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Short communication

Effect of travel restriction on PM_{10} concentrations in Naples: One year of experience

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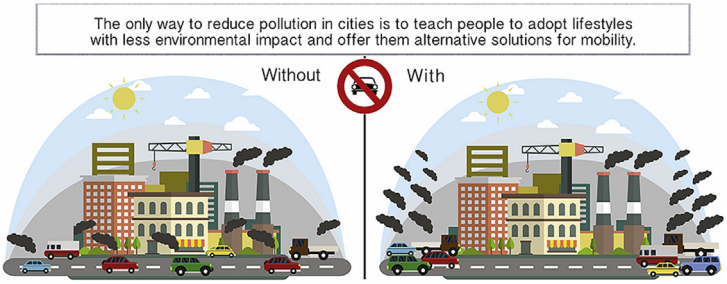
GRAPHICAL ABSTRACT



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ABSTRACT

The PM_{10} is an ubiquitarian and most common pollutant in the world, especially in the Western countries, and it is responsible onset of many pathologies from cancer to cardiorespiratory diseases and human reproduction, on the pregnant women and birth outcomes, in addition to recently has been associated with metabolic diseases (like diabetes). In the light of this scenario, the city of Naples decided in 2010, attempting to reduce PM_{10} concentrations, to establish a travel restriction for the cars over the city to time slots and on alternate days. We have analyzed the PM_{10} data from eight monitoring stations dislocated on the city ground. The period of analysis was a year, from July 2010 to July 2011. The results were not absolutely close to expectations, having practically demonstrated that there is no statistically significant difference between the days and hours when the travel restriction was active and those where no have the travel restriction. In conclusion, the travel restriction at time slots and alternate days as structured in the city of Naples seems have not significant improvement of air quality but should need further studies to obtain more reliable data.

1. Introduction

The ambient air pollution (AAP) is a main worry for the western countries as it is ubiquitarian. The primary pollutants are the particulate matter (PM) in all its fractions (PM_{10} diameter $\leq$ 10 μm, $PM_{2.5}$ diameter $\leq$ 2.5 μm, PM_1 diameter $\leq$ 1 μm and the ultrafine particles), SO_2, CO, NO_x, O_3 and polycyclic aromatic hydrocarbons (Rodríguez et al., 2004; Polichetti et al., 2009; Stranger et al., 2009; Rogula-Kozłowska et al., 2014). Numerous epidemiological studies have found correlations between these pollutants and several human pathologies such as cardiovascular and respiratory diseases (Bai et al., 2007; Polichetti et al., 2009; Adar et al., 2014), such as the male reproductive system (Yauk et al., 2008; Polichetti et al., 2011) and pregnant women and birth outcomes (Bell et al., 2007; Brauer et al., 2008; Polichetti et al., 2013) or carcinogenic effects

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(Valavanidis et al., 2008; Callén et al., 2011). For these reasons the reduction of the AAP is of great importance for the entire western world both for public health and public spending.

The PM in all its fractions is a mixture of solid and liquid particles coming from several sources such as vehicle emissions, industrial and domestic emissions, forest fires, cigarette smoke, natural trees, climate variations, geographic position (see Fig. 1). The primary instruments for the governments in particular for local government in the cities is the possibility of travel restriction (Kelly et al., 2009, 2011a,b; Ruprecht and Invernizzi, 2009; Invernizzi et al., 2011; Whitlow et al., 2011; Acero et al., 2012; Qadir et al., 2013; Fensterer et al., 2014).

In 2010 the city of Naples established the travel restriction for the cars belonging to the classes Euro 0, 1, 2, 3. For the cars belonging to the classes Euro 2 and 3 it was allowed to travel if they have on board at least 3 passengers, while to all cars it is allowed to travel if provided of methane or LPG system. The restriction was valid from 7.30 to 10.30 a.m. on Monday, Wednesday and Friday. This travel restriction has been renewed in 2011 at same conditions with addition of restriction from 3.00 to 5.30 p.m. on Thursday (see Table 1). In this study we are analyzed the effects of travel restriction on PM_{10} concentrations both on daily means and on the means in the hour with travel restriction.

2. Methods

Using the data supplied by the ARPAC (Agenzia Regionale per la Protezione Ambientale della Campania), we compared the PM_{10} levels obtained from 8.00 to 10.00 a.m. in the days with and without restriction during the period from July 2010 to July 2011 and from 3.30 to 5.30 p.m. in the only day of Thursday during period from January to July 2011. In addition, we compared also the PM_{10} concentrations obtained for 24 h. The PM_{10} concentrations are expressed as $\mu g/m^3$ and reported as means±standard deviations. Student's *t*-test for paired data has been used to evaluate the statistical significances.

The data were compared by correlating Monday-Wednesday-Friday (days with travel restriction) to Tuesday-Thursday-Saturday (days without travel restriction); while the next travel restriction of Thursday afternoon was compared with Tuesday afternoon (without travel restriction).

3. Results

We have analyzed one year period from July 2010 to July 2011, and compared the data obtained during the 24 h between the means of days with travel restriction and those obtained during the days without travel restriction (see Table 2). These data confirm what has already been found in a previous short study on three months (Polichetti et al., 2011). The current study instead includes one year period, and is more complete since includes all seasons and all possible climatic variations. The results were obtained from eight monitoring stations dislocated in various places of the city; because of that data represent all territorial characteristics; considering the busy and not busy areas. As you can see in Table 2 it does not show any statistically significant difference between the PM_{10} concentrations measured during the days with travel restriction and those obtained during the days without travel restriction (see Fig. 2). Since it was possible that the daily average could not be indicative of the daily variations we decided to analyze PM_{10} concentrations during the only hours of travel restriction. In fact, were also analyzed the data from the monitoring stations during the only hours of travel restriction (8:00–10:00 a.m.) and compared with the same hours of days without travel restriction,

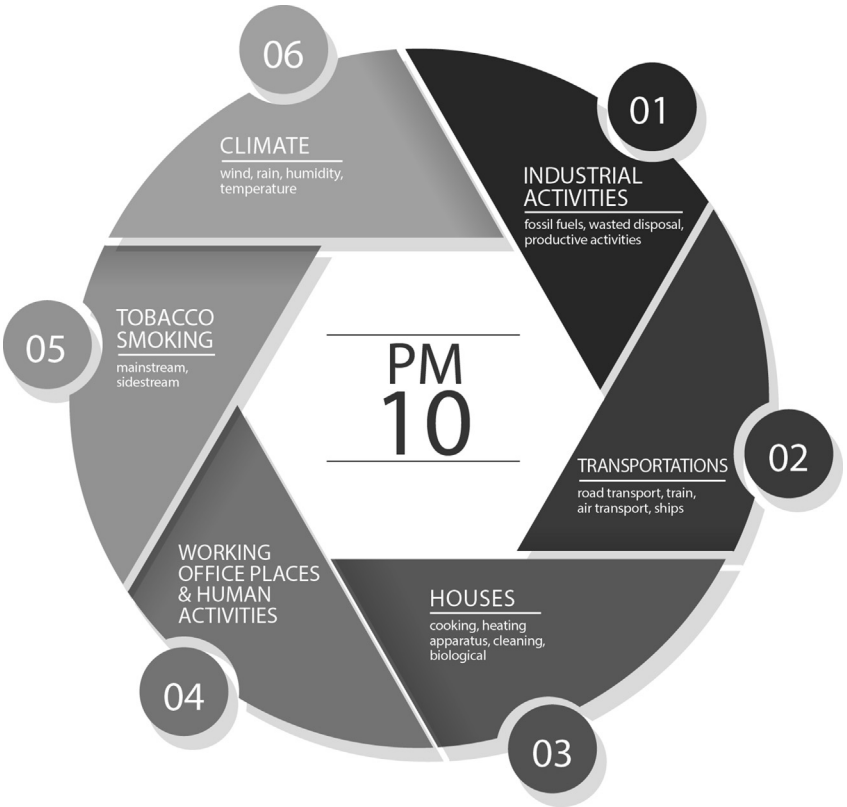

Fig. 1. Main sources of PM_{10}.