(Revised 07/09)

RGC Ref.: N_PolyU556/11 NSFC Ref. : 41161160561
(please insert ref. above)

NSFC/RGC Joint Research Scheme
Joint Completion Report

(Please attach a copy of the completion report submitted to the NSFC by the Mainland researcher)

Part A: The Project and Investigator(s)

1. Project Title

Air-surface exchange of persistent organic pollutants (POPs) and heavy metals (HMs) in peri-urban agricultural ecosystems of the Pearl River Delta, South China

2. Investigator(s) and Academic Department/Units Involved

	Hong Kong Team	Mainland Team
Name of Principal Investigator *(with title)*	Prof. Xiang-dong Li	Prof. Gan Zhang
Post	Professor	Research Professor
Unit / Department / Institution	Civil & Environmental Engineering/Hong Kong PolyU	Guangzhou Institute of Geochemistry, Chinese Academy of Sciences
Co-investigator(s) *(with title)*		

3. Project Duration

	Original	Revised	Date of RGC/ Institution Approval *(must be quoted*)
Project Start date	01-JAN-2012		
Project Completion date	31-DEC-2014		
Duration *(in month)*	36 months		

Part B: The Completion Report

5. Project Objectives

5.1 Objectives as per original application

1. To investigate the seasonal variations and dynamics of the atmospheric deposition and diffusive air-surface exchange of OCPs (DDTs, HCHs) and BFRs (PBDEs, HBCD, and TBBPA) in peri-urban rice paddy fields of the Pearl River Delta, south China;

2. To study the influence from rice culture practices on the air-surface exchange of the target organic compounds in the paddy fields of a subtropical region; and

3. To calculate the budget of DDTs, HCHs, PBDEs, HBCD, TBBPA, and selected metal pollutants in the paddy fields, and to assess the overall net accumulation or emissions of these chemicals, and their implications on soil quality and food safety.

5.2 Revised Objectives

Date of approval from the RGC: _____

Reasons for the change: _____

_____

1.
2.
3. ....

6. Research Outcome

Major findings and research outcome
(maximum 1 page; please make reference to Part C where necessary)

PAHs, PCBs and PBDEs are three typical POPs and ubiquitous in the environment. Here, we analyzed PAHs, PCBs, and PBDEs in two seasonal samples collected from a paddy field of the suburban area, Guangzhou. The concentrations, compositions, distribution, and air-surface exchange of PAHs, PCBs, and PBDEs were investigated in the paddy field, as well as the effects of rice on the exchange trend of POPs among the different environmental compartments. The difference of the results from the new designed fugacity sampler and the results from fugacity model were also fully studied in this project. The results are of great significance on evaluating the influence of paddy field ecosystems on the transfer and environmental fate of POPs in South China or other subtropical regions.

Total 23 soil samples, 22 paddy samples, 40 air samples, and 8 water samples collected from paddy field of Guangzhou suburban area were analyzed for PAHs, PCBs, and PBDEs. The results showed that the concentrations of PAHs, PCBs and PBDEs were 563 ng/g, 0.660 ng/g, and 0.235 ng/g in the surface soils, respectively. The concentrations of PAHs, PCBs, and PBDEs in surface soils decrease with rice growth period. The PAH and PCB concentrations in irrigation water were much higher than those in field water, suggesting that the irrigation was an important source for POPs into paddy field. PAHs and PCBs in the air gaseous phase were 57.6 ng/m^3, 0.173 ng/m^3 during day and 101 ng/m^3,0.140 ng/m^3 during night. PAHs in paddy shoots were mostly from atmospheric particle deposition, while PCBs in paddy shoots were mainly from foliar uptake from gaseous phase. Meanwhile, PAHs and PCBs in paddy roots came mostly from the adsorption or absorption by root surface from field water.

PAH concentrations were higher in the passive air samples above the canopy in the first half year, but higher in the samples below the canopy in the next half year. However, PCBs were always higher in the samples below the canopy in the whole year, especially for the low chlorine PCBs, suggesting that the evaporation was dominant for PCBs. The transfer of PAHs was mainly affected by the variations of environmental sources. The average PAH concentration of nine fugacity samples above the canopy was higher than that under the canopy, while the average PCB concentration of fugacity samples under the canopy was higher. The transfer trends of PAHs and PCBs varied with the growth of rice plant, especially for the low molecular weight PAH and PCB congeners. This implied that the growth of paddy can significant affect the transfer or exchange of POPs in paddy fields. In summary, the transfer of PAHs was influenced by new environmental sources, while the transfer of PCBs was always from paddy field to air. The estimated transfer trends using fugacity model were different with the observed trends using the new designed fugacity samplers, suggesting that fugacity sampler can obtain more accurate results than the modeled data.

Potential for further development of the research and the proposed course of action
(maximum half a page)

The degradation study: ^{13}C-labbled BDE-209, HBCD, and TBBPA will be spiked in soil collected from the paddy fields. The spiked soil will be put into a glass container, capped with PUF plugs, and exposed in the field. Water will be added, and

subsequently drained to/from the glass container in accordance with the normal practice of rice cultivation, and a new PUF plug will be used after each wet/dry cycle. The soil, PUF plugs, and water samples will be analysed for isotopically labeled BFRs, and a mass balance of ^{13}C-labbled compounds will be calculated at each sampling time. The apparent degradation rates of selected BFRs in soil will be derived based on the experimental results.

The accumulation rate and potential environmental risks of the targeted chemicals in the peri-urban agricultural ecosystems of south China will be evaluated. The data will also contribute to the understanding of the role played by paddy fields on the cycling of these chemicals in regional and global scales.

7. The Layman's Summary

(describe in layman's language the nature, significance and value of the research project, in no more than 200 words)

Persistent organic pollutants (POPs) are chemicals toxic to humans and wildlife. They are able to stay in the environment from months to decades, and can be distributed among different environmental media. The accumulation of POPs and heavy metals (HMs) in agricultural soils can lead to deterioration in soil quality; this, in turn, could post a threat to food safety and human health. A peri-urban agricultural ecosystem is susceptible to the receipt of large amounts of toxic chemicals from intensive human activities in nearby cities. However, little is known of the accumulation rates and fate of typical POPs in peri-urban agricultural eco-systems, where intensive industrialization and urbanization are taking place. This is particularly the case with regard to rice paddy fields, which occupy a vast land area in Asian developing countries. In this research project, we have studied the air deposition exchange fluxes in typical paddy fields using a combination of innovative field sampling programmes and laboratory modelling experiments. The outcome of the project contributes to a better understanding of the biogeochemical processes and dynamics of POPs in peri-urban paddy ecosystems of a subtropical region, and their potential impact on the global fate of these chemicals.

Part C: Research Output

8. Peer-reviewed journal publication(s) arising directly from this research project

(Please attach a copy of each publication and/or the letter of acceptance if not yet submitted in the previous progress report(s). All listed publications must acknowledge RGC's funding support by quoting the specific grant reference.))

The Latest Status of Publications				Author(s) *(**bold** the authors belonging to the project teams and denote the corresponding author with an asterisk*)*	Title and Journal/Book *(with the volume, pages and other necessary publishing details specified)*	Submitted to RGC *(indicate the year ending of the relevant progress report)*	Attached to this report *(Yes or No)*	Acknowledged the support of this Joint Research Scheme *(Yes or No)*
Year of publication	Year of Acceptance *(For paper accepted but not yet published)*	Under Review	Under Preparation *(optional)*					
2013				Liu, F.B., Xu, Y., Liu, J.W., Liu, D., Li, J., Zhang, G., Li, X.D., Zou, S.C., Lai, S.C.	Atmospheric deposition of polycyclic aromatic hydrocarbons (PAHs) to a coastal site of Hong Kong, South China. *Atmospheric Environment*, 69, 265-272		Yes	Yes
2014				Cheng, Z.; Wang, Y.; Wang, S.; Luo, C.; Li, J.; Chaemfa, C.; Jiang, H.; Zhang, G.,	The influence of land use on the concentration and vertical distribution of PBDEs in soils of an e-waste recycling region of South China. *Environ. Pollut*. 191, 126-131.		Yes	Yes (PI has acknowledged for the NSFC Ref. 41161160561 and missed to acknowledged RGC Ref. N_PolyU556/11)
2014				Wang, Y.; Wang, S.; Luo, C.; Xu, Y.; Pan, S.; Li, J.; Ming, L.; Zhang, G.; Li, X.D.	Influence of rice growth on the fate of polycyclic aromatic hydrocarbons in a subtropical paddy field: A life cycle study. *Chemosphere* 2015, 119, 1233-1239.		Yes	Yes

2015				Wang, Y.; Luo, C.; Wang, S.; Liu, J.; Pan, S.; Li, J.; Ming, L.; Zhang, G.; Li, X.D.	Assessment of the air-soil partitioning of polycyclic aromatic hydrocarbons in a paddy field using a modified fugacity sampler. *Environ. Sci. Technol* , 49, 284-291.		Yes	Yes
2015				Wang, Y., Li, Q.L., Wang, S.R., Wang, Y.J., Luo, C.L., Li, J., Zhang, G.	Seasonal and diurnal variations of atmospheric PAHs and OCPs in a suburban paddy field, South China: Impacts of meteorological parameters and sources. *Atmospheric Environment*, 112, 208-215.		Yes	Yes (PI has acknowledged for the NSFC Ref. 41161160561 and missed to acknowledged RGC Ref. N_PolyU556/11)
2015				Wang, Y., Wang, S.R., Luo, C.L., Li, J., Ming, L.L., Zhang, G., Li, X.D. 2015.	The effects of rice canopy on the air–soil exchange of polycyclic aromatic hydrocarbons and organochlorine pesticides using paired passive air samplers. *Environmental Pollution*, 200, 35-41.		Yes	Yes

9. Recognized International conference(s) in which paper(s) related to this research project was/were delivered *(Please attach a copy of each delivered paper)*

Month/Year/ Place	Title	Conference Name	Submitted to RGC *(indicate the year ending of the relevant progress report)*	Attached to this report *(Yes or No)*	Acknowledged the support of this Joint Research Scheme *(Yes or No)*
June 2012/Montreal/Canada	Trace metals in atmospheric particular matters over the northern South China Sea (SCS): regional sources and long-range atmospheric transport	Goldschmidt Geochemistry Conference 2012		No	Yes
July 2014/Beijing/China	Influence of rice growth on the environmental fate of polycyclic aromatic hydrocarbons in the paddy field ecosystem of South China	2014 International Symposium on Environment and Health		No	Yes

10. Student(s) trained *(Please attach a copy of the title page of the thesis.)*

Name	Degree registered for	Date of registration	Date of thesis submission/ graduation
Lili Ming	PhD	January 2012	January 2016

11. Other impact *(e.g. award of patents or prizes, collaboration with other research institutions, technology transfer, etc.)*

The project has been conducted in close collaboration with Dr. Gan Zhang of Guangzhou Institute of Geochemistry, Chinese Academy of Sciences. The two research teams have well-coordinated field sampling programmes and laboratory analysis tasks. Regular seminars have been organized among the involved research staff and PhD students.