Article **ECORFAN Journal-Republic of Nicaragua**
June 2022, Vol.8 No.14 11-14

Evaluation of the UV index in the campus UAZ siglo XXI for the year 2019

Evaluación del índice UV en el campus UAZ siglo XXI para el año 2019

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DOI: 10.35429/EJRN.2022.14.8.11.14 Received January 15, 2022; Accepted June 30, 2022

Abstract

The objective of this research is to quantify the UV Index in the city of Zacatecas. The UV Index is a measure of the intensity of UV radiation at the earth's surface and is an indicator of its ability to cause skin damage. UVB radiation is the main cause of skin cancer. The Methodology consisted of collecting ultraviolet radiation data (UVB) in the period from January 1 to December 31, 2019, using a Solar Ligth 501-A Biometer, installed in the Zacatecas_04 solarimetric station belonging to the National Solarimetry System, located in Building E6 of the UAZ Siglo XXI Campus. Subsequently, the data was transformed to the UV Index (2.332 by the Biometer reading in Med/hr to W/m² at IUV). The results that were obtained in the period of time evaluated show that most of the year the radiation received is high and very high according to the sun protection system recommended by the O.M.S. UVB exposure begins with greater intensity at 10:00 am until 4:00 pm. Concluding, that in the city of Zacatecas most of the year there is a high UV Index.

Ultraviolet radiation, biometer, UV Index

Resumen

El Objetivo de esta investigación es cuantificar el Índice UV en la ciudad de Zacatecas. El índice UV es una medida de la intensidad de la radiación UV en la superficie terrestre y es un indicador de su capacidad de producir lesiones cutáneas. En específico la radiación UVB es la principal causante de cáncer de piel. La Metodología consistió en recopilar datos de radiación ultravioleta (UVB) en el periodo comprendido del 1 de enero al 31 de diciembre de 2019, utilizando un Biómetro 501-A de Solar Ligth, instalado en la estación solarimétrica Zacatecas_04 perteneciente al Sistema Nacional de Solarimetría, ubicada en el Edificio E6 del Campus UAZ Siglo XXI. Posteriormente los datos se transformaron al Índice UV (2.332 por la lectura del Biómetro en Med/hr a W/m^2 a IUV). Los resultados que se obtuvieron en el lapso de tiempo evaluado muestran que la mayor parte del año la radiación recibida es alta y muy alta de acuerdo al sistema de protección solar recomendado por la O.M.S. La exposición a los UVB inicia con mayor intensidad a las 10:00 am hasta las 16:00 pm. Concluyendo, que en la ciudad de Zacatecas la mayor parte del año existe un alto Índice UV.

Radiación ultravioleta, biómetro, Índice UV

Citation: FRÍAS-HERNÁNDEZ, Juan Daniel, GONZÁLEZ-CABRERA, Adriana Elizabeth, VILLEGAS-MARTÍNEZ, Rodrigo Cervando and GARCÍA-GONZÁLEZ, Juan Manuel. Evaluation of the UV index in the campus UAZ siglo XXI for the year 2019. ECORFAN Journal-Republic of Nicaragua. 2022. 8-14:11-14.

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Introduction

The city of Zacatecas is located at a latitude of 22°46'18" N and a longitude of 102°34'31" W. The average altitude above sea level is 2460 m. The average annual temperature is 17°C, the average maximum temperature is around 30°C and occurs in May, while the average minimum temperature is 3°C and occurs in January. Since if the solar potential is high, therefore, the radiation is high in all its wavelengths including the ultraviolet region (García *et al*., 2020).

Ultraviolet (UV) rays are invisible to the human eye and are classified according to their wavelength. It should be noted that the shorter the wave, the more intense the energy of the sun's rays. These are divided into three types: UVA, UVB and UVC. UVA rays have a long wavelength, between 320 and 400 nm, which pass through the atmospheric layers and are increasingly filtered to a lesser extent by the ozone layer and clouds. They hit the earth's surface throughout the day. These penetrate the deep layers of the skin, activating the production of melanin and causing tanning, but when penetrating the skin, this type of radiation destroys the collagen that gives elasticity to the skin and causes premature aging, spots and precancerous lesions. UVB rays are medium wavelength rays that are in the range of 280 to 320 nm. These are largely absorbed by the ozone layer and moderately blocked by clouds, but nevertheless reach the earth's surface. The time of greatest intensity of this type of radiation is between 11:00 a.m. and 4:00 p.m. and the main cause of skin cancer. And finally UVC rays are short wavelength rays that range between 200 and 280 nm, they are potentially dangerous and extremely aggressive for humans. They do not reach the earth's surface because the ozone layer absorbs and retains them.

Ultraviolet radiation and the damage it causes in humans

The largest organ that the human being has is the skin, it is a non-compacted superficial organ that covers and protects the external surface of the organism, it has a surface area of 1.6 to 2 m2, a thickness of 0.5 to 4 mm and its weight is 4-5kg. Its functions are: protection, emuntory, melanogenesis, thermoregulation, deposits, sensitivity, and so on.

The damage that ultraviolet radiation can cause due to prolonged exposure can produce significant changes in some biological functions, this is due to the high energy of its photons. These changes can manifest as severe damage to living beings, such as DNA replication failure, skin lesions, premature skin aging, melanoma, sunburn, etc. (Figure 1). This is why the population has to be informed of the damage caused by exposure to the sun for a long time and if we are, take the precautions that the protection system sets for us.

Figure 1 Pathologies caused by the interaction of UV rays in the human body

The World Health Organization (WHO) recommends the protection system for the five different levels of radiation, which is presented in Table 1.

UV index	Protection	Solar protective action
0-2	Low	Minimal sun protection. More than one hour exposed to sunlight. Gloves and sunscreen are required.
3-5	Moderate	To take precautions. Wear a hat and sunglasses if exposed to the sun for 45 minutes or more.
6-7	High	Protection such as a hat, sunglasses and sunscreen is required for damage caused to the skin by exposure for more than 30 minutes. Reduce the time you are exposed to the sun between 11:00 and 16:00 hours.
8-10	Very high	Extreme precautions are required. Wear a hat, sunglasses and sun protection cream, otherwise the skin can be damaged and burned if exposed to sunlight for more than 20 minutes. Avoid solar radiation between 11:00 and 16:00 hours.
>11	Extreme	Take all necessary precautions. Unprotected skin damage and burns occur in minutes. Avoid sun exposure between 11:00 and 16:00 hours.

Table 1 Sun protection system recommended by the WHO
Source: (Olarte S, 2015)

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Roy *et al*., (1998), used SRM spectroradiometers to measure solar ultraviolet radiation, due to the high rates of skin cancer since the mid-1980s (Roy C.R., 1998). Diffey presented in his work the biological effects of UV radiation, using an optically filtered xenon arc lamp or fluorescent lamps to simulate the UV component of sunlight to have controlled experimentation (Diffey, 2002). Vallejo D. Luís (2003), presented a study of the Ultraviolet Index (UVI) in Chile. In addition, he explained the physical meaning of the IUV, as well as the main factors that affect it (Vallejo Delgado, 2003). Pinedo et al (2006), carried out an analysis of the ultraviolet spectral irradiance recorded in the city of Zacatecas. A Bentham radiometer was used to obtain the spectra. Measurements showed relatively high levels of ultraviolet irradiation (Pinedo V. J. L., 2006).

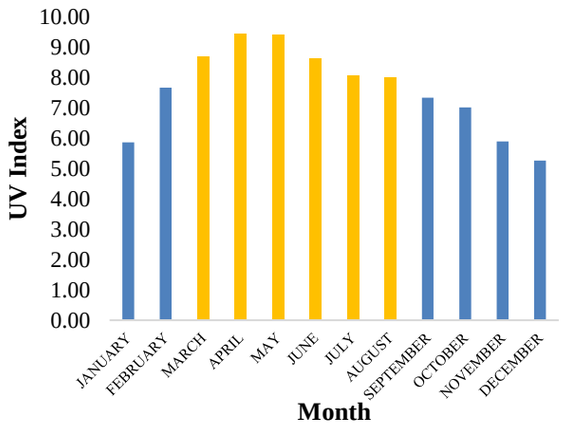
Methodology

Ultraviolet radiation (UVB) data were obtained in the period from January 1 to December 31, 2019. To measure UVB, a Solar Light 501-A Biometer was used (Figure 2), which is installed at the station. solarimetric Zacatecas_04 of the National Solarimetric System, located in Building E6 of the UAZ Siglo XXI Campus. Data was recorded on a Campbell Scientific CR-3000 datalogger, taken every two seconds and recorded every minute (average). The data is then transformed into the UV Index using the conversion factor of 2.332 UVB (1 MED/h = 0.0583 W/m² and 1 IUV = 0.025 W/m²). They are then averaged per hour, per day, per week and per month. The results obtained are analyzed and interpreted.

Figure 2 Solar Light 501-A Biometer

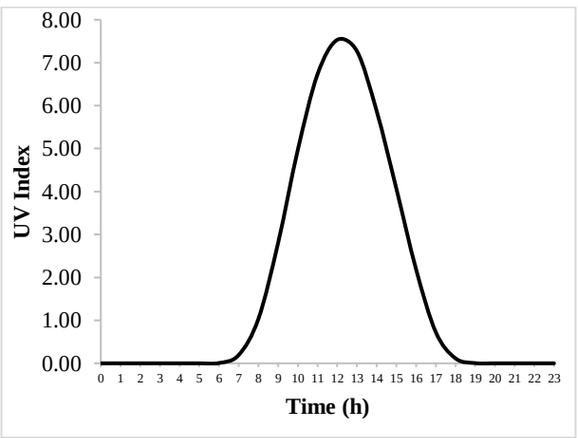
Results

In Graphic 1 it can be seen that during the months of March to August a higher UVB radiation index is registered, where it corresponds to the seasons of the year spring and summer where solar energy reaches the earth with more intensity, also during the months of From June to August there is a decrease that could be due to the rainy season where the clouds block the passage of the sun's rays, therefore the radiation received by the earth is less.



Graphic 1 Period from January 1 to December 31, 2019, showing the highest UVB index of each month

Graphic 2 shows the average UV Index per hour in the evaluated period. It is observed that the geometric shape of the Figure has a negative bias. The incidence of UVB radiation begins at 7:00 am and ends at approximately 7:00 pm. Exposure to UVB radiation with greater intensity is between 10:00 am and 3:00 pm.



Graphic 2 Average UV index per hour in the period from January 1 to December 31, 2019

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Table 2 shows what day of the month and at what time the highest UV Index was recorded. Where in the month of April and May a UV Index of 12 was recorded, placing it on the scale that manages the Sun Protection System recommended by the OMS at an EXTREME level, so extreme precautions are required.

Month	Hour	Day	UV Index
January	13:00	9	7
February	13:00	21	10
March	12:00	19	11
April	12:00	17	12
May	12:00	12	12
June	12:00	28	11
July	12:00	6	11
August	13:00	20	10
September	12:00	14	11
October	12:00	8	10
November	12:00	9	8
December	12:00	22	7

Table 2 Day and time where the highest UV index of each month was obtained

According to Vallejo (2003), UV radiation increases with altitude because the amount of absorbers in the atmosphere decreases with height. The measurements made by him showed that UV radiation increases between 6% and 8% for every 1000 m (Vallejo Delgado, 2003). Based on the above, it implies that the altitude of the city of Zacatecas should contribute to increasing UV radiation above 8%.

Conclusions

In conclusion, the cleanliness of the sky, the low presence of atmospheric aerosols, the average height above sea level of the city of Zacatecas, the UV Index throughout the evaluated period is High to Very high. The months with the highest UV Index are from March to August, although extreme instantaneous values are presented in April and May, at solar noon. According to the OMS. Preventive protection is required such as wearing a hat, long sleeves, and in some cases glasses, in addition to sunscreen, otherwise the skin ´can suffer damage and burns if exposed to sunlight and the population must be informed so that they take the necessary and sufficient care. And do everything possible so that society reduces unnecessary sun exposure time between 11:00 and 16:00.

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