (DSP), LLC (from Arizona), using modified Garstang Models (e.g. Garstang 1991, and references therein).

However, it is not clear whether light pollution will be the only serious problem from the energy facilities. Construction phases require mining quarries for roads and other development, generating substantial amounts of air-borne dust. For hydraulic fracturing (aka fracking), this is an issue during operations as well as during construction. For wind farms, this is likely to be a challenge during construction and erecting of wind turbines. Turbulence (seeing), and even potential changes in weather patterns may be expected when wind farms are operating. All these are issues which would need careful consideration and modelling with limited resources, while multiple plans are being put forward. It is also not clear what levels of compliance from developers we will have once facilities are up and running.

3. Summary

Sutherland Observatory is one of the darkest astronomical sites in the world, and the South African Government has enacted legislation to help protect the skies. Nevertheless, there are multiple large facilities being proposed in the region catering for the growing energy needs of the country, which makes for a challenging decade ahead for the Observatory. Collaboration between different stakeholders is needed to address the issues of protection of the Observatory's research facilities against light and dust pollution, and any other detrimental activity to optical astronomy, while acknowledging energy developments addressing the energy crisis in South Africa.

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