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Atlas Dark Sky Reserve

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Abstract. In 2016, Morocco organized the United Nations Climate Change Conference (COP22) in the city of Marrakesh. Following this conference, Morocco, like other countries, has made the commitment to become a major player in the international fight against pollution. In this context, the Atlas Dark Sky Reserve (ADSR) project was born.

ADSR aims to create the first Dark Sky reserve in North Africa and the biggest one in the world. The Observatory of Oukaïmeden located in the Atlas mountains in Morocco will be the central region of this reserve.

Keywords. Atlas Dark Sky Reserve, Oukaimeden Observatory, Light Pollution, Astronomy Development

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1. Introduction

The project "Atlas Dark Sky Reserve" (ADSR) consists in creating an International Dark Sky Reserve covering a large part of the Toubkal National Park in Morocco. There are only 12 Dark Sky Reserves in the world (8 in Europe, 2 in America, 1 in Africa and 1 in Oceania) certified by the International Dark-Sky Association (IDA) at the moment. With a radius of about 50 km, the Mont-Mégantic Dark Sky Reserve in Canada is the largest one in the world (IDA 2018). Once created, the ADSR will be the first reserve in North Africa and the largest in the world in terms of area with a radius of about 80 km.

Given that light pollution impact on the health, on the economy, the energy bill, and on the quality of the night sky, all citizens located in the targeted area will benefit from the project.

2. Astronomy and Light Pollution

Astronomy in Morocco has experienced a spectacular development over the last 10 years (Benkhaldoun 2018). The Oukaimeden observatory has played an important role in the exponential growth of Moroccan publications in the fields of Astrophysics and Space Sciences. Indeed, by its exceptional sky quality it has attracted the interest of several renowned organizations searching for good astronomical places (Benkhaldoun 2018).

Decades ago, light pollution was identified as a threat to the quality of astronomical observatories. Since then, the artificial sky brightness has increased at rate of around 6% per year worldwide. Before the arrival of the LEDs, High Intensity Discharge (HID) technology was essentially the only one used for street lighting. It was dominated by the yellowish High Pressure Sodium (HPS). During that period, the sky brightness increase

was mainly explained by the addition of new light points. Under HPS technology era, Artificial Light at Night (ALAN) was already identified as capable of disrupting the night sky quality but also wild life (Longcore & Rich 2004; Rich & Longcore 2013; Navara & Nelson 2007; Buchanan 2006; Gauthreaux Jr et al. 2006; Kuijper et al. 2008; Salmon 2003; Nightingale et al. 2006; Perry & Fisher 2006; Briggs 2006), along with human health (Stevens 2009; Haim et al. 2010; Garcia-Saenz et al. 2018; Cajochen et al. 2013). While these threats are linked to a certain level to the night sky brightness (or indirect ALAN) for remote rural sites, the intrusive light (or direct ALAN) is dominant for urban environments. The fact that most LED emits white light may result in an increase of unwanted effects of ALAN even without any increase of the luminous points. This is mostly because of that the blue light component of white LEDs is more efficiently scattered by the atmosphere and that many biological processes are sensitive to the blue (e.g. the melatonin suppression).

In order to restrict the light pollution level in Morocco, but more specifically around Oukaimeden observatory, it will be crucial to use the most efficient lighting methods. In that set of methods, if any light fixture have to be replaced or any new one installed, amber lighting devices with low ground level illuminance (ideally below 6 lux in average) without any light emitted upward and hopefully no light outside the desired area to lit must me favored. Moreover, when possible, the use of temporal modulation of the lighting devices should be considered. At least the luminous flux should be reduced by a factor of two or more after the normal human activities hours (23h or midnight). When possible, motion detectors should be used, especially for private lighting. The implementation of a monitoring network to follow the temporal evolution of the sky brightness at the observatory and more generally of the protected area will be a priority (Hänel et al.

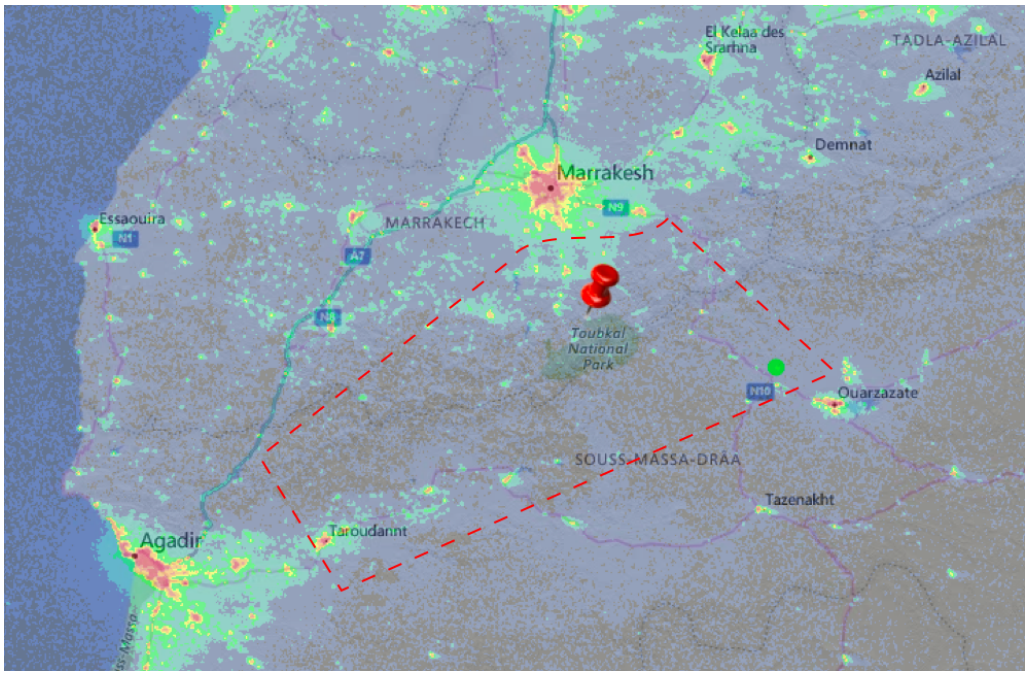

Figure 1. The Atlas Dark Sky Reserve: The pin point indicates the position of the Oukaimeden Observatory which is the Central Region of the reserve. ADSR communities between the Central Region and the City of Marrakesh are the most important sources of light pollution.

2017). One important aspect to monitor, is the color of the sky brightness because of the rapid addition of white LEDs in public and private lighting.

3. Atlas Dark Sky Reserve (ADSR) Project

The project will start by improving lighting practices and citizen involvement on this central region. Dark Sky Communities will be composed of about 120 villages and cities located in a diameter of 80 km from the central region. Communities between the Observatory and the city of Marrakesh show high light pollution contribution and can impact the astronomical observation of faint objects. They will be our target after the central region. The communities near of the city of Taroudount are also another important source of light pollution in this reserve. The communities between the city of Ouarzazate and the Oukaimeden Observatory are still not contaminated by the light pollution but we will immunize them during this project by including them to the ADSR before the situation becomes worst.

The ADSR project involves an international collaboration in different fields (astronomy, light pollution, health sciences, energy, ecology, etc..). An international workshop on Light pollution will be held in Marrakesh (Morocco) on October 22-26, 2018. This event will be the official starting of the ADSR project. Our strategic plan to create ADSR is divided in three phases (Phase 1: 2018-2019; Phase 2: 2018-2020; and Phase 3: 2018-2021). The first phase of the project will be dedicated mainly to cover the Central Region of the ADSR which include the Oukaimeden Observatory. The aim of the second phase is to cover 90% of the ADSR by changing the lamps and the municipal lighting regulations in these ADSR communities. Efforts in the last phase will be focused on covering all the remaining ADSR communities and preparing the paperwork to be officially recognized by the IDA as the first Dark Sky Reserve in North Africa and the biggest one in the world.

4. Conclusion

ADSR is an exciting project that will help to develop a smart way to use light in the targeted regions. The impact of this project will be seen in different aspects: In astronomy, ADSR will protect the excellent sky quality of the Oukaimeden Observatory. This is very important for the future of Astronomy on this site which is often selected to host medium size telescopes; Economically, this project will reduce the bill of electricity by reducing the waste of unused light; Environmentally, ADSR communities will adopt a smart way to illuminate their territories which will help significantly to reduce the effects of that kind of pollution; Educationally, this will be an important opportunity to develop exciting projects for undergraduate and graduate students in different fields (astronomy, biology, geology, local politics, etc..) along with an exceptional public outreach opportunity in the fields of astronomy and ecology of the night.

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