Measurement of Sky Brightness at the Iranian National Observatory

Davoud Afshari[1] and Sadollah Nasiri[1,2]
[1]Physics Department, Zanjan University, Zanjan 45195-313, Iran;
[2]Institute for Advanced studies in Basic Science (IASBS), Zanjan 45195-1159, Iran;

Introduction

Among 34 candidate sites at the central part of the country, 5 sites namely Garkesh(in Kashan), Kolahbarfi(in Kashan), Deynava (in Qom), Sardar(in Kerman), and Mazarkahi(in Birjand) are selected using meteorological and geophysical data. The seeing parameter is measured for these sites.
Therefore among those five candidate sites only deynava(name of mountain in Qom) and Garkesh(name of mountain in Kashan) are remaining, due to their seeing values.

We started to study and prepare measuring the sky brightness of these sites by two years ago. Light pollution makes the level of sky brightness higher and results in less signal-to-noise ratio. With low S/N we have to build larger telescopes beside the bad effect of light pollution on them. By studying the effect of light pollution on famous telescopes we can see horrible conclusions.

We had studied many numerical and experimental methods. We had gathered sample photometric data with a SBIG ST2000 CCD, a celestron telescope and the UBVRI standard filters to define the sky brightness exactly.

Sky brightness & Light pollution

Astronomy is suffering from rapidly growing environmental problems. One of these is light pollution. Urban sky glow is taking away the prime view of the stars and the universe. Many things can bring light pollution to us, such airglow, artificial sources as urban lights, zodiacal light, and solar wind and of course moon light.

The problem of light pollution became important mainly since 1960, by growth of urban development and using more artificial lights and lamps at the nighttimes.
The natural sky brightness is mainly due to moonlight, zodiacal light and solar wind. One important factor that increases the local sky brightness is the artificial sources of urban lights, or namely light pollution.
The earth's atmosphere causes the light coming from sources in an urban area to be scattered, creating the halo of light visible over the city even from great distances. Optical telescopes share mostly the same range of wavelength as are used to provide illumination of roadways, buildings and automobiles.
The man made light glow scatters by the atmosphere and enters as an unwished light in the image taken by the observational instruments. Light pollution makes the level of sky brightness higher and results low Signal to Noise Ratio (SNR) which in turn reduces the effective aperture of the telescopes.

Measurement of light pollution

Various models have been introduced in the literature to estimate the light pollution. The pioneering work in this area was done by Walker, 1970-1973. After some years Walker's formula corrected. The formula we use to estimate urban sky glow, looking at a zenith of 45 degrees toward an urban source **r** kilometers away, is

$$I = c\,Pr^{-n}$$

"**I**" is the percent increase of the night sky brightness above the natural background, at 45° down from directly overhead, "**P**" is the population of the city, "**r**" is the distance, in kilometers, from the observing site to the center of the city. also
"**c**" = 0.01 and "**n**" = 2.5 for "**r**" values between 10 and 50 km,
"**c**" = 0.000632"**n**" = 1.4281 for values of "r" less than 10 km.
Using Walker's law we estimated the percent increase of the night sky brightness above the natural background for Garkesh and Deynava sites. The results are shown in Tables 1 and 2.

Town or village	Population	Distance (km)	Direction	I
Qom	1030682	60	N	0.370
Kashan	248789	52	E	0.128
Aran & Bidgol	55651	52	E	0.028
Mahallat	48458	55	SW	0.022
Delijan	31852	30	SW	0.065
Niasar	4823	25	SE	0.015
Naragh	2508	17	SW	0.021
Nashlaj	2168	21	SE	0.011
Jasb	1373	8	W	0.044
Khavaran	963	8	S	0.031
Rahgh	536	7	E	0.021

Table 1. The percent increase of the night sky brightness for Deynava

Town or village	Population	Distance (km)	Direction	I
Kashan	248789	39	N	0.261
Kamo	2000	7	S	0.078
Joshaghan	3477	12	S	0.069
Aran & Bidgol	55651	46	N	0.038
Barzak	3211	16	NW	0.031
	3566	18	NE	0.025
Ghahrood	657	10	E	0.015
Meimeh	5733	28	S	0.013
Ghazaan	548	12	NE	0.010

Table 2. The percent increase of the night sky brightness for Garkesh

Sky brightness measurements & Conclusion

The zenith brightness of the moonless night sky at a clear dark observing site, measured at high ecliptic and galactic latitudes, and during solar minimum, for V, B and R band are 21.9, 22.9 and 21.0 magnitude per arcsec squared, respectively. However, the measured sky brightness for observatory sites are normally less than above values.
In the first step we estimated the sky brightness by Walker's law. The results are given in Tables 1 and 2. We also measured the sky brightness of the candidate sites by photometry of the Landolt stars. The data was obtained using SBIG ST2000 CCD, a 11inch celestron telescope with F/10 and the UBVRI standard filters.
We used the stars from Landolt catalog with magnitude greater than 10. Taking into account the effects of bias, flat and dark frames on the CCD image of the reference stars, We calculated the sky brightness using the IRAF software for the Deynava and Garkesh sites. The results are shown in Figures 1,2 and 3.

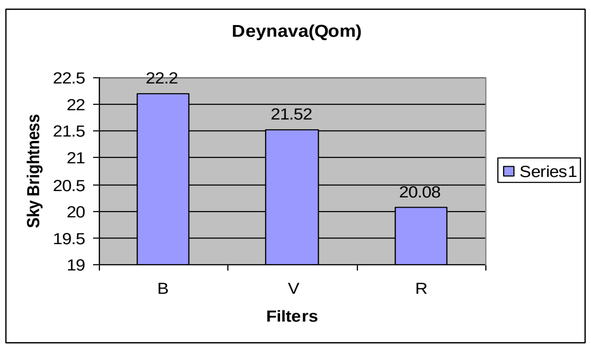

Figure 1. Sky brightness for Deynava site

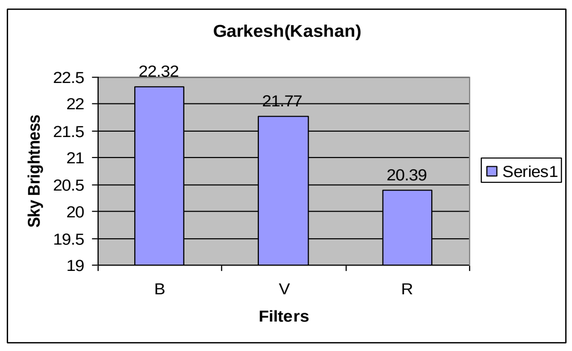

Figure 2. Sky brightness for Garkesh site

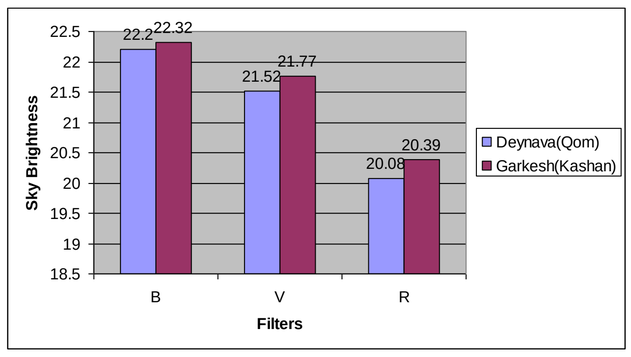

Figure 3. Sky brightness in B, V and R band for Deynava and Garkesh site

Sky brightness results in B, V, R filters are acceptable for Iranian National Observatory that can be comparable with other observatories. But there is a worry about light pollution of Qom and Kashan that according to first and second tables.

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