News Article for RISUD Strategic Focus Area (SFA) Scheme

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

4. **First/Second/Third Year Progress/Achievement (***in layman's language, no more than two A4 pages, pls attach a few figures***)**

Urban air pollution has long been a serious concern for its impact on human health and the other negative effects. It ranks the fourth among all the factors causing premature deaths globally. With the development of human society, air pollution is changing from time to time, and so is the health implication. In the fast-developing Hong Kong, an updated understanding of urban air pollution and health is necessary, hence the motivation of the project. We focus on the anthropogenic processes responsible for human exposure to urban air pollution and the associated health effects.

The achievements of the project are multifaceted. First, with the application of online mass spectrometry, we improved the time and species resolutions of organic aerosol (OA) measurement. For the first time, a Thermal desorption Aerosol Gas chromatograph – Time of Flight – Mass Spectrometer (TAG-ToF-MS) and a High Resolution – Time of Flight – Aerosol Mass Spectrometer (HR-ToF-AMS) have been applied jointly at roadside, urban and urban background sites. It was striking that cooking played an equally important role as vehicle emissions in constituting OA even at a roadside site in downtown Hong Kong. Secondary OA (SOA) at the roadside site was at a high oxidation state, challenging our conventional understanding that roadside air pollution is dominated by fresh emissions. In the urban atmosphere, we found that anthropogenic SOA derived from aromatics overwhelmed biogenic SOA, even in the summer. Interestingly, the burning of offerings in funeral parlors at Hung Hom significantly elevated the ambient levels of polycyclic aromatics hydrocarbons in the nearby downwind area, which might increase the health risks of the air exposure. With the in-situ measurement of OA molecular markers by TAG, we made a breakthrough in determining the dynamic contributions of unambiguous OA sources. The time-resolved indicative data also allowed to track the rapid changes in atmospheric chemistry throughout transient pollution events that are common in Hong Kong (Figure 1). Overall, the understandings of dynamic processes responsible for atmospheric OA pollution were enhanced in this project.

Second, we have kept an eye on indoor air pollution and focused on organics in this project. Common household activities were performed in an apartment at normal frequency and intensity to mimic real daily life. The emission characteristics and sources of a broad spectrum of air pollutants were revealed. We constructed the emission profiles of speciated particulate organics for high-emission indoor activities (Figure 2), which to our knowledge were the most chemically comprehensive profiles in Hong Kong to date. The specific fingerprints, such as 2,5-dimethylfuran, iso-/anteiso-alkanes and fructose for smoking, and monoterpenes for air freshener and cleaning, will be important references for source identification of indoor air pollution for future studies. Moreover, we uncovered efficient chemical aging of unsaturated fatty acids emitted by cooking in the apartment, although ozone (the main suspected oxidant) was at low levels (<15 ppbv). It highlighted the importance of heterogeneous chemistry in indoor environment that we knew little about. While the decay of most air pollutants was fast, we identified potential carryover and/or reemission for some organic compounds emitted from smoking and incense burning. Therefore, high-emission activities must be managed properly in enclosed environment, especially for those whose emissions are persistent and toxic.

Third, the health risks of urban air pollution were assessed based on empirical estimation, epidemiological analysis and toxicological study. In an ordinary apartment, non-carcinogenic health risks were caused by propanal, acrolein and nitrogen dioxide, and respiratory system was the most susceptible endpoint (Figure 3). Some household activities led to acute health risks, due to the markedly increased formaldehyde concentrations. Formaldehyde was also the number one carcinogen, which caused definite cancer risk and contributed >80% of the total risks. It is worth noting that young people were the most vulnerable group to all the health risk. Regarding ambient air pollution, epidemiological evidences pointed to increased risks of heart failure due to alkyne and benzene exposure. Long-term exposure to fine particulate matters ($PM_{2.5}$) might increase the ischemic heart disease mortality for patients with chronic kidney disease. From a toxicological point of view, we found that maternal exposure to $PM_{2.5}$ could induce neuroinflammation in offspring brain and hamper neurodevelopment. Sub-chronic exposure to low levels of traffic related inhalable suspended particulates led to significant inflammatory response in the lung of mice. Therefore, the health risks of traffic emissions should be considered when planning roads and residential buildings.

The project updated our understanding of urban air pollution in Hong Kong, especially organic compounds, and provided new evidences for the associated health effects. It also strengthened multidisciplinary collaboration involving the expertise in at least atmospheric chemistry, indoor air quality research, epidemiology and environmental toxicology. Significant synergy with other research activities was achieved. As an important outcome of this project, we won an RGC/CRF grant, extending the research to health risks of airborne pathogens (Figure 4). Dozens of high-quality papers were generated from the project, and the financial support of RISUD was acknowledged. Therefore, the project contributed to the development and impact of the institute.

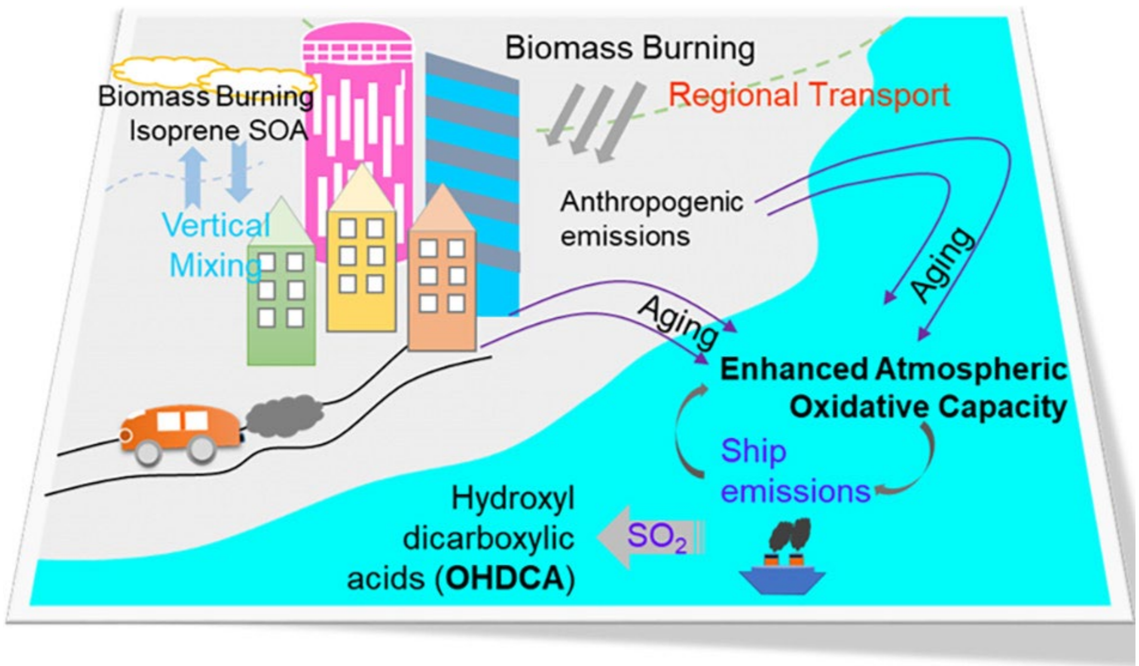

Figure 1. A conceptual model illustrating the main factors accounting for OA pollution at an urban background site in Hong Kong.

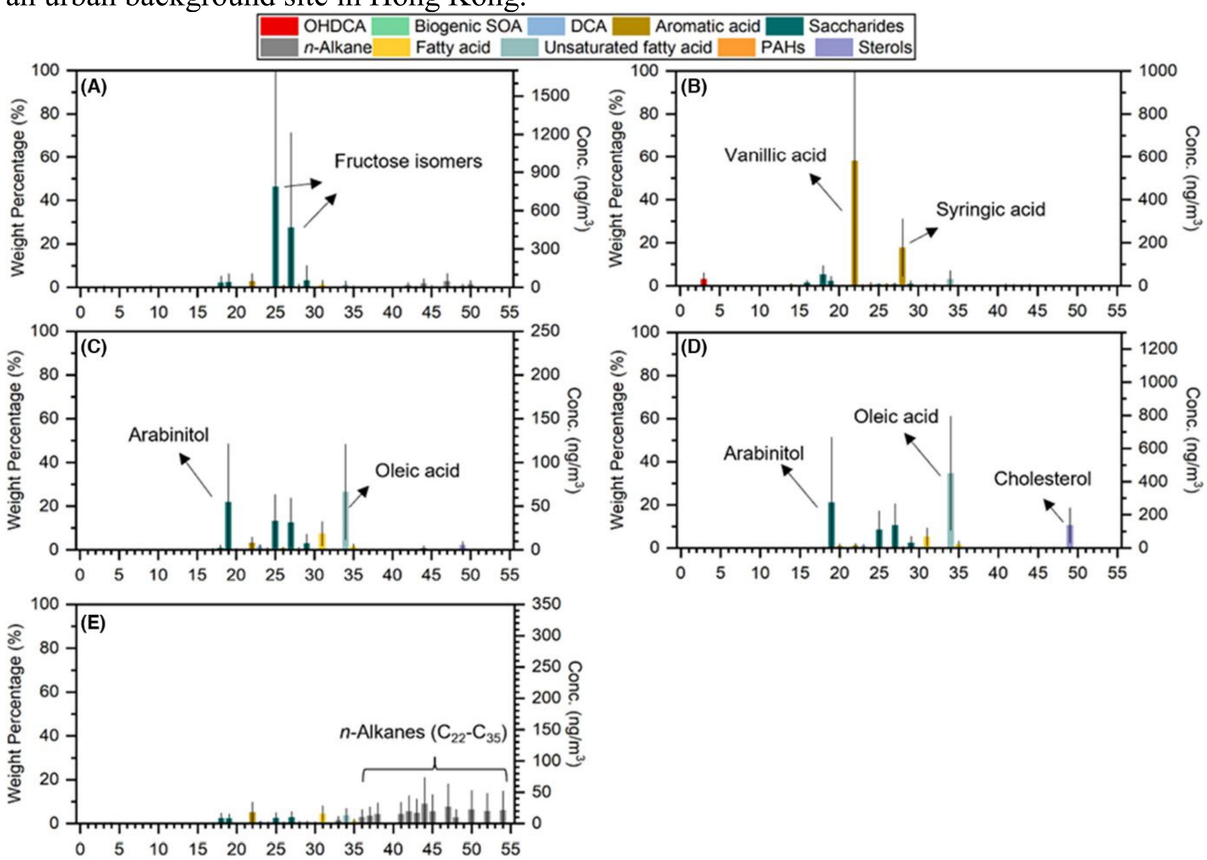

Figure 2. Emission profiles of particulate organics for cigarette smoking (A), incense burning (B), cooking-1 (C), cooking-2 (D), and ritual candle burning (E).

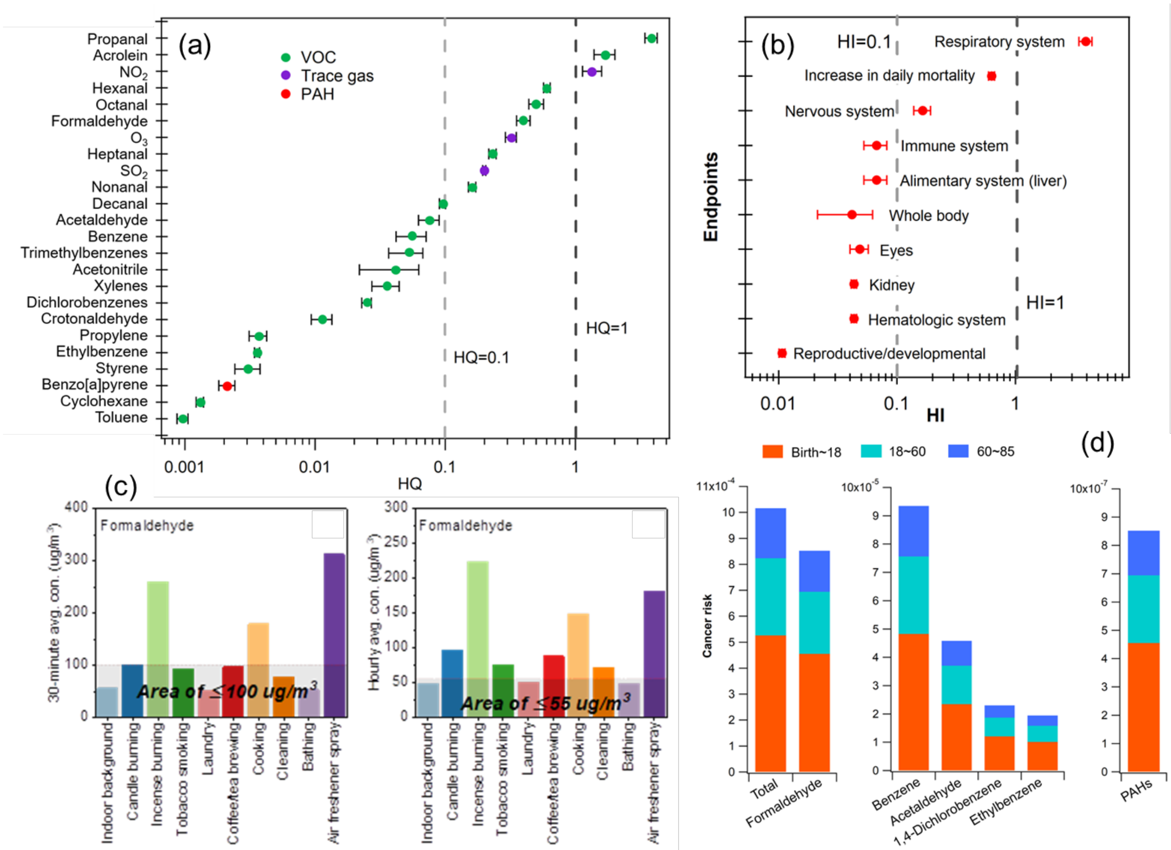

Figure 3. Health risks of indoor air pollutants assessed for an ordinary apartment using empirical methods.

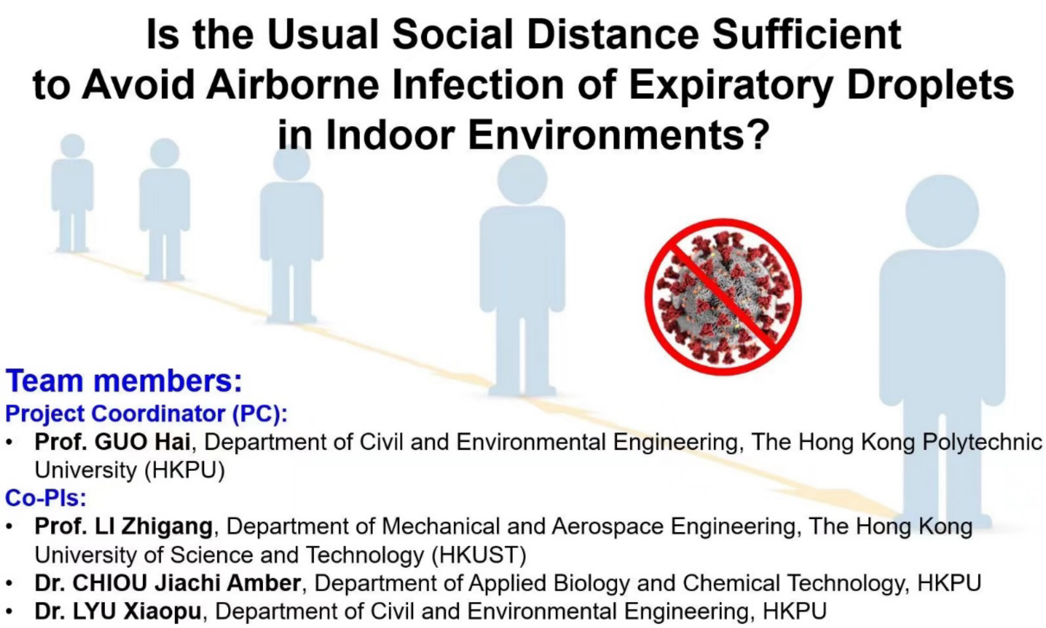

Figure 4. Title page information for a funded RGC/CRF partially as an outcome of this project.