

Indoor-Outdoor Volatile Organic Compounds (VOCs) Levels in Urban and Industrial Area of Dhaka City, Bangladesh

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**BIDS RESEARCH
ALMANAC**

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Introduction

Volatile Organic Compounds (VOCs)

EU

- Organic compounds
- Vapor pressure greater than 10 Pa at 20°C

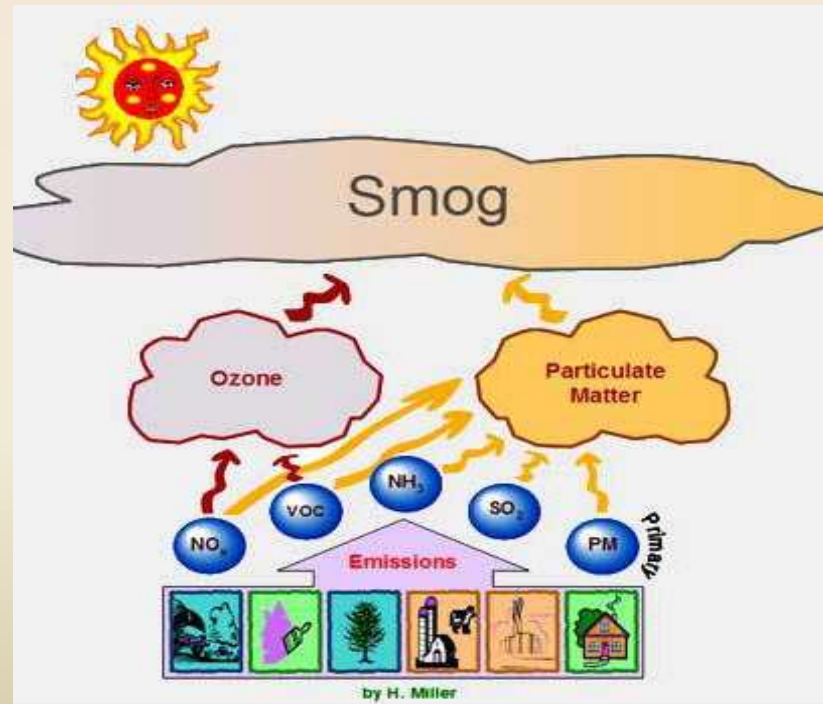
VOCs » impact on **human health** and **global environment**

Health effects

- Indoors
- Outdoors

Environmental effects

- Stratospheric ozone depletion
- Tropospheric ozone formation
- Global warming



Objectives

Main Objective:

To investigate the presence and ambient concentration levels of VOCs in both **indoor** and **outdoor** environment in **urban** and **industrial** areas of **Dhaka** city, Bangladesh

Specific objectives:

- **Comparison** on the **indoor** and **outdoor** VOCs in the **urban** and **industrial** area of **Dhaka city**
 - » **TVOCs, individual group** and **subgroup** of TVOCs, **BTEX and benzene** levels
- Indoor-to-outdoor ratio(I/O)
- Source identification » diagnostic ratios and correlation of coefficients
- Estimation of ozone formation potential of the measured VOCs
- **Comparison with other countries studies**

Materials and Methods

Sampling plan

Two Sampling Campaigns in Dhaka

**Urban
area(Mirpur)**



- 1.House (indoor)**
- 2.Roadside(outdoor)**
- 3.Park(outdoor)**

3 sites/area

**Industrial
area(Tejgaon)**



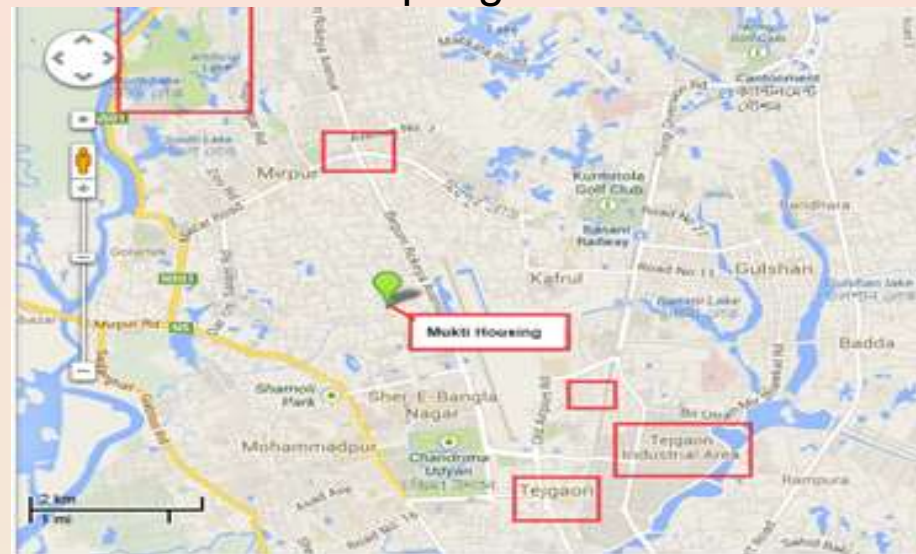
- 1.House (indoor)**
- 2.Roadside(outdoor)**
- 3. Industrial ambient(outdoor)**

- 3 days sampling/site (1 weekend and 2 weekdays)
- 2 times sampling/day-Morning and afternoon at rush hour
- 6 sampling sites with 6 samples/site
- In total 36 samples and 3 blanks
- Roadside sample: heavy traffic

Materials and Methods

- Active sampling: portable pump (Gilair)
- Sorbent: Tenax TA Tube
- Internal Standard: Tol-d₈
- Analysis: TD-GC-MS analysis
- Quantification

Sampling sites



$$C_a = \frac{m_a}{Q \times t} = \frac{m_a}{V}$$

V : volume of sampled air

Q : flow rate of sampling pump = 93mL/min

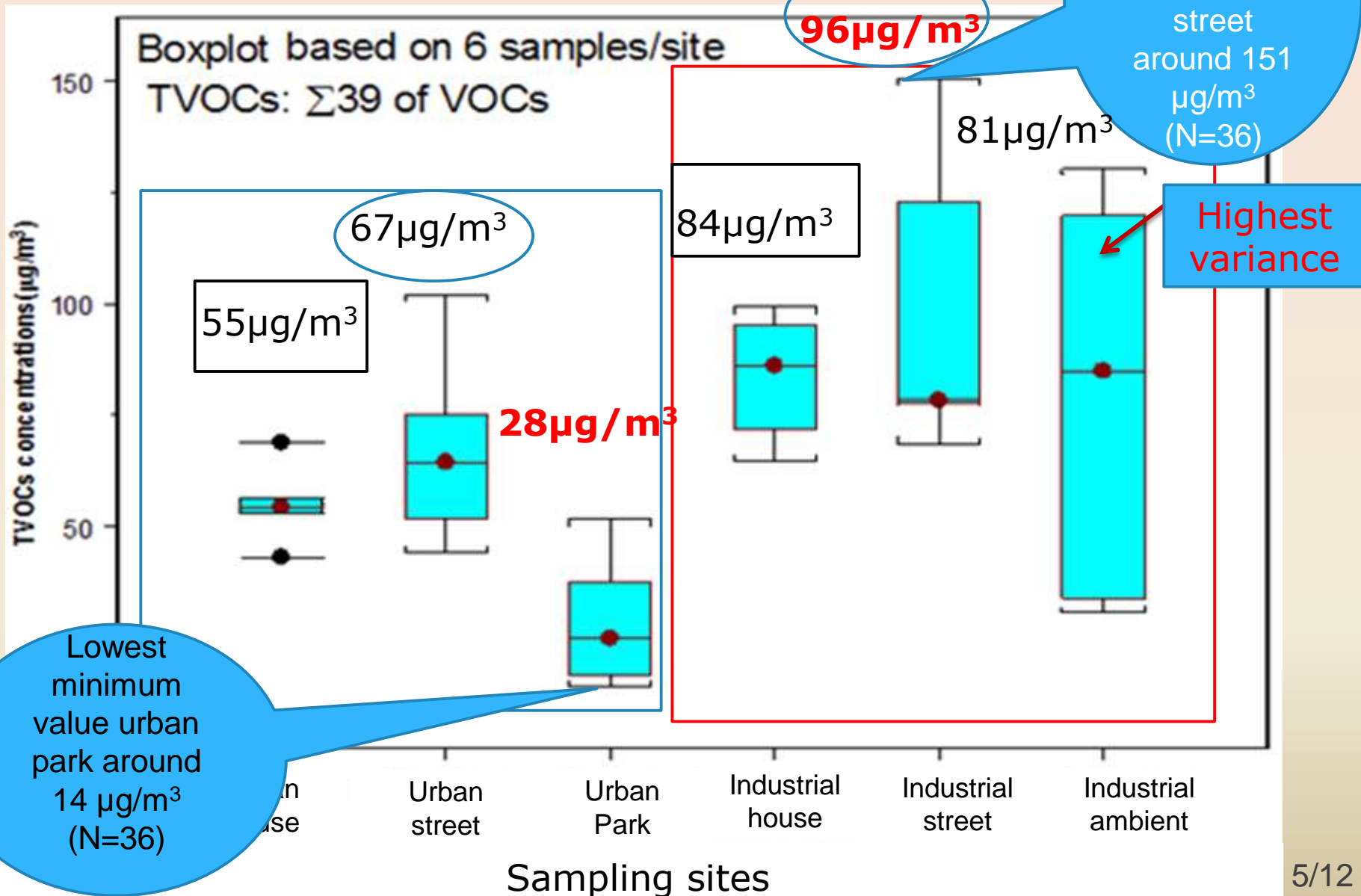
t : sampling time = 30min

C_a: concentration of analyte



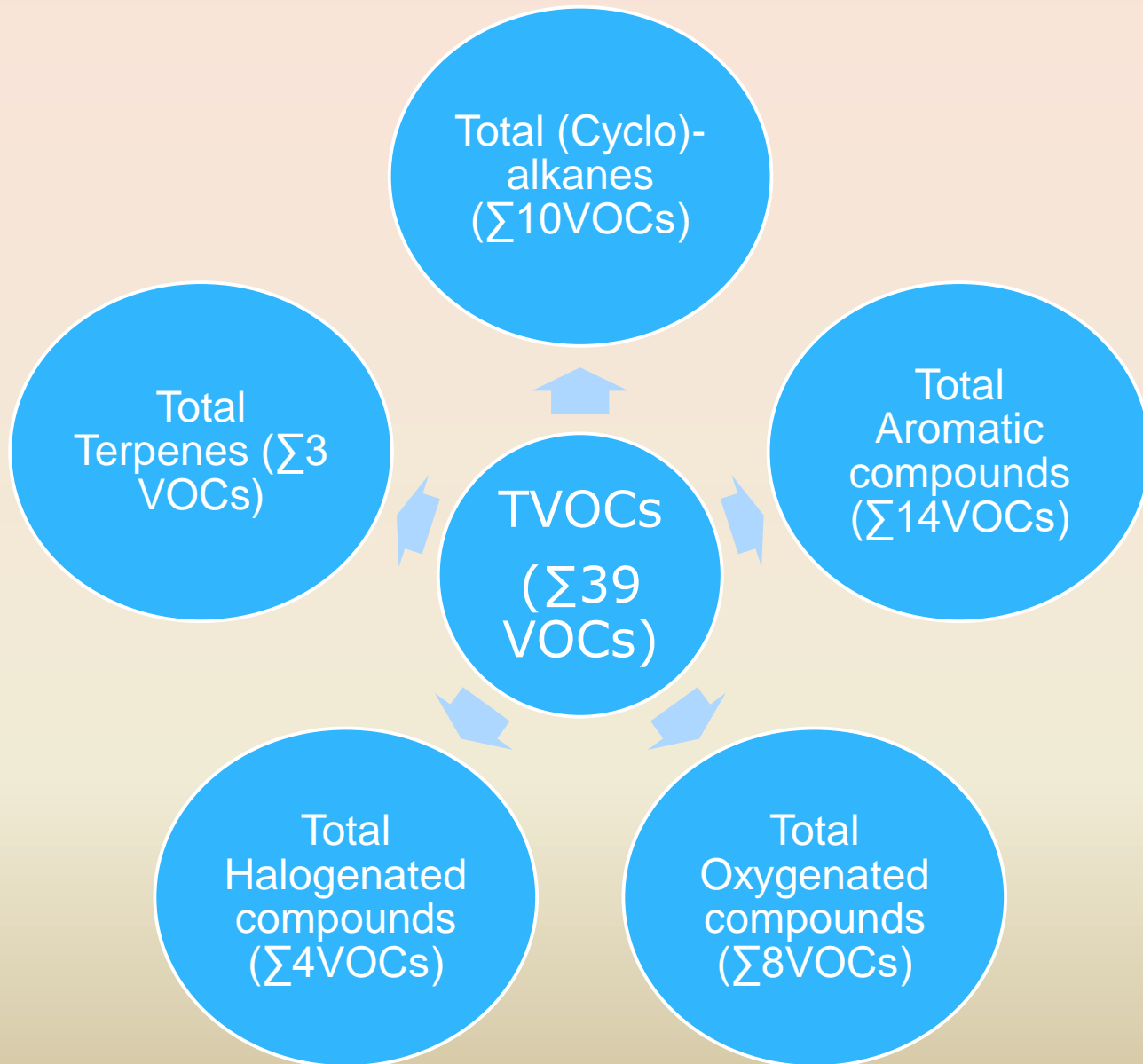
Results and Discussion

Total Volatile Organic Compounds(TVOCs)



Results and Discussion

Total Volatile Organic Compounds (TVOCs) Groups



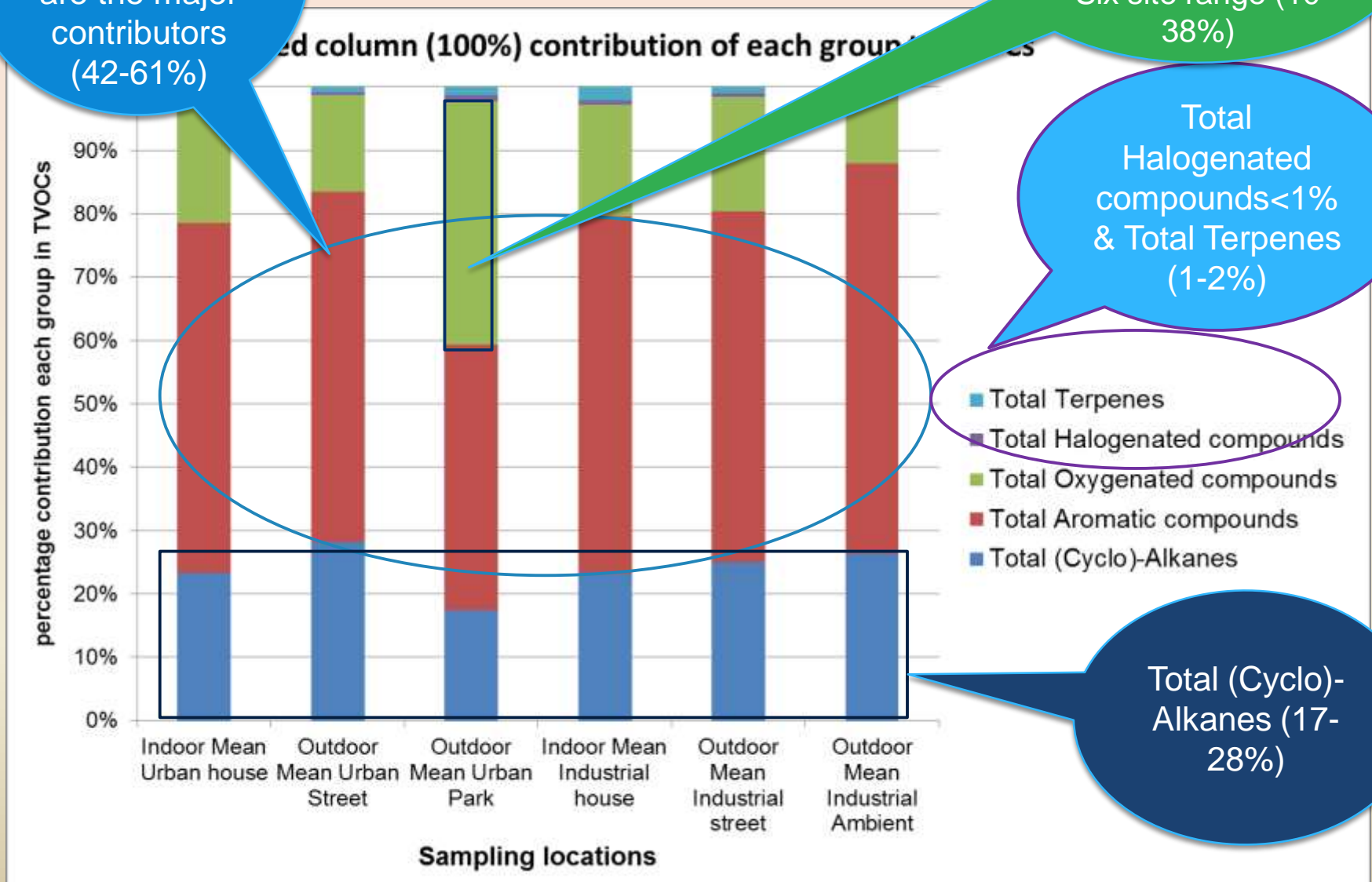
Stacked column (100%) contribution of each group

Total Aromatic compounds are the major contributors (42-61%)

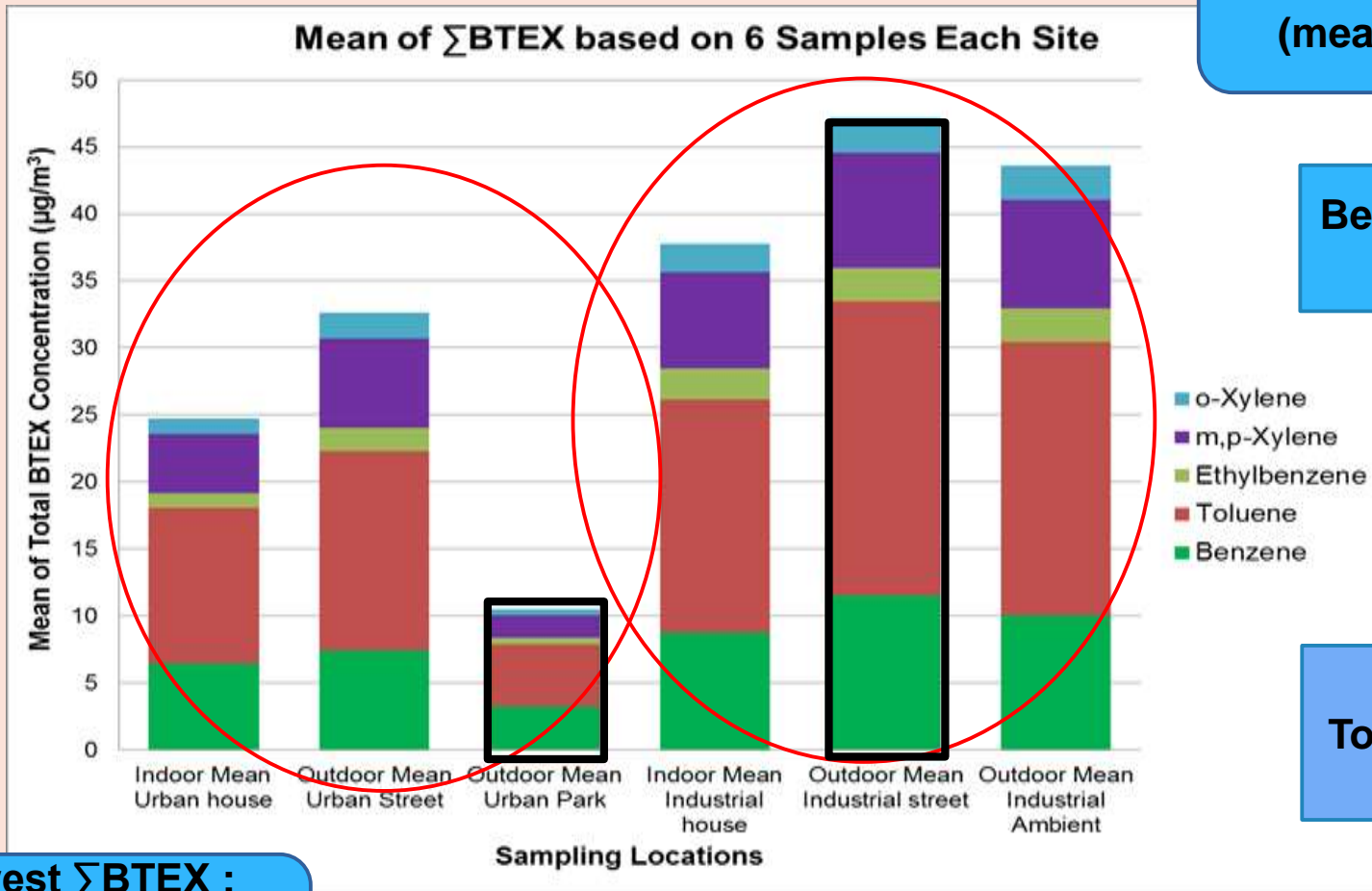
Total Oxygenated compounds are 2nd major contributors in park 38%; Six site range (10-38%)

Total Halogenated compounds <1% & Total Terpenes (1-2%)

Total (Cyclo)-Alkanes (17-28%)



Mean of Total Benzene-Toluene-Ethylbenzene-Xylene (Σ BTEX)



**Highest Σ BTEX:
Industrial Street
(mean:47 $\mu\text{g}/\text{m}^3$)**

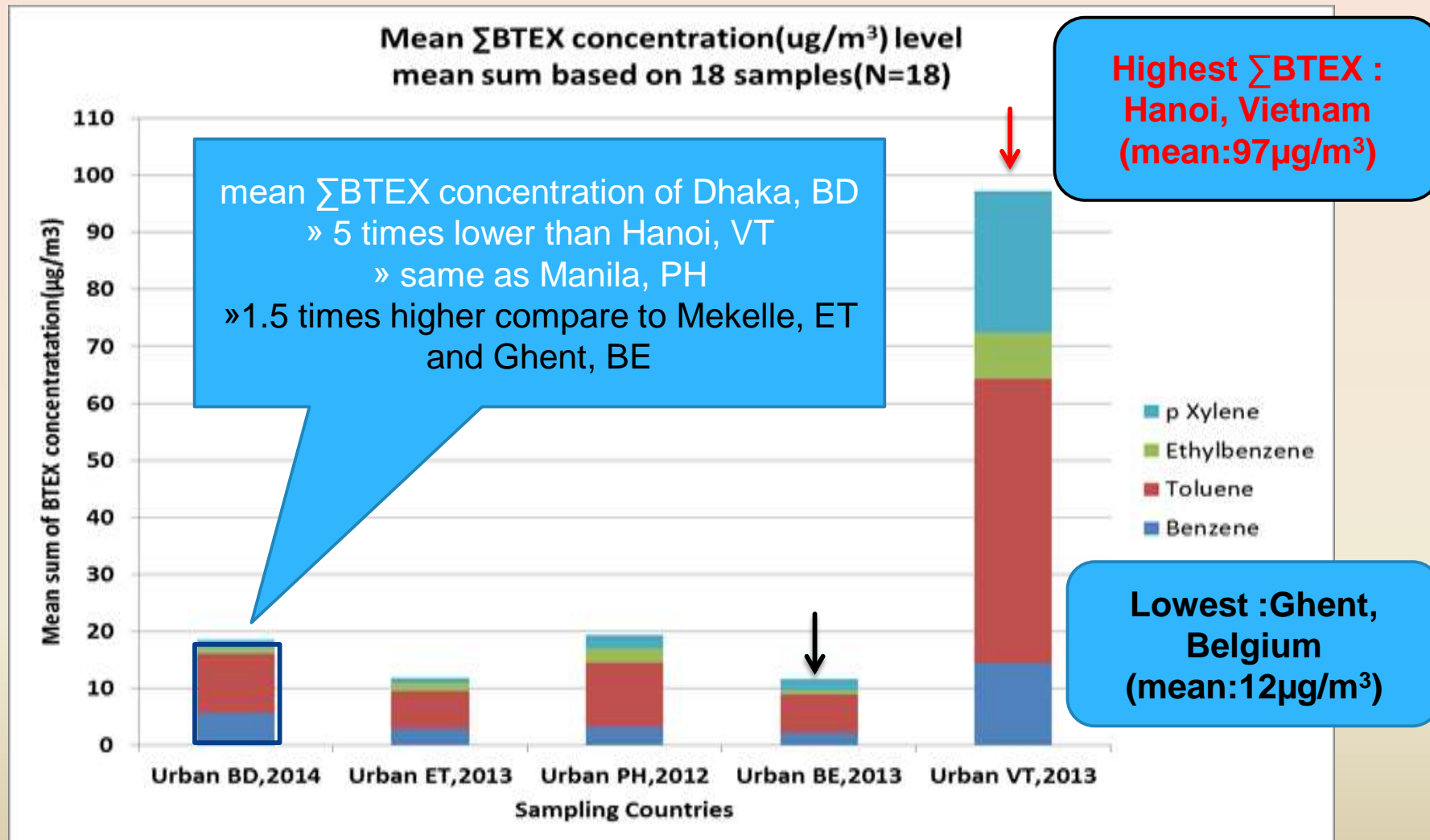
**Benzene : (mean
3-12 $\mu\text{g}/\text{m}^3$)**

**Highest
Toluene : (mean
5-22 $\mu\text{g}/\text{m}^3$)**

**Lowest Σ BTEX :
urban park
(mean:10 $\mu\text{g}/\text{m}^3$)**

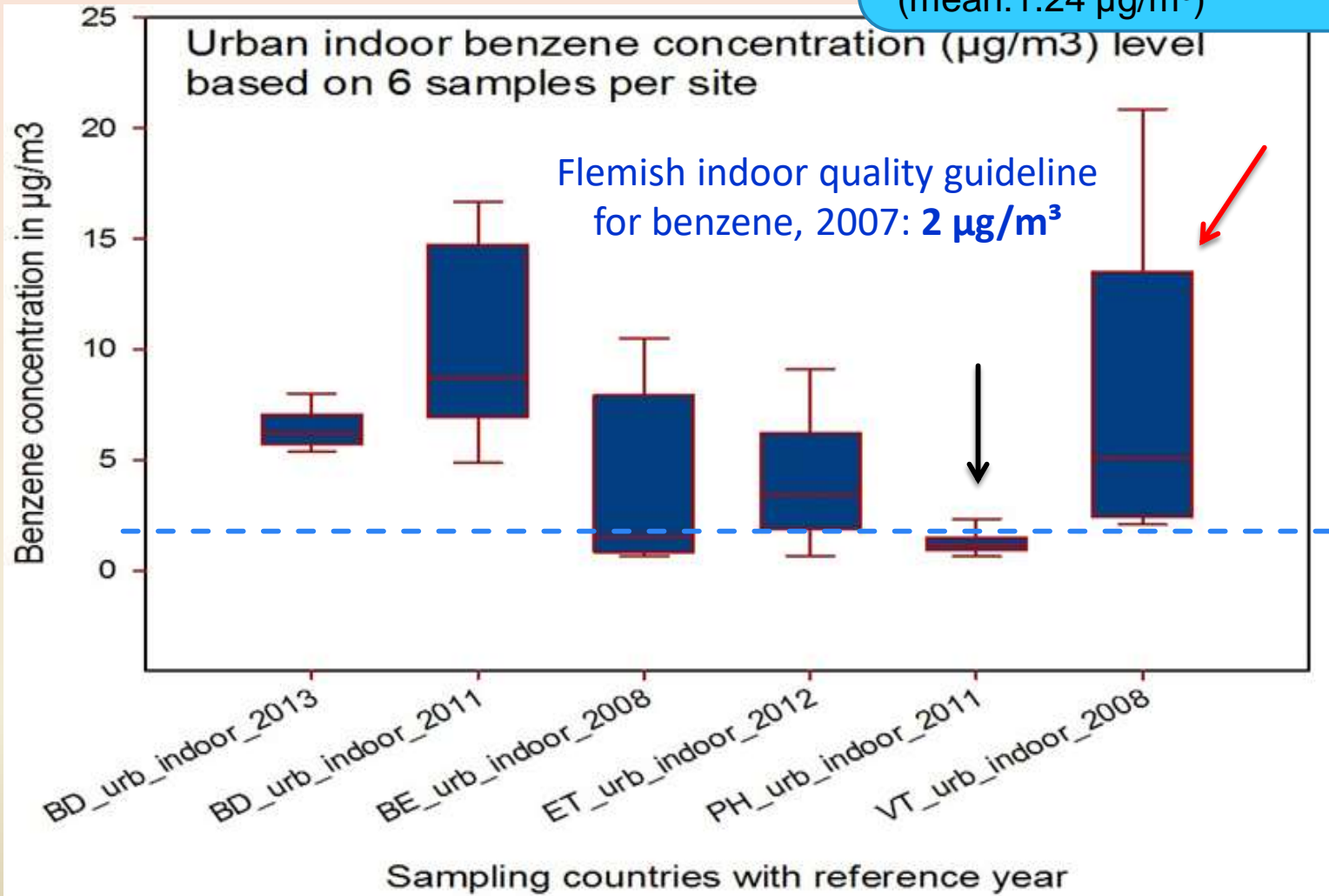
Country level comparison for BTEX in urban area

Benzene-Toluene-Ethylbenzene-Xylene (Σ BTEX)

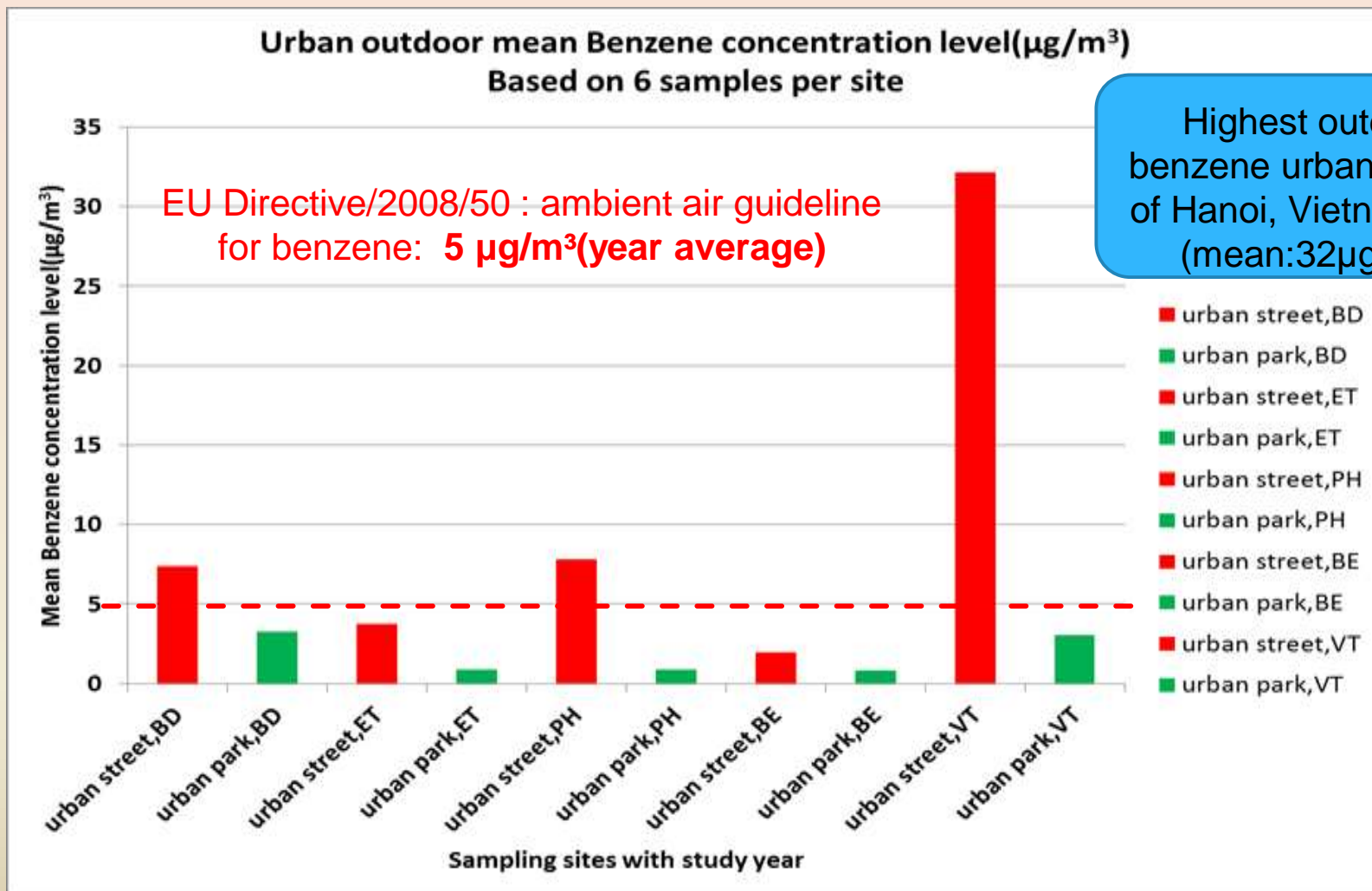


Country level comparison of mean Benzene

Highest indoor benzene: Hanoi, Vietnam (mean: $8\mu\text{g}/\text{m}^3$)
Lowest :Manila, Philippines(PH) (mean: $1.24\mu\text{g}/\text{m}^3$)



Country level comparison of mean Benzene concentration

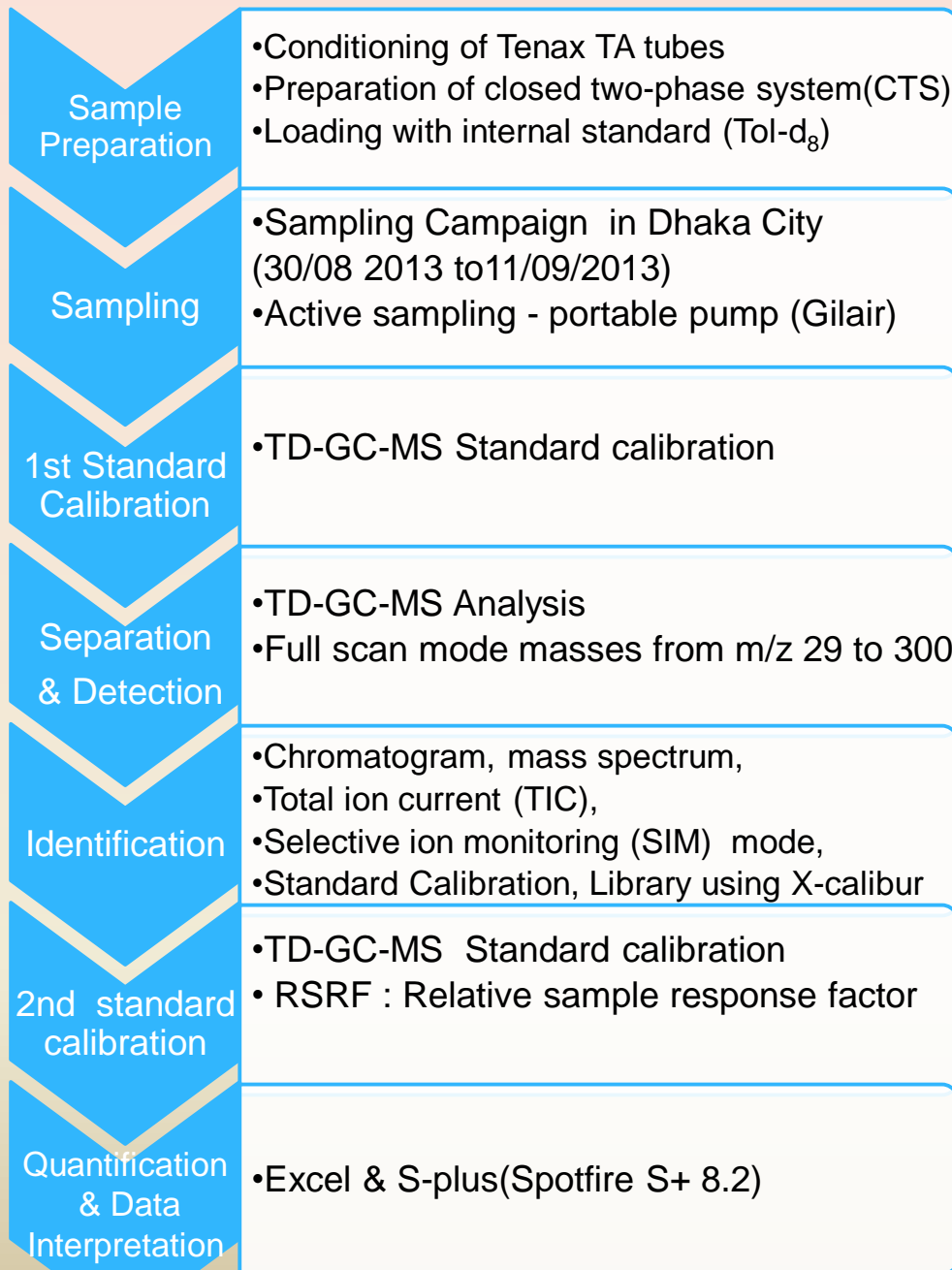


Conclusions and Recommendation

- This study provide information on a spectrum of 39 VOCs concentration levels;
- The differences in concentration profile of VOCs at urban and industrial area in Dhaka were interpreted by TVOCs, BTEX and benzene values;
- The benzene concentration level was higher than the guidance value (indoor: $2\mu\text{g}/\text{m}^3$ and outdoor: $5\mu\text{g}/\text{m}^3$) except urban park;
- Aromatic compounds were the major contributors (42-61%) and Halogenated compounds were minor contributors(<1%);
- Among the countries, the highest $\sum\text{BTEX}$ (mean: $97\mu\text{g}/\text{m}^3$) was measured in Hanoi, Vietnam and the lowest indoor benzene measured in the Manila, Philippines (mean: $1.24\mu\text{g}/\text{m}^3$);
- Further studies concerning more sites and seasonal variations are recommended.

Thank You

Materials and Methods(Extra)



Thermal Desorption-Gas Chromatography-Mass Spectrometry

Materials and Methods(Extra)

Quantification

$$\text{RSRF} = \frac{\text{SRF}_a}{\text{SRF}_{st}}$$

$$\text{RSRF}_{L,L} \approx \text{RSRF}_{G,G}$$
$$= \left(A_a / A_{st} \right) \times \left(m_{st} / m_a \right)$$

$$m_a = \frac{A_a \times m_{st}}{\text{RSRF}_{L,L} \times A_{st}}$$

$$C_a = \frac{m_a}{Q \times t} = \frac{m_a}{V}$$

$\text{RSRF}_{L,L}$: loaded from liquid phase

$\text{RSRF}_{G,G}$: loaded from gas phase

SRF_a : sample response factor of the analyte

SRF_{st} : sample response factor of standard

m_a : mass of analyte

m_{st} : mass of internal standard(Tol-d₈)

A_a : peak area of the analyte

A_{st} : peak area of the internal standard

V : volume of sampled air

Q : flow rate of sampling pump

t : sampling time

C_a : concentration of analyte

Sampling sites(Extra)

Urban Sampling

Industrial Sampling

