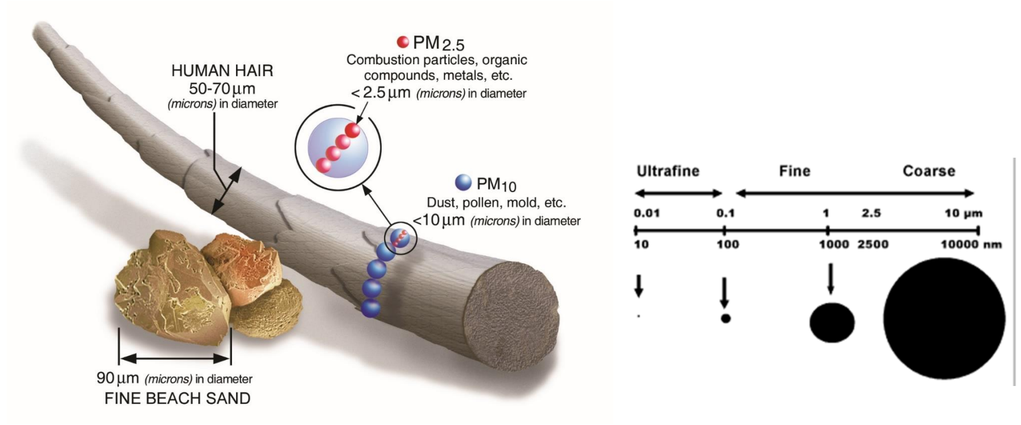
$PM_{2.5}$ in the Atmosphere

Introduction

Airborne particulate matter (PM) significantly impacts global climate, causes visibility degradation in both urban and pristine environments, and accelerates material decay. Different sizes of PM have been found to have varying toxicities, impacting human health. The variability in size fraction and composition of fine particles are strongly influenced by seasonal meteorological factors, gaseous parameters and location. $PM_{2.5}$ describes fine inhalable particles, with aerodynamic diameter that are generally 2.5 micrometres and smaller (Fig. 1).

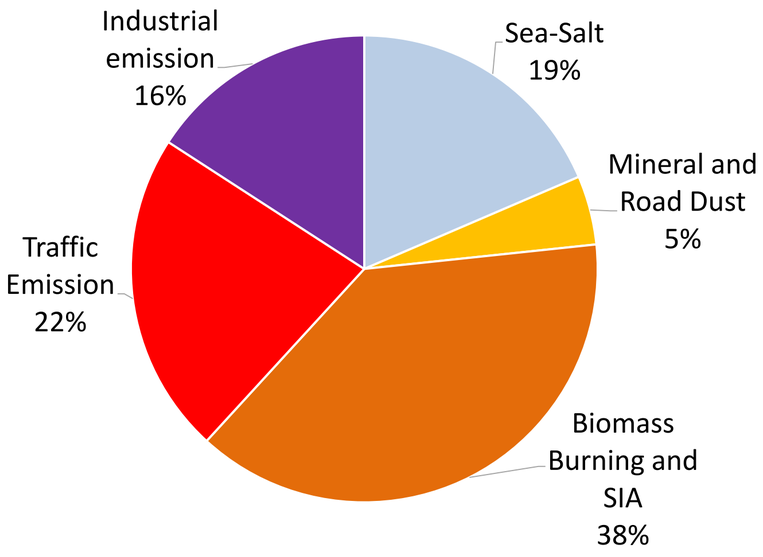


(Source US EPA)

Fig. 1. Comparison of $PM_{2.5}$ to fine beach sand, human hair, dust and PM_{10}. $PM_{2.5}$ also categorise as fine particle

Sources of $PM_{2.5}$

$PM_{2.5}$ can be generated in the atmosphere by differences sources. Common chemical constituents of PM include sulphates, nitrates, ammonium as well as other inorganic ions such as ions of sodium, potassium, calcium, magnesium and chloride. Organic and elemental carbon, crustal material, particle-bound water, metals and polycyclic aromatic hydrocarbons (PAH) are also common constituents. In addition, biological components such as allergens and microbial compounds can also be found in PM. Based on source apportionment study by Sulong et. al. [1], among the main sources of $PM_{2.5}$ are biomass burning and secondary inorganic aerosols (SIA), traffic emission, industrial emission and sea salt (Fig. 2).



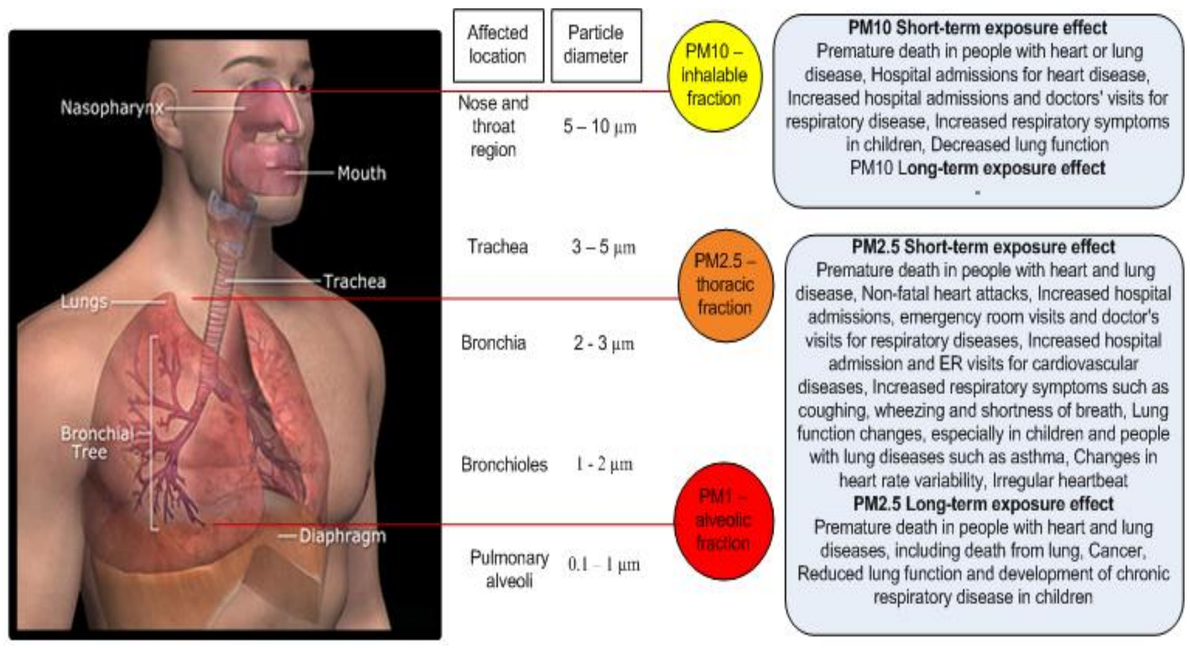
Source: Sulong et al. [1]

Fig. 2. Source apportionment results from positive matrix factorisation (PMF) analysis

Effect of $PM_{2.5}$

$PM_{2.5}$ can penetrate deeply into the lung, irritate and corrode the alveolar wall, and consequently impair lung function (Fig. 3). A study by Schwartz [2] found that long-term exposure to $PM_{2.5}$ significantly increased not only the chances of cardiopulmonary problems but also mortality due to lung cancer. Another study conducted for almost a decade (from 2000 to 2007) in the United States indicated that the average life span was extended by 0.35 years for every 10 µg/m^3 decrease of $PM_{2.5}$ [3].

$PM_{2.5}$ also effects the physical environment as it can reduce visibility due to light scattering. $PM_{2.5}$ will be suspended in ambient air longer than coarse mode particles and can be transported by local and regional winds (Fig. 4). During biomass burning episode in Southeast Asia, $PM_{2.5}$ concentration was found to be dominant (around 74% of PM_{10} concentration) [4,5].



Source: Amil [5]

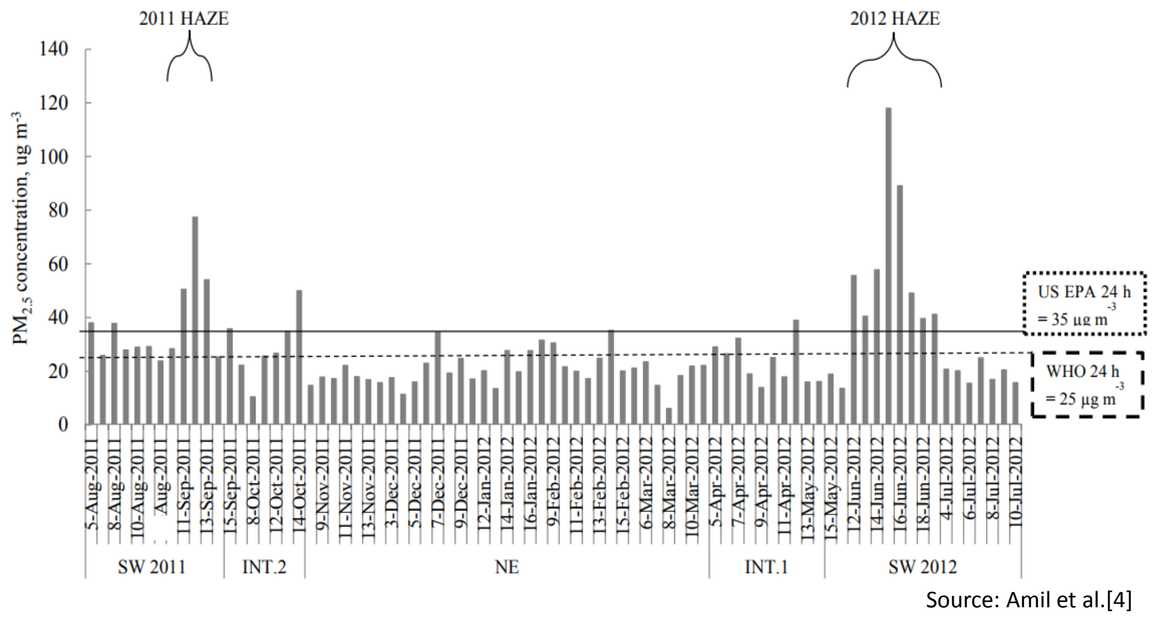
Fig. 3. Deposition of PM in human lung and the associated health effect

(a) Satellite image of smoke from forest fire (b) Haze episode in Malaysia

Fig. 4. Haze episode in Peninsular Malaysia due to biomass burning in Sumatra, Indonesia

$PM_{2.5}$ Concentration in Malaysia

The concentration of $PM_{2.5}$ in ambient air in Malaysia has been determined by researchers since 1997 [6]. The concentration of $PM_{2.5}$ is usually categorised based on haze and non-haze days. During normal conditions, the average concentration of $PM_{2.5}$ recorded in urban environment is 20-21 µg/m^3 [7]. During haze episode in Malaysia, the concentration of $PM_{2.5}$ exceeded the limit of 25 and 35 µg/m^3 suggested by World Health Organization (WHO) and United States Environmental Protection Agency (US EPA), respectively (Fig. 5) [4].



Source: Amil et al.[4]

Fig. 5. $PM_{2.5}$ mass concentration subject to World Health Organization (WHO) daily $PM_{2.5}$ guideline and United States Environmental Protection Agency (US EPA) daily $PM_{2.5}$ standard

References

1) Sulong, N.A., Latif, M.T., Khan, M.F., Amil, N., Ashfold, J., Abdul Wahab, M.I., Chan, K.M., Sahani, M., 2017. Source apportionment and health risk assessment among specific age groups during haze and non-haze episodes in Kuala Lumpur, Malaysia. Sci. Total Environ. 601-602, 556-570.
2) Schwartz J., 2000. Harvesting and long term exposure effects in the relation between air pollution and mortality. Am J Epidemiol 2000;151:440-8.
3) Correia A.W., Pope C.A.,Dockery D.W., et al., 2013, Effect of air pollution control on life expectancy in the United States: an analysis of 545 U.S. counties for the period from 2000 to 2007. Epidemiology ,24:23-3.
4) Amil, N., Latif, M.T., Khan, M.F., Mohamad, M., 2016. Seasonal variability of PM2.5 composition and sources in the Klang Valley urban-industrial environment. Atmos. Chem. Phys. 16, 5357-5381.
5) Amil, N., 2016. Characterization and Source Apportionment of Fine Particulate Matter in the Klang Valley Urban Environment. PhD Thesis, Universiti Kebangsaan Malaysia.
6) Pinto, J.P., Lester, D.G., Hartlage, T.A., 1998. Report on U.S. EPA Air Monitoring of Haze from S.E. Asia Biomass Fires. U. S. Environmental Protection Agency, North Carolina.
7) Fujii, Y., Tohno, S., Amil, N. & Latif, M. T. Quantitative Assessment of Source Contributions to PM2.5 on the West Coast of Peninsular Malaysia to Determine the Burden of Indonesian Peatland Fire. Atmospheric Environment. Article in press. doi: 10.1016/j.atmosenv.2017.10.009

This Poster is Prepared by Pakar Scieno TW Sdn. Bhd. for Malaysian Department of Environment.