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Air pollution Estimation Over Brikama

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Emetere M.E.[1,2], and Olawole O.C..[4]
[1]Department of Physics, Covenant University Canaan land, P.M.B 1023, Ota, Nigeria.
[2]Department of Mechanical Engineering and Science, University of Johannesburg, APK, South Africa

E-mail: emetere@yahoo.com

Abstract. Recent reports on the air pollution over Brikama-Gambia by United Nations Environment Programme (UNEP) and the National Environment Agency (NEA) may be shocking. In this paper, fifteen years primary (aerosol optical depth) dataset was obtained from the Multi-angle Imaging Spectro-Radiometer (MISR). The secondary datasets were generated from the primary dataset to understand the short and long term effect of aerosol loading over Brikama. The dataset is important to help researcher understand the dynamics of the aerosol loadings in the area. It was discovered that the air pollution over Brikama is not seasonal and do not come from same source. It was observed that the pollution over Brikama is determined by the massisve influx and migration of human population.

Keywords: air pollution, aerosol, Brikama, aerosol loadings

1. Introduction

In 2008, Departement of State for Forestry and the Environment, the United Nations Environment Programme (UNEP) and the National Environment Agency (NEA) created awarenes on sulphur reduction in vehicule fuels in The Gambia [1]. In most cities of West africa, ground measurement is inadequate. There are no significant contribution from government in the sub-region to invest in ground measurement of air pollution. The Ground measurement that is found in the region are that of DACCIWA, AERONET and some Institutions. This situation is disturbing as satellite imagery had revealed that the West Africa region had one of the highest air pollution in the globe (Figure 1). Cases of respiratory infection or diseaes has become very common. With this projection, it is easy to infer that the health risk is on children and women that resides in the research area.

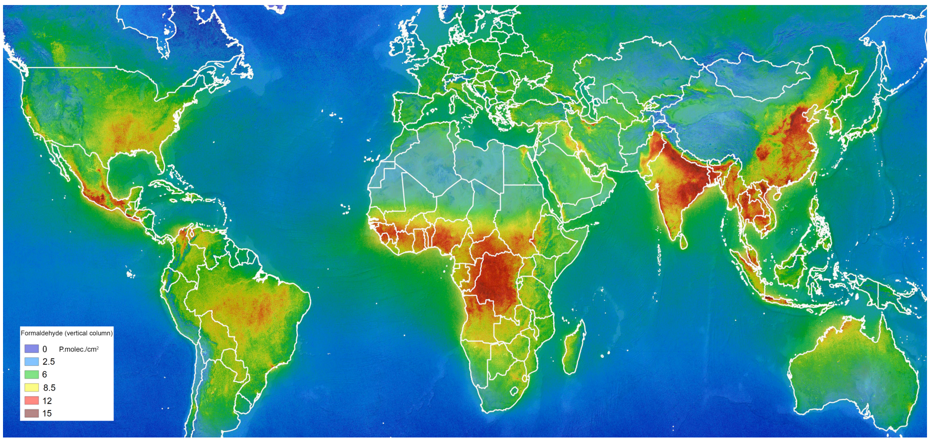

Figure 1: Air pollution around the globe

At the moment, satellite measurement is the main means of investigating air pollution [2-5] in the research area.
In the past, satellite measurement has shown baise that may be significant – depending on the geographical location. In this paper, the aerosol loading over Brikama was derived from satellite measurements. The quantity of risk on aerosols loading in West Africa cannot be estimated due to the fact that the theoretical validation concerning the aerosol dispersion model between the Stokes' rule has no longer been clarified. There is need to quantify the myriads of challenges dealing with aerosols dataset. The focus of this research is to repoort the current air pollution state for further research work.

2. Experimental Design, Materials and Methods

Brikama is one of the largest cities in the Gambia, lying south of the country's capital, Banjul. Brikama is located on longitude and latitude of 16.6409° W and 13.2748° N respectively (Figure 1). The dataset was obtained from MISR (https://l0dup05.larc.nasa.gov/L3Web/download). The data was processed using excel. The conversion from AOD to aerosol loading was done using West African regional scale dispersion model WASDM. The statistical analysis was carried out to observe the trends and significance of the dataset. Hence, among many other things, the dataset in this work is important to: give a good background for further study on aerosol loading; provide meteorological centers insight towards configuring sun-photometer over Brikama-Gambia; help to quantify the extent of air pollution; and provide modeller necessary insight on aerosol loading and retention challenges over Brikama-Gambia.

Figure 2: Geographical map of Brikama

WASDM was used aerosol loading over a region [7,8]:

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

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 validation of the summarized dataset was done using mathematical models and statistical software. The analysis of equations (1) was done using the C++ codes.

3. Results and Discussion

The summarized primary data was obtained from Multi-angle Imaging Spectro-Radiometer (MIS shown in Table 1 for 550 nm wavelength [6]. It was observed the months of highest AOD v significantly across the months over the years (see green boxes in Table 1). This result signifie the air pollution over Brikama is not seasonal and do not come from same source. Hence the poll over Brikama is caused by massisve influx and migration of human population. The missing d was due to biases as discussed above [7].The aerosol loading over the area was obtained usin West African regional scale dispersion model (WASDM) from the primary dataset (Tables 2) highest aerosol loading varies across month i.e. over the years. This means that the aerosol load not highest at months of highest AOD. This shows that the mathematical model was accurate tc an estimate value of aerosol deposition in the atmosphere.

Table 1: Summarized Aerosol Optical Depth Dataset over Brikama

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	201
Jan	0.493	0.174	0.150	0.201	0.105	0.223	0.336	0.571	0.210	0.203	0.290	0.193	0.276	0.2
Feb	0.569	0.340	0.246	0.382	0.381	0.291	0.175	0.282	0.424	0.396	0.207	0.181	0.408	0.2
Mar	0.322	0.348	0.413	0.411	0.535	0.209	0.423	0.444	0.394	0.373	0.517	0.340	0.729	0.3
Apr	0.456	0.487	0.490	0.419	0.346	0.411	0.489	0.343	0.509	0.363	0.493	0.561	0.428	0.5
May	0.304	0.281	0.486	0.576	0.186	0.351	0.362	0.504	0.562	0.517	0.576	0.366	0.515	0.5
Jun	0.541	0.481	0.425	0.568	0.561	0.577	0.658	0.497	0.331	0.316	0.605	0.398	0.573	0.6
Jul	0.175	0.104	0.384	0.294	-	-	-	0.437	0.145	0.303	1.453	0.664	0.367	0.2
Aug	0.322	-	0.193	0.356	0.235	0.390	0.438	0.262	0.313	0.221	0.280	0.400	0.360	
Sep	0.255	0.249	0.271	0.412	0.177	0.470	0.130	-	0.304	0.546	0.283	0.253	0.185	0.0
Oct	0.219	0.317	-	0.303	0.660	0.399	0.264	0.260	0.097	0.270	0.102	0.507	0.256	
Nov	-	0.244	0.167	0.308	0.204	0.179	0.147	0.297	0.247	0.145	0.224	0.207	0.227	0.1
Dec	-	0.165	0.168	0.185	0.264	0.191	0.131	0.164	0.284	0.137	0.193	0.246	0.124	

Table 2A: Aerosol loading over Brikama

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	201
Jan	0.845	0.931	0.935	0.927	0.940	0.923	0.897	0.812	0.926	0.927	0.909	0.929	0.912	0.9
Feb	0.813	0.896	0.919	0.884	0.884	0.909	0.931	0.911	0.870	0.879	0.926	0.930	0.875	0.9
Mar	0.901	0.894	0.874	0.874	0.828	0.926	0.870	0.863	0.880	0.887	0.835	0.896	0.736	0.8
Apr	0.859	0.847	0.846	0.872	0.894	0.874	0.847	0.895	0.838	0.889	0.845	0.817	0.868	0.8
May	0.906	0.911	0.848	0.810	0.930	0.893	0.890	0.840	0.816	0.835	0.810	0.889	0.836	0.8
Jun	0.825	0.849	0.870	0.814	0.817	0.810	0.772	0.843	0.899	0.902	0.797	0.878	0.812	0.7
Jul	0.931	0.940	0.883	0.908	-	-	-	0.865	0.935	0.906	0.298	0.769	0.888	0.9
Aug	0.901	-	0.929	0.891	0.921	0.881	0.865	0.915	0.903	0.924	0.911	0.878	0.890	
Sep	0.917	0.918	0.913	0.874	0.931	0.854	0.937	-	0.906	0.823	0.911	0.917	0.930	0.9
Oct	0.924	0.902	-	0.906	0.771	0.878	0.915	0.916	0.940	0.914	0.940	0.839	0.917	
Nov	-	0.919	0.932	0.905	0.927	0.931	0.935	0.907	0.919	0.935	0.923	0.926	0.923	0.9

Dec	-	0.933	0.932	0.930	0.915	0.929	0.937	0.933	0.910	0.936	0.929	0.919	0.938	

The statistical analysis of the summarized primary dataset is shown in Tables 3. The close ranges of values of the variance, average deviation and standard deviation are close indication that the correlation of each year would be nataurally be >0.75. It means the pattern of aersol dispersion in the research area is unique as there are no data spikes over the years.

Table 3: statistics of aerosols content over Brikama

Statistics	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Number of values	10.000	11.000	11.000	12.000	11.000	11.000	11.000	11.000	12.000	12.000	12.000	12.000	12.000
Minimum	0.175	0.104	0.150	0.185	0.105	0.179	0.130	0.164	0.097	0.137	0.102	0.181	0.124
Maximum	0.569	0.487	0.490	0.576	0.660	0.577	0.658	0.571	0.562	0.546	1.453	0.664	0.729
Mean	0.366	0.290	0.308	0.368	0.332	0.335	0.323	0.369	0.318	0.316	0.435	0.360	0.371
First quartile	0.255	0.192	0.174	0.299	0.190	0.213	0.154	0.267	0.229	0.212	0.215	0.226	0.241
Third quartile	0.493	0.346	0.422	0.415	0.497	0.408	0.434	0.484	0.409	0.384	0.546	0.454	0.472
Standard error	0.044	0.037	0.040	0.035	0.055	0.039	0.052	0.039	0.040	0.038	0.104	0.045	0.050
95% confidence interval	0.100	0.082	0.090	0.078	0.122	0.086	0.115	0.086	0.088	0.084	0.229	0.099	0.111
99% confidence interval	0.143	0.117	0.128	0.110	0.174	0.123	0.164	0.123	0.124	0.118	0.323	0.139	0.156
Variance	0.019	0.015	0.018	0.015	0.033	0.017	0.029	0.017	0.019	0.017	0.130	0.024	0.030
Average deviation	0.119	0.095	0.119	0.093	0.150	0.106	0.139	0.111	0.105	0.103	0.245	0.123	0.133
Standard deviation	0.139	0.122	0.134	0.122	0.182	0.129	0.172	0.128	0.138	0.132	0.361	0.155	0.174
Coefficient of variation	0.381	0.422	0.433	0.333	0.548	0.384	0.531	0.348	0.434	0.417	0.829	0.432	0.470
Skew	0.247	0.322	0.169	0.333	0.683	0.399	0.520	0.075	0.222	0.386	2.282	0.666	0.635
Kurtosis	-1.462	-0.488	-1.837	-0.201	-0.813	-0.656	-0.414	-1.154	-0.366	-0.552	6.200	-0.444	0.119
Kolmogorov-Smirnov stat	0.224	0.135	0.170	0.172	0.191	0.173	0.170	0.168	0.131	0.105	0.239	0.170	0.123
Critical K-S stat, alpha=.10	0.369	0.352	0.352	0.338	0.352	0.352	0.352	0.352	0.338	0.338	0.338	0.338	0.338
Critical K-S stat, alpha=.05	0.409	0.391	0.391	0.375	0.391	0.391	0.391	0.391	0.375	0.375	0.375	0.375	0.375
Critical K-S stat, alpha=.01	0.489	0.468	0.468	0.449	0.468	0.468	0.468	0.468	0.449	0.449	0.449	0.449	0.449

This result is further affirmed by the averages of the AOD over the years i.e. within the range of 0.3±0.05. The year 2010 had the highest AOD average over the years. The standard error is a good indication that the satellite measurement has a very low baise. Hence, the dataset presented is reliable for modelling and optimization process.

4. Conclusion

The research affirm that air pollution in Brikama is not seasonal and do not come from same source. It was observed that the pollution over Brikama is determined by the massive influx and migration of human population. Though the aerosol loading is safe for the inhabitants, however, if the massive vehicular movement is not checked, the continous emission of sulphur dioxide as reported by United Nations Environment Programme (UNEP) and the National Environment Agency (NEA) would be a massive threat to all the life form in the research area.

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References

[1]. Abdoulie John, Environment: Efforts to combat air pollution, http://africa.gm/africa/gambia/article/environment-efforts-to-combat-air-pollution (accessed 16th June, 2018)
[2]. Fioletov, V.E., Bodeker, G.E., Miller, A.J., McPeters, R.D. and Stolarski, R., Global and zonal total ozone variations estimated from ground-based and satellite measurements: 1964–2000, Journal of Geophysical Research 107 (D22) (2002) 4647-4651.
[3]. Giglio, L., Randerson, J.T., van der Werf, G.R., Kasibhatla, P.S., Collatz, G.J., Morton, D.C. and DeFries, R.S., Assessing variability and long-term trends in burned area by merging multiple satellite fire products. Biogeosciences 7 (2010) 1171-1186.
[4]. Mohammad Hadi Dehghani Sima Jarahzadeh , Mostafa Hade, Nabiollah Mansouri, Yousef Rashidi, Mahmood Yousefi, The Data on the Dispersion Modeling of Traffic-related PM10 and CO Emissions using CALINE3; A Case Study in Tehran, Iran, Data in Brief 19 (2018) 2284-2290.
[5]. Liu, Y., Wang, Z., Wang, J., Ferrare, R., Newsom, R. and Welton, E., The effect of aerosol vertical profiles on satellite-estimated surface particle sulphate concentrations. Remote Sensing of Environment, 115 (2) (2011) 508-513.
[6]. McGill, M., CATS/ISS L2O D-M7.1 05kmPro HDF-5 File - Version 1.05 [Data set]. NASA Langley Research Center Atmospheric Science Data Center DAAC. (2016). https://doi.org/10.5067/iss/cats/l2o_d-m7.1-v1-05_05kmpro
[7]. M. E. Emetere, Impacts of recirculation event on aerosol dispersion and rainfall patterns in parts of Nigeria, GLOBAL NEST JOURNAL 19 (2) (2017) 344-352
[8]. Moses Eterigho Emetere, (2017). Investigations on aerosols transport over micro- and macro-scale settings of West Africa, Environ. Eng. Res., 22(1), 75-86