Air Quality, Atmosphere and Health
https://doi.org/10.1007/s11869-020-00867-x

Air pollution and its health impacts in Malaysia: a review

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Received: 12 January 2020 / Accepted: 30 June 2020

Abstract
Air pollution is strongly tied to climate change. Industrialization and fossil fuel combustion are the main contributors leading to climate change, also being significant sources of air pollution. Malaysia is a developing country with a focus on industrialization. The preference of using private cars is a common practice in Malaysia, resulting in the after-effects of haze and transboundary air pollution. Hence, air pollution has become a severe issue in Malaysia in recent times. Exposure to air pollutants such as ozone and airborne particles is associated with increases in hospital admissions and mortality. For the past few years, the focus of the research is moving towards air quality and the impacts of air pollution on health in Malaysia. In this study, we establish the definition of air pollution, the motivation to study it, and its impacts and sources of air pollution and climate change. We discuss the air quality monitoring system in Malaysia and compare Malaysian ambient air quality standards with global standards. We also look comprehensively on the health impacts of air pollution globally and in the Malaysian context. We discuss where the health impact studies in Malaysia are lacking and what are the gaps in the research. The role of the Malaysian government concerning air pollution and its impacts is discussed. Lastly, we look into the future work and research opportunities with a focus on engineering, estimation, predictive models and lack of research projects.

Keywords Air pollution · Health · Air quality · Haze · Climate change

Introduction

Air pollution is the driving force behind climate change, and it is considered to be one of the biggest environmental challenges faced by humanity in the twenty-first century (Matson 2001). The primary motivation behind air pollution studies is the health impacts involving air pollution. The air pollution has severe and harmful effect on health, and it has become a serious global threat to human health and welfare (Kampa and Castanas 2008). Ninety-two percent of the world's population breathes dirty air, and which has caused 6.5 million deaths worldwide (11.6% of all global deaths) (WHO 2016a). Numerous cardiovascular and respiratory diseases caused by air pollution contribute enormously to loss of life. Cardiovascular diseases (CVD) are the leading cause of deaths worldwide. As estimated, 17.9 million die due to CVD each year, which amounts to 31% of all deaths. Similarly, CVDs are the leading cause of death in Malaysia with a mortality rate of 35% (WHO 2016b). Air pollution and CVD are highly linked as 60–80% of air pollution–related deaths are due to CVD (WHO 2017).

Figure 1 shows the health effects of air pollution, especially ground-level ozone and fine particles in the form of a pyramid, highlighting the magnitude and severity of these effects. This pyramid is provided by the Benefits Mapping and Analysis Program (BenMAP) by the United States Environmental Protection Agency (EPA) (EPA 2020b). The "pyramid of effects" shows how pollutants are related to incidence and severity. At the bottom, asthma attacks and cardiac effects are less severe and affect a larger population. Towards the tip of the pyramid, heart attacks and hospital admissions are more severe and affect a smaller proportion of the population.

Another motivation for studying air pollution and its health impacts is the annual monetary value of health burden. Global examples of economic burden state that the

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Published online: 22 July 2020