Air Pollution in term of $PM_{2.5}$ and $PM_{2.5-10}$ in Andravoahangy area.

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The data from the site installed at Andravoahangy Public School are exploited to establish the variation of atmospheric pollution of particulate matters in terms of days in a week, working days, rush days. The results of the experimental studies have shown that the PM_{10} concentration values on wednesday (103.5µg/m^3 mean value), thursday (57.9µg/m^3 mean value), friday (71.7 µg/m^3 mean value) and saturday (49.9µg/m^3 mean value) exceed the World Health Organization (WHO) maximum admissible values (50µg/m^3 daily mean value). The PM may be dichotomized in two classifications according to their size: the $PM_{2.5}$ and the $PM_{2.5-10}$ which constitute together the PM_{10}. Among these particulate matters, $PM_{2.5}$ are very risky because they may be deeply breathed in to the lung. Thus, the particulate matters have significant effects on the air quality and originate a large range of sanitary effect which requires sanitary impact assessment bringing out the relationship between the exposure to atmospheric pollution and its effect on human health.

1. INTRODUCTION

Atmospheric pollution becomes more and more worrying due to its disastrous effects on public health and environment. Particulate matters represent one of the existing atmospheric pollutants. Therefore, the quantity of PM_{10} are taken as a sign of atmospheric pollution.

The main objectives of this study are the following :

- to increase the information with regards to the authorities and the public to raise their awareness on the importance of air quality ;
- to strengthen the institutional capacity of authorities and all stakeholders in the problematic of air pollution in order to enable them to develop their knowledge on current issues and research related to air pollution.

The present work is done in collaboration with EGIS BCEOM International [1]. Madagascar-INSTN takes care of doing measurements of pollutants in the air, the airborne dust $PM_{2.5}$, $PM_{2.5-10}$ and PM_{10}. The following notation is taken into account :

$PM_{2.5}$: Particulate Matters with granulometric diameter less than 2.5µm
$PM_{2.5-10}$: Particulate Matters with granulometric diameter between 2.5 and 10µm
PM_{10} : Particulate Matters with granulometric diameter less than 10µm

2. GENERAL INFORMATION ON PARTICULATE MATTERS

Particulate pollutants in the atmosphere differ in their size and composition. Particulate matters which are discussed in this study have an aerodynamic diameter equal to 10 micrometers or less (PM_{10}). These particles include two parts: $PM_{2.5}$ and $PM_{2.5-10}$. These may consist of a wide range of chemical species such as nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon oxide (CO), metals and volatile organic compounds (VOCs).

The origin, the length of stay in atmosphere, the health effects and the WHO regulations are summarized in table 1.

Table 1: $PM_{2.5}$ and $PM_{2.5-10}$ origin, length of stay, health effects and regulations

$PM_{2.5}$ (ultrafine particles)	**$PM_{2.5-10}$ (fine particles)**
Origin: combustion engines (vehicles running on gasoline and fuel diesel), industrial processes and heating with wood (charcoal).	Origin: wind erosion, dust roads, construction sites and careers. Are also included the molds, spores or pollen.
Length of stay in the atmosphere: $PM_{2.5}$ stay in the atmosphere for a few days and even a few weeks.	Length of stay in the atmosphere: $PM_{2.5-10}$ stay in the atmosphere for a few minutes to few hours.
Health effects: respiratory diseases such as bronchitis, asthma, emphysema, various types of heart diseases and cancer.	Health effects: respiratory diseases such as bronchitis, asthma, emphysema, various forms of heart diseases.
Regulations (WHO Guidelines 2005)[1]: • daily mean value: 25µg/m^3 (no exceeding day is allowed for the year) • annually mean value: 10µg/m^3	Regulations (WHO Guidelines 2005): • daily mean value: 50µg/m^3 (35 exceedings days are allowed for the year) • annually mean value: 20µg/m^3

3. METHODOLOGY

For this four-month campaign, from 14 April to 21 August 2008, the measurement site was chosen so that it is representative of consequent impact of pollution in the vicinity. The site was located in a fairly populated area, with dense traffic and indeed in the enclosure of a public elementary school where children 6 to 13 years old are educated.

The collection of dust airborne was performed using an impactor GENT [2]. The sensor was placed 7m above the ground surface. The sampling lasts 24 hours which permits to obtain the daily concentration value.

Nucleopore polycarbonate filters of diameter 47mm, porosity 0.4µm and 8µm were used respectively to collect the $PM_{2.5}$ and $PM_{2.5-10}$.

It is important to note that the standard method is with a daily sample flow of about 16L/mn or 23m^3 of air per day.

Gravimetric method is used to determine the total mass.

4. RESULTS AND INTERPRETATION

The daily concentration values are shown graphically in Figure 1 and the data are summarized in table 2 where are mentioned the daily mean value, the maximum daily value, the minimum daily value and the number of days exceeding the Maximal Admissible Limit Value (MALV). Seventeen (17) measurements are carried out during the campaign.

[1] http://www.who.int/mediacentre/factsheets/fs313/fr/index.html

4.1. Periodicity of the particulate pollution phenomenon

Figure 1 shows a recurrent period T of one week with a maximum peak on Wednesday that is market day and a minimum peak on Sunday that is holidays.

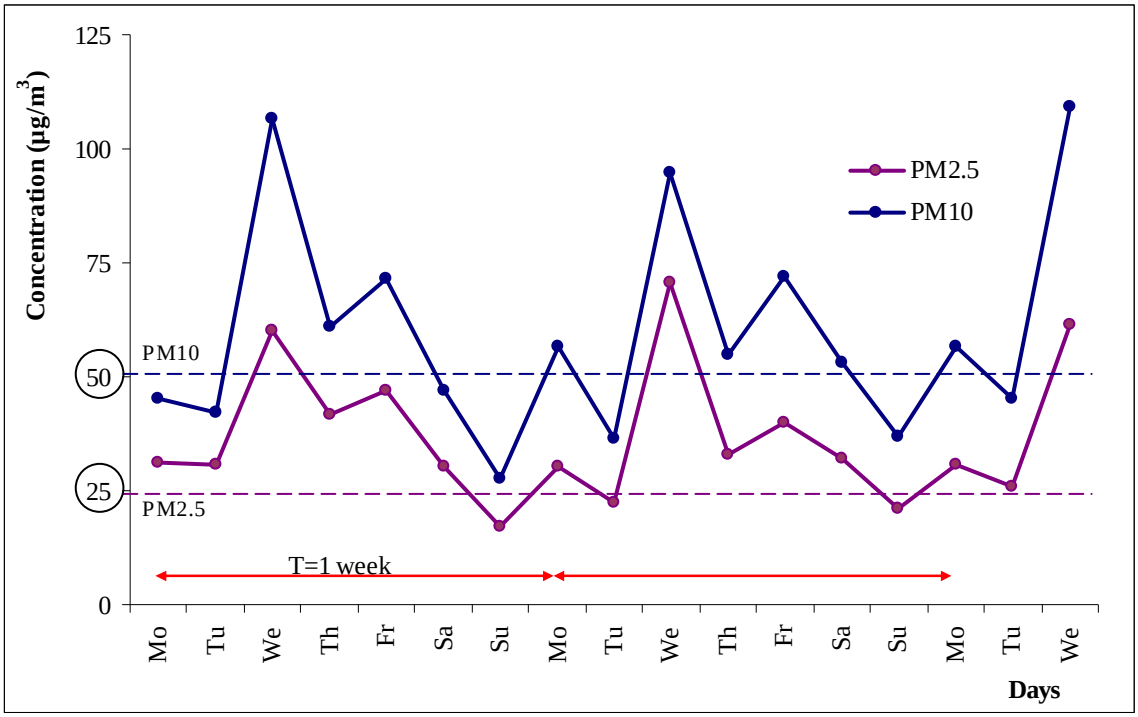

Figure 1: Daily variation of $PM_{2.5}$ and PM_{10} contents (14 April-21 August 2008)

4.2. Incidence of traffic on $PM_{2.5}$ contents

The maxima corresponding to both $PM_{2.5}$ and PM_{10} (Figure 1) appear on Wednesday, the market day in Andravoahangy i.e. busy day of human and vehicular traffic leading to creation of traffic jam in several neighborhoods.

Not only these values are too high but they exceed by a factor 3 (for $PM_{2.5}$) and factor 2 (for PM_{10}) the AMLV set by international standards. The minimum daily values that are lower than the standards occur on Sunday, holidays.

However, pollution peaks correspond to the period of heavy traffic.

4.3. $PM_{2.5}$ and PM_{10} contents in relation to regulation

As far as PM_{10} are concerned, the limit value recommended by the WHO guidelines, set at 50µg/m^3, was exceeded 10 days out of 17 (Table 2). Taking into account the periodicity of the phenomenon, calculation by extrapolation gives an average of 208 days over a year which is too high compared to the maximum of allowed number (35 days per year).

The same result is obtained for $PM_{2.5}$: the limit value of $25\mu g/m^3$ has been exceeded 14 days out of 17 (Table 2). Therefore, the quality of the air in the area of Andravoahangy does not meet the standards.

Table 2: Summary data

	Unit	**$PM_{2,5}$**	**PM_{10}**
Daily mean value	$\mu g/m^3$	36,8	59,8
Maximum daily value	$\mu g/m^3$	70,8	109,3
Minimum daily value	$\mu g/m^3$	17,1	27,7
Number of days (C_{PM}[2]$> 25\mu g/m^3$)	day	14	
Number of days ($C_{PM} > 50\mu g/m^3$)	day		10

4.4. Proportion of $PM_{2.5}$ in PM_{10}

The proportion of $PM_{2.5}$ into PM_{10} varies from a day to the next. The results show that the fraction of $PM_{2.5}$ is about 62% [minimum 53%, maximum 75%] (Figure 2). Generally, airborne particles at the Andravoahangy neighborhood contain much more harmful particles. The more a particle is fine, the more its potential toxicity is high.

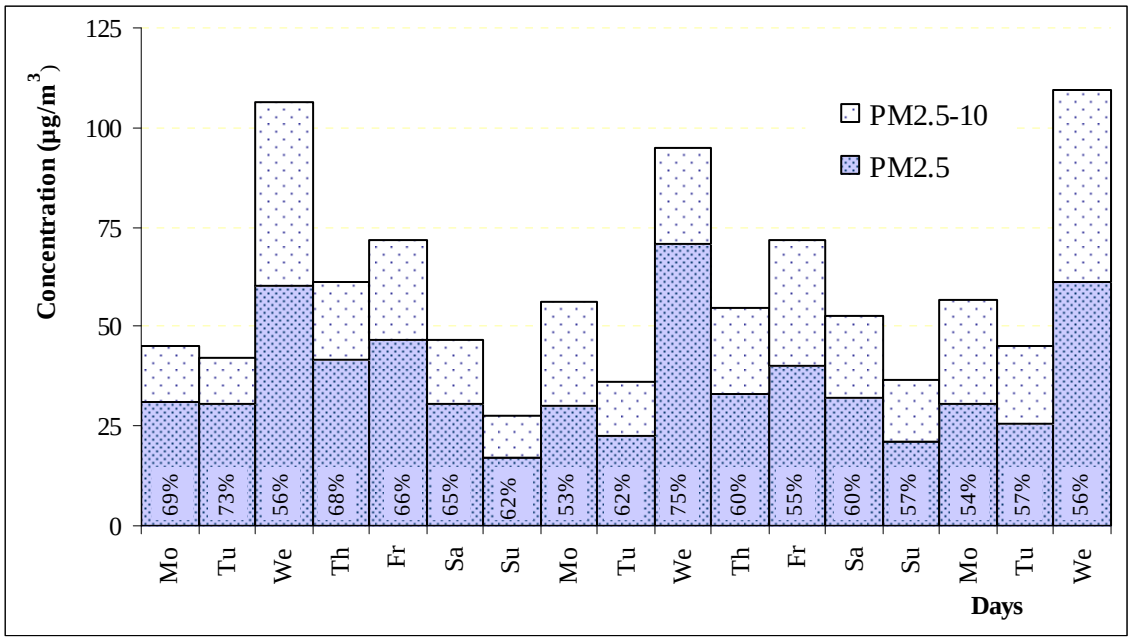

Figure 2: Proportion of $PM_{2.5}$ into PM_{10} (14 April-21 August 2008)

[2] C_{PM} : Concentration of particulate matters

5. CONCLUSION

View the high proportion of $PM_{2.5}$ (62%) that are in PM_{10} and the location of sampling site which is near the road, we conclude that road traffic contributes in this episode of particulate pollution.

It is now established that these smallest particles ($PM_{2.5}$) are emitted mainly by diesel engines that reach more alveoli of the lungs and cause the most damage to health.

Following the results of this study, it is possible to extend the work in other parts of the agglomeration of Antananarivo to estimate the population exposure to PM_{10} , particularly to $PM_{2.5}$.

In addition, the study presents an advantage so that it opens a new horizon to establish the correlation between particulate air pollution and respiratory infections, both among adults than children.

6. OUTLOOK

The perspective follows up on the previous conclusion.

It is essential

- to extend the monitoring/control of PM_{10} contents in all areas with high population density and traffic,
- to carry out further studies to characterize the association between exposure to high concentrations of fine particles and its effects on health,
- to quantify NO_2, SO_2 and CO in order to complete the data on air pollutants.

It is hoped a participative approach of all concerned entities that are the authorities, scientists, population, and in particular the higher authority related to public health in Madagascar.

Acknowledgments

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References

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