PRELIMINARY RESULTS OF PARTICULATE POLLUTION AT THE UNIVERSITY OF PATRAS, GREECE

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ABSTRACT

The present work deals with the concentration levels of air-borne particulate matter of diameter less than 10 μm (PM_{10}) and 2.5 μm ($PM_{2.5}$) of the area of the University of Patras Campus during the period of 2012 - 2018. The concentration measurements were made by the stationary air pollution monitoring station of the Environmental Engineering Laboratory (EEL) of the Civil Engineering Department of the University of Patras. The sampling site is in a suburb.

The annual variations of PM_{10} and $PM_{2.5}$ concentrations for the period 2012 -2018 are presented. Also, the annual levels for warm and cold period are presented. Finally, the yearly variations of mean monthly values are shown for the specific period.

The aim of this project is to derive implications from the PM_{10} and $PM_{2.5}$ levels of the air of University of Patras Campus. The analysis of such a program of continuous measurements of air quality may provide a cost-effective strategy for air quality monitoring.

KEYWORDS

Air pollution, air quality, PM_{10}, $PM_{2.5}$, suburban concentration, suburban

1. INTRODUCTION

The airborne particulate matter (PM) is one of the most significant air pollutants [1, 2]. They consist of a mixture of solid particles and liquid droplets that are suspended in air with a wide range in size and chemical composition. Human health is affected mainly by the “inhalable particles” of a diameter less than 10μm (PM_{10}), and more specifically by the “fine particles” of diameter less than 2.5μm ($PM_{2.5}$). PM is originated by anthropogenic combustion and non-combustion sources as well as by natural sources, like sea salt emissions, re-suspended dust and transported Saharan dust[3].

The existence of particle pollution affects both health and the environment. Health effects of short or long term exposure to PM may be the appearance or aggravation of cardiovascular and respiratory diseases. The correlation between PM and mortality is also significant. The environmental impact may be assessed by the temporary occurrences of PM that affect visibility, climate and vegetation. In addition, building materials do not remain unaffected due to exposure to particulate pollution [1, 3, 4]. Air quality standards by European Environment Agency (EEA)[2] and US Environmental Protection Agency (US-EPA) [4] and Guidelines by World Health Organization (WHO) [1] are continuously updated according to the progress of research data.

The University of Patras Campus (UPC) is established at an area of 2.66 km^2, 12 km NNE of the city center, adjacent to Rion and at the foot of Panachaicon Mountain. It has 21 Departments with a total population of 30,000 approximately, including the University Hospital of Patras, where extensive infrastructure works, sports facilities, agricultural and other significant activities take place [5]. The present study deals with the presentation of PM_{10} and $PM_{2.5}$ concentrations measured by the Environmental Engineering Laboratory (EEL) of the Civil Engineering Department of the University of Patras during the period 08/04/2012 - 31/12/2018. The annual average values, as well as the average values of the relative cold and warm periods have been calculated and used herein.

2. METHODOLOGY

2.1 Sampling Area

The position of the air quality monitoring EEL station is shown in Figure 1. It is located at the western parking lot of the Building of the Department of Civil Engineering (geographical longitude 21º47΄22΄΄, geographical latitude 38º17΄22΄΄ and 60.60 m altitude above sea level). At this area, the inclination is 4-5% toward NW. Apart from asphalt-covered streets, the major area consists of natural soil with low vegetation, bushes, and sporadic trees, mainly pine and olive trees. The EEL station is free from nearby objects of any kind from the NE to SE wind sectors (i.e., for an angle of at least 247.5°). The main traffic network consists of the old National Road and the new National Road Korinthos – Patras (E65) that are approximately 0.7 km far N from the EEL station, and the Patras By-Pass (E55) that is 1.2 km SE away. At a distance 2.2 km far N is the local ferry port of Rion – Antirrion. Also, the traffic load is charged due to the University Hospital of Patras that is located 1.5 km NE from EEL. Also, more than 2 km toward NE, there is a limited number of industrial activities of moderate size. The EEL air pollution originates from classic sources of a suburban-rural area, augmented by emissions due to central heating during winter and additional emissions from aforementioned activities and a cement factory operating 2-3 km NE of the UPC. The Station is classified as "Suburban – background station". More details about the location of the monitoring EEL station are given in the literature [6].

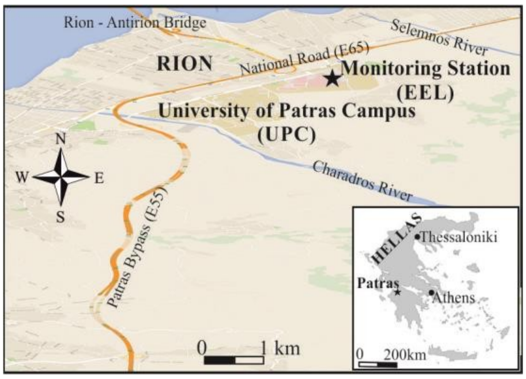

Figure 1. General view of University Campus of Patras and air quality monitoring location

2.2 Sampling equipment

The EEL station includes an automatic analyzer of PM (model Grimm 180) based on the 90° scattering light measurement principle. The analyzer provides data records of mean values every five minutes. Based on these data the 24-h average concentrations of PM_{10} and $PM_{2.5}$ are calculated. At the roof of the station, a weathering station is located. More details about this sampling equipment are given in the literature [6, 10].

2.3 Data

The sampling period is from 08/04/2012 until 31/12/2018. A time series of 2094 out of 2458 days (85%) daily average concentrations of PM10 and PM2.5 are produced using the 5min values recorded by the automatic analyzer. Missing data were skipped. Using the data above, annual average values and the mean concentrations of yearly cold and warm periods are calculated.

3. RESULTS AND DISCUSSION

During this period, the yearly concentrations ranged from 7.8 to 20.5 μg m^{-3} and from 6.7 to 12.8 μg m^{-3} for PM_{10} and $PM_{2.5}$, respectively (Figure 2). The mean values for the PM_{10} and

PM2.5 concentrations are 13.2 μg m^{-3} and 9.5 μg m^{-3}, respectively. These values are lower than the Limit values of EEA, EPA and WHO [1, 2, 4].

According to Figure 2 it is obvious that there is a confident reduction trend at PM10 and PM2.5 levels at UPC. During the 8 years sampling period PM10 and PM2.5 levels were reduced about 62% and 48%, correspondingly.

In Table 1 the annual PM10 and PM2.5 concentrations (μg m^{-3}) during the sampling period are presented. Also, the

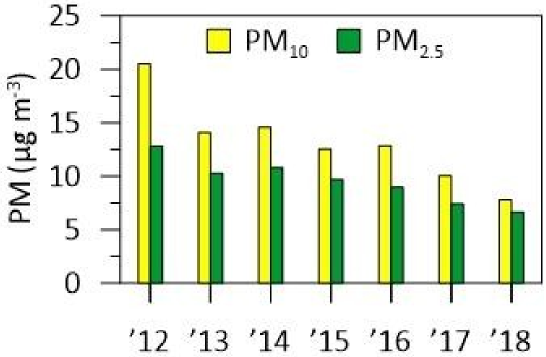

Figure 2. Annual variation of mean PM10 and PM2.5 concentrations at UPC (suburban) during 2012 - 2018.

Table 1. Mean yearly PM10 and PM2.5 concentrations (μg m-3) during 2012 - 2018.

Year	**PM_{10} (*μg m^{-3}*)**	**$PM_{2.5}$ (*μg m^{-3}*)**	**Completion (%)**
2012	20.5	12.8	93
2013	14.1	10.3	75
2014	14.6	10.8	90
2015	12.5	9.7	97
2016	12.8	9.0	70
2017	10.1	7.4	95
2018	7.8	6.7	80

yearly completion of recorded data is included. It is obvious that the annual concentration levels are representative as data's completion is constantly above 70%.

In Figure 3 the mean PM10 concentrations at cold (October - March) and warm (April - September) periods during the sampling period are presented. During warm periods, PM10 concentrations ranged from 7.7 to 22.7 μg m^{-3} with a mean value of 14.1 μg m^{-3}. The relative range for cold periods was 7.9 – 15.5 μg m^{-3} with a mean value of 12.0 μg m^{-3}. The downward trend in concentration levels at warm periods is similar to that shown in Figure 2. At warm periods, the PM10 levels were reduced

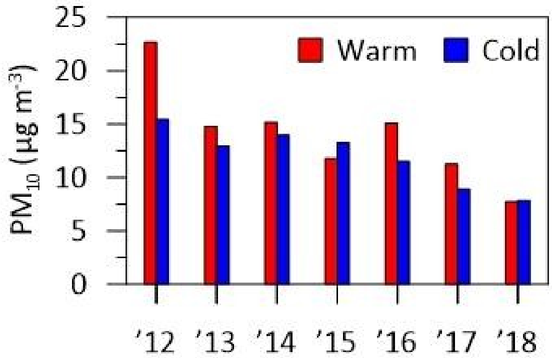

Figure 3. Yearly variation of mean PM10 concentrations at UPC (suburban) during warm and cold periods of 2012 – 2018.

approximately 66%. At cold periods, the reduction was rather mild, especially during 2012 – 2016. The mean PM10 concentration at the cold period 2018 was 38% lower than the corresponding value of 2012. The PM10 values at cold periods are lower than those at cold periods, except of 2015. As UPC is a suburban area is not affected by central heating or biomass burning during cold periods but is strongly affected by Saharan dust events and forest fires that usually occur during warm periods [6-9]. In Tables 2 and 3, the mean yearly PM10 concentrations during warm and cold periods are presented, respectively. Except of the cold periods of the years 2013 and 2018 and the warm period of 2016, the data's completion is rather high. However, the concentrations of the periods where data's completion is less than 70% are well indicative as completion is still over 50%.

Finally, the mean PM2.5 concentrations at cold and warm periods during the sampling period are presented. During warm periods, PM2.5

concentrations ranged from 6.4 to 13.4 μg m^{-3}. The mean value was 9.4 μg m^{-3}. PM2.5 range at cold periods, was 7.1 – 11.5 μg m^{-3} with a mean value of 9.6 μg m^{-3}. PM2.5 levels are decreasing through years. During the

Table 2. Mean yearly PM_{10} *and* $PM_{2.5}$ *concentrations* (μg m^{-3}) *during cold periods of* 2012 - 2018.

Year	PM_{10} (*μg m*$^{-3}$)	$PM_{2.5}$ (*μg m*$^{-3}$)	Completion (%)
2012	15.5	11.5	80
2013	13.0	10.2	58
2014	14.0	11.2	85
2015	13.3	10.7	98
2016	11.5	9.0	87
2017	8.9	7.4	98
2018	7.9	7.1	63

Table 3. Mean yearly PM10 *and* PM2.5 *concentrations* (μg m^{-3}) *during warm periods* of 2012 - 2018.

Year	PM10 (*μg m*$^{-3}$)	PM2.5 (*μg m*$^{-3}$)	Completion (%)
2012	22.7	13.4	99
2013	14.8	10.3	92
2014	15.2	10.5	95
2015	11.8	8.7	96
2016	15.1	8.9	52
2017	11.3	7.5	91
2018	7.7	6.4	97

sampling period the initial PM2.5 values at warm and cold periods are reduced approximately 52% and 40%, respectively. These values are lower than those of PM10 showing that PM2.5 levels are less affected by warm or cold periods during a year.

4. CONCLUSIONS

The recorded values of PM10 and PM2.5 concentrations at the University Campus of Patras in the period 2012 - 2018 show the air quality of the area is under the limits that EU has adopted for annual mean. The initial PM10 and PM2.5 levels that were recorded in 2012 are reduced

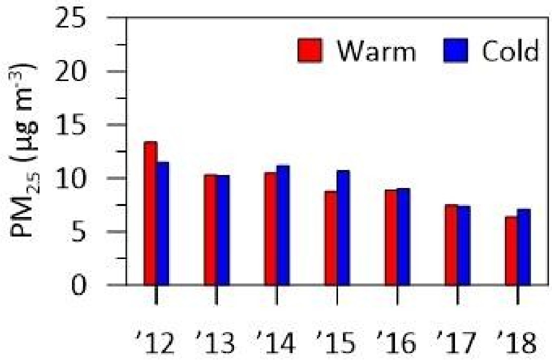

Figure 4. Yearly variation of mean PM2.5 *concentrations at UPC (suburban) during warm and cold periods of 2012 – 2018*.

significantly during the sampling period. The warm/cold period seems to affect PM10 levels more than PM2.5. Additionally, PM10 concentrations are stably lower during cold periods while this is not noticed at PM2.5 values. Overall, the significant low PM2.5 and PM10 concentrations can characterize these values as background values.

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