

News Article for RISUD Strategic Focus Area (SFA) Scheme

	Name	Department
1. Principal Investigator:	<u>Prof. Hai Guo</u>	<u>CEE</u>
2. Name of SFA:	<u>Urban Air Pollution and Health</u>	
3. Project Title:	<u>Urbanization and Atmospheric Air Pollution: Anthropogenic Processes and Human Exposure/Health</u>	

4. **Third Year Progress/Achievement**

Due to rapid urbanization in East Asia, Hong Kong has been facing severe air pollution for a long period. Air pollution and the health problems caused by it have caused great public concern. To fulfill the mission of “To create innovative solutions to problems generated by high-density urban development through multi-disciplinary, collaborative research”, Research Institute for Sustainable Urban Development (RISUD) funded the project “Urbanization and Atmospheric Air Pollution: Anthropogenic Processes and Human Exposure/Health”, which aimed to understand the primary and secondary air pollutants in Hong Kong and the health effects caused by exposures to these pollutants. The project was kicked off in January 2018 and should be ended in December 2020. However, due to the social unrest in 2019 and the outbreak of COVID-19 in 2020, the project’s work was adversely affected and thus extension to December 2021 was kindly approved by the EXCO committee of the RISUD.

During this (the third) reporting period (January – December 2020), in spite of all the difficulties, satisfactory progresses were made, and significant results were obtained. Through the field campaign in a typical residential apartment of Hong Kong, in-depth data analyses were completed to understand the household air pollution under the high-density urban development and the relationship of indoor air pollution with the outdoors. During the sampling, occupant-related activities, including cooking, candle burning, incense burning, cigarette smoking, cleaning, painting and makeup were designed and carried out. Results showed that the indoor to outdoor ratios were higher than 1 for most of the primary air pollutants, due to emissions of indoor activities. In contrast, many secondary air pollutants exhibited higher concentrations in outdoor air. Among all the indoor activities, painting ranked first in aldehyde emissions, which also caused great enhancement of aromatics. Incense burning had the highest emissions of particle-phase organics, with vanillic acid and syringic acid as markers. The other noteworthy fingerprints included linoleic acid, cholesterol and oleic acid for cooking, 2,5-dimethylfuran, stigmaterol, iso-/anteiso- alkanes and fructose isomers for smoking, C28–C34 even n-alkanes for candle burning, and monoterpenes for the use of air freshener, cleaning agents and camphor oil. In particular, the sources of organic matters (OMs) and their contributions to OMs level were pointed out and concluded. Seven main sources were identified for the emission of OMs, including incense burning, ritual candle burning, cigarette smoking, cooking (3 types), and secondary sulfate and nitrate. During the periods with indoor activity, cooking, incense

burning and cigarette smoking heavily affected the indoor OMs level, while secondary sulfate and nitrate, mainly from outdoor air, was the most important contributor in the periods without indoor activity. In addition, the indoor inhalation health risks were comprehensively evaluated and some new discoveries were identified: (i) nitrogen dioxide (NO₂), hexanal, octanal and benzene likely caused chronic non-cancer health risks to young people, especially infants and children, and the health risks to the hematologic system and immune system occurred in infants under 2 years of age; (ii) acrolein and propionaldehyde might pose health risks to residents of any age or life stage; (iii) there were acute inhalation health risks of acrolein, formaldehyde, NO₂ and benzene in daily life in modern cities; (iv) the total cancer risk encountered in the minor stage was approximately three times that of the working-adult stage (18-60 years of age), and formaldehyde induced the most serious carcinogenic health risk, followed successively by benzene, acetaldehyde, 1,4-dichlorobenzene and ethylbenzene; and (v) after careful deconstruction of the sources of indoor hazardous air pollutants and quantification of their impacts on inhalation health risks to residents, it was found that household background air pollution contributed far more to the total inhalation health risks than the total air pollution caused by all indoor emission-intensive activities. Furthermore, animal experiments were conducted by using mice to understand the neurotoxic effects of maternal exposure to PM_{2.5} on offspring. Results indicated that PM_{2.5} was a risk factor for developing autism-like behavior in offspring. Maternal exposure to PM_{2.5} impaired working memory and increased in repetitive behavior in both male and female offspring mice. In contrast, impairment in spatial recognition memory and social novelty was only observed in female offspring mice.

Apart from the above experimental results and analyses, the project team submitted five proposals for grant application. Two of them were successful. One failed and the other two were pending. To broadcast the findings to the research community, five publications were generated from the project in this reporting period, with acknowledgement to the financial support from RISUD. Six manuscripts were under submission, and four manuscripts were in preparation. The project enhanced the inter-/multi-disciplinary collaboration among the investigators of different fields, and at the same time, contributed to the development/impact of RISUD.