IOP Conference Series: Earth and Environmental Science

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Abstract. The air quality over Moundou-Chad was examined using satellite dataset. Fifteen years aerosol optical depth (AOD) was obtained from the Multi-angle Imaging Spectro-Radiometer (MISR). The AOD dataset is statisticaly stable for further prediction. The highest AOD mean was observed in 2008. The standard deviation, average deviation and coefficient of variation all agrees that the AOD dataset is reliable. It is shown that the aerosol loading over Moundou is high and the size of the aerosol is very tiny to deposit in the human lungs.

Keywords: air quality, aerosol, pollution, deposition

1. Introduction
Pollution is one of the major environmental problems confronting Chad area, this pollution ranges from air pollution to water pollution as well as land pollution. Outdoor air pollution involves the reaction of particulate matter, biological materials as well as chemicals from different sources. Some of the industries that have the potential to affect the pollution level in Moundou include oil, sodium carbonate production, cotton textiles, soap, brewing, construction and cigarettes production industries among others (1). Some of the important Pollutants generated from these industries include particulate matter (PM), sulphur (IV) oxide (SO_2) and oxides of nitrogen (NO_x). Other generators of air pollution in this country are the transport sector, pollution result from increase in number of vehicles, use of old and dirty fuel as well as poorly managed public transport (2-3). Also, uncontrolled waste burning is one of the practice in this country which result in deterioration of the air quality in the country. In addition, air pollution from indoor sources is the largest contributor to the negative health effects of air pollution in Chad. Wood and charcoal provide 90% of the energy consumed in Chad which is the main contributor to indoor pollution, this result in estimated 9,600 premature deaths every year as reported by WHO, (4).
The research site is fast developing with the presence of industries (5). Hence, there are possibilities that among the anthropogenic emission, there may be industrial pollution. Industrial pollution is common in developing countries because there is inadequate enforcement of refuse disposal and particulates or gaseous emission laws. Another potential source of air pollution is from the agricultural sector via bush burning, emission of bio aerosols etc. Also, the desertification and dryness of the region between 1972–1973 and 1984–1985) are sources of pollution (6). Some of the air pollutants deposit over water ways are sources of heavy metal introduction. There is a typical case on the metallic pollution of Lake Chad and Chari River beside Sarh and N'Djamena cities (7).
In this paper, the air pollution over Mondou, chad was investigated to ascertain the level of pollution that may have arisen from previous air pollution sources. Air pollutants or aerosols over the research

area are commonly from anthropogenic pollution and Sahara dust pollution. However, there is the need to understand the accumulated aerosol deposits in the atmosphere. It is upon this background that aerosol retention was used in this study as a salient parameter for understanding the level of air pollution over a geographical area.

2. Methodology

Moundou is the second largest city in Chad and is the capital of the region of Logone Occidental. The city lies on the Mbéré River some 475 kilometres south of the capital N'Djamena. Moundou is located in Chad on latitude and longitude of 8.5915° N, 16.0758° E
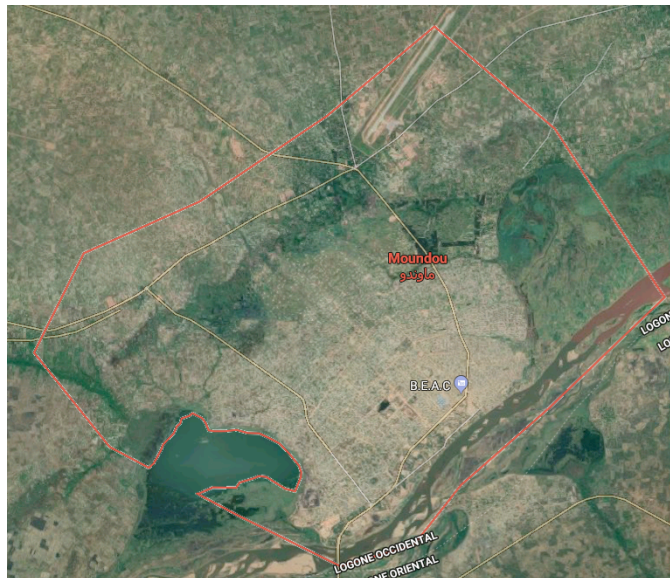

Figure 1: Satellite map of Moundou Chad

Fifteen years aerosol optical depth dataset was obtained from Multi-angle Imaging Spectro-Radiometer (MISR) (8). The dataset was treated using the excel programme. The aerosol loading calculation was accomplished using the West African regional scale dispersion model (WASDM) expressed below (9-10).

$$\psi(\lambda) = a_1{}^2 \cos\left(\frac{n_1\pi\tau(\lambda)}{2}x\right)\cos\left(\frac{n_2\pi\tau(\lambda)}{2}y\right) + \cdots \ldots a_{i2}{}^2 \cos\left(\frac{n_3\pi\tau\lambda_1}{2}x\right)\cos\left(\frac{n_n\pi\tau(\lambda)}{2}y\right) \quad (1)$$

a is atmospheric constant gotten from the fifteen years aerosol optical depth (AOD) dataset from MISR, n is the tunning constant, $\tau(\lambda)$ is the AOD of the area and $\psi(\lambda)$ is the aerosol loading.

The angstrom exponent is used to estimate the particle size of atmospheric aerosols or clouds. It was calculated using

$$\alpha = \frac{\log\frac{\tau\lambda_1}{\tau_\lambda}}{\log\frac{\lambda_1}{\lambda_2}} \quad (2)$$

where τ_λ is the optical thickness at wavelength λ and $\tau_{\lambda0}$ is the optical thickness at the reference wavelength λ_0

3. Results and Discussion

The statistical analysis of the AOD dataset after treatment is presented in Table 1. Unlike most cities in West Africa that have 44% data loss, Moundou has data loss of 17%. This means that there are more dataset to analyse without extrapolation. The highest AOD mean was observed in 2008. The standard deviation, average deviation and coefficient of variation all agrees that the dataset is reliable. Hence, the average monthly AOD dataset was used to calculate the aerosol loading over Moundou as presented in Figure 2. The aerosol loading at the moment is extremely high. Hence, the possibility of increased non cureable diseases and deaths is inevitable if not controlled. In order to have a better understanding of the aerosol size, we calculated the Angstrom exponent over Moundou as presented in Figure 3. It is observaed that the Angstrom exponent ranges between 0.05 to 0.3. However, there is still the need to know in more specific terms the radius of the atmospheric aerosols over Moundou. The radius of the aerosol is presented in Figure 4.

Table 1: statistical analysis of AOD over Moundou

	2000	2001	2002	2003	2004	2005	2006
Number of values	9	11	10	11	11	11	11
Number of missing values	3	1	2	1	1	1	1
Mean	0.296	0.284	0.358	0.343	0.344	0.330	0.327
First quartile	0.227	0.216	0.227	0.245	0.256	0.264	0.225
Third quartile	0.347	0.392	0.508	0.402	0.449	0.409	0.368
Standard error	0.045	0.030	0.052	0.039	0.035	0.027	0.051
95% confidence interval	0.103	0.068	0.119	0.087	0.078	0.061	0.114
99% confidence interval	0.150	0.096	0.170	0.124	0.112	0.087	0.162
Variance	0.018	0.010	0.027	0.017	0.014	0.008	0.029
Average deviation	0.100	0.089	0.135	0.100	0.100	0.076	0.112
Standard deviation	0.134	0.101	0.166	0.130	0.117	0.091	0.169
Coefficient of variation	0.451	0.354	0.463	0.377	0.339	0.276	0.518
Skew	1.337	0.187	0.848	1.225	0.536	-0.428	1.949
Kurtosis	0.913	-1.794	-0.378	1.779	-0.948	-0.961	5.049
Kolmogorov-Smirnov stat	0.300	0.234	0.204	0.187	0.219	0.163	0.285
Critical K-S stat, alpha=.10	0.387	0.352	0.369	0.352	0.352	0.352	0.352
Critical K-S stat, alpha=.05	0.430	0.391	0.409	0.391	0.391	0.391	0.391
Critical K-S stat, alpha=.01	0.513	0.468	0.489	0.468	0.468	0.468	0.468
	2007	2008	2009	2010	2011	2012	2013
Number of values	10	11	11	11	11	12	10
Number of missing values	2	1	1	1	1	0	2
Mean	0.333	0.387	0.369	0.352	0.353	0.296	0.376
First quartile	0.257	0.307	0.241	0.232	0.240	0.203	0.232
Third quartile	0.394	0.438	0.483	0.531	0.439	0.411	0.518
Standard error	0.039	0.049	0.054	0.052	0.050	0.037	0.056
95% confidence interval	0.089	0.108	0.121	0.116	0.111	0.081	0.127
99% confidence interval	0.128	0.154	0.172	0.165	0.158	0.115	0.182

| Variance	0.015	0.026	0.032	0.030	0.027	0.016	0.031
Average deviation	0.095	0.115	0.146	0.137	0.129	0.106	0.145
Standard deviation	0.124	0.161	0.180	0.172	0.165	0.128	0.177
Coefficient of variation	0.372	0.417	0.488	0.489	0.468	0.432	0.471
Skew	1.044	0.733	0.692	0.699	1.386	0.633	0.885
Kurtosis	1.260	0.446	0.692	-0.871	1.421	0.946	-0.706
Kolmogorov-Smirnov stat	0.200	0.179	0.183	0.268	0.258	0.175	0.210
Critical K-S stat, alpha=.10	0.369	0.352	0.352	0.352	0.352	0.338	0.369
Critical K-S stat, alpha=.05	0.409	0.391	0.391	0.391	0.391	0.375	0.409
Critical K-S stat, alpha=.01	0.489	0.468	0.468	0.468	0.468	0.449	0.489
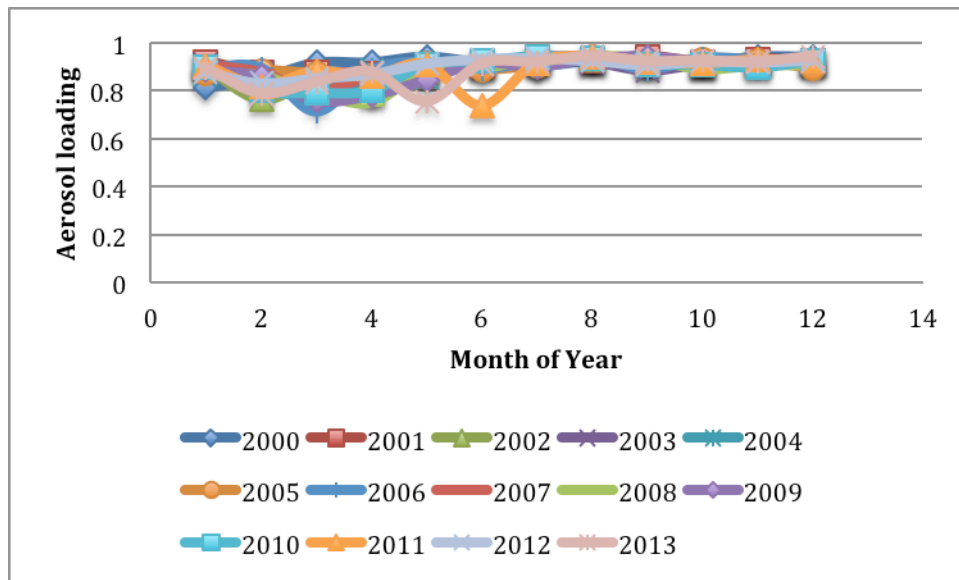
Figure 2: Aerosol loading over Moundou
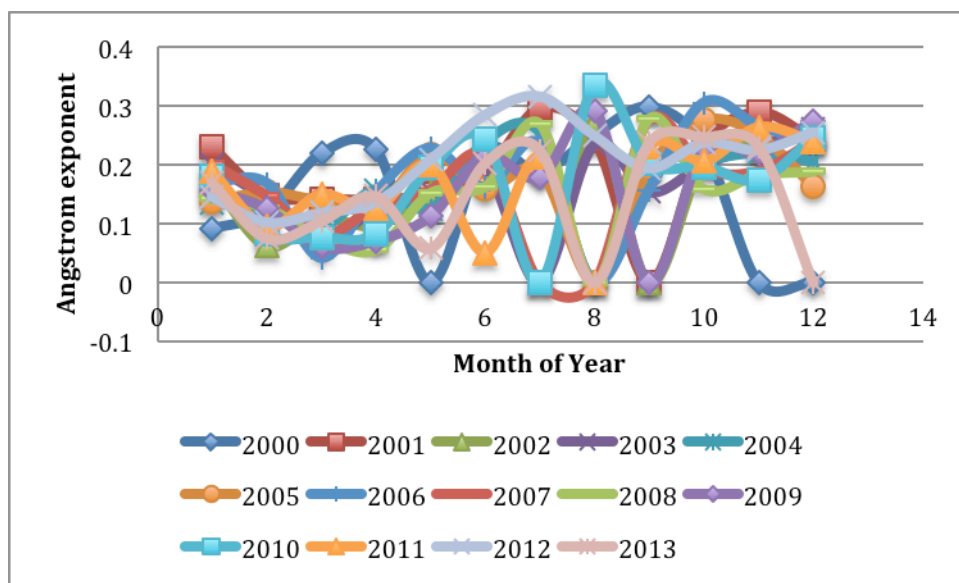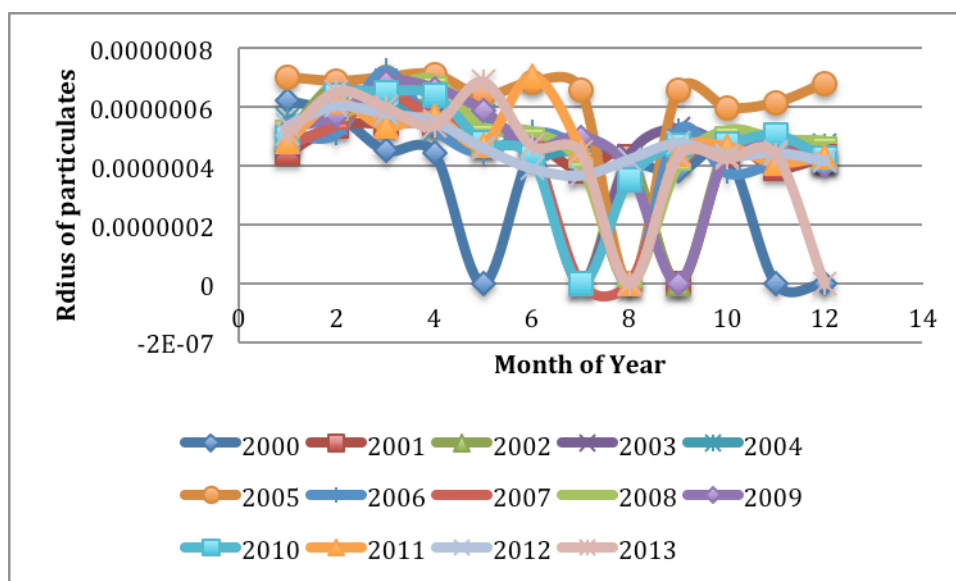

Figure 3: Angstrom exponent over Moundou

Figure 4: Angstrom exponent over Moundou

From Figure 4, it can be inferred that the radius of the aerosols in Moundou are fine minute particulates that are possible deposition chances in the human lungs.

4. Conclusion

The AOD dataset is statsticaly stable for further prediction. The standard deviation, average deviation and coefficient of variation all agrees that the AOD dataset is reliable. It is shown that the aerosol loading over Moundou is high and the size of the aerosol is very tiny to deposit in the human lungs.

Acknowledgement

5. References

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