Background Concentrations of Polycyclic Aromatic Hydrocarbons and Heavy Metals in Florida Urban Soils

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Abstract

- Polycyclic aromatic hydrocarbons (PAHs) result from phytogenic, petrogenic and pyrogenic sources in the environment. Generally, anthropogenic factors have the most impact on PAH distribution in urban areas, whereas natural factors affect their distribution in remote areas.
- Among all the environmental matrix, soil is the most important sink for PAHs. This is because PAHs are hydrophobic, semi-volatile, readily adsorbed by soil particles, and resist degradation. It has been estimated that ~90% of total residues remain in the soil. In addition, heavy metals are also a problem in soils.
- Heavy metals and PAHs often co-exist in contaminated soils, with different chemical properties, modes of toxicity, and potential for interactions with soils.
- It is unclear when trying to assess the risks associated with mixtures of metals-PAHs.
- This study determined the background concentrations and distributions of PAHs and heavy metals in urban soils in Florida State.

Introduction

- Soil has been identified as the primary reservoir for PAHs in the environment. The major sources of PAHs are anthropogenic and derived from combustion processes.
- PAHs are globally distributed and the highest concentrations generally occur close to urban areas, which. Urban have been impacted by human activity for decades may contribute to higher level of contaminants.
- Soil samples in a city may contain elevated levels of contaminants, such as metals and PAHs that are commonly referred to as "urban background" or "anthropogenic background". Because these contaminants are from urban activity and not specific site releases, and it can be challenging to account for the contribution to urban background in contaminated media.
- This project established a comprehensive soil survey on the background concentrations of PAHs and trace metals in Orlando and Tampa urban soils.

Materials and Methods

- 64 sites in Tampa and 50 sites in Orlando were chosen randomly
- Top 6-inch soil and 3 m × 3 m grid (5 subsamples from four corners and the center to make composite sample)
- 4 photos with 4 directions on the site
- PAHs samples stored in aluminum foil and metals samples stored in polyethylene lined paper bag
- Dry at room temperature and sieved into 10-mesh size particles
- Select 22 PAHs analysis: modified USEPA method 3550C and USEPA method 8270D (Table 1)
- Select metals analysis: modified USEPA method 3050B and USEPA method 6020A

Table 1. Select 22 PAHs for determination in Florida urban soils

PAHs	Type	Diagnostic ion
Decafluorobiphenyl (DF)	Surrogate	334
Naphthalene (NA)	Non-carcinogenic	128
Acenaphthylene (ACY)	Non-carcinogenic	152
Acenaphthene (ACE)	Non-carcinogenic	153
Fluorene (FL)	Non-carcinogenic	166
Phenanthrene (PH)	Non-carcinogenic	178
Anthracene (ANC)	Non-carcinogenic	178
o- Terphenyl (TE)	Surrogate	230
Fluoranthene (FLA)	Non-carcinogenic	202
Pyrene (PY)	Non-carcinogenic	202
Benzo[c]fluorene, 7H- (BcF)	Non carcinogenic	216
Benzo[a]anthracene (BaA)	Carcinogenic	228
Chrysene (CH)	Carcinogenic	228
6-Methylchrysene (Me)	Surrogate	242
Benzo[b]fluoranthene (BbF)	Carcinogenic	252
Benzo[k]fluoranthene (BkF)	Carcinogenic	252
Benzo[a]pyrene (BaP)	Carcinogenic	252
Perylene-d12 (PE)	Surrogate	264
Indeno[1,2,3-cd]pyrene (IP)	Carcinogenic	276
Dibenz[a,h]anthracene (DhA)	Carcinogenic	278
Benzo[g,h,i]perylene (BP)	Non-carcinogenic	276
Anthanthrene (AN)	New carcinogenic	276
Dibenzo[a,e]pyrene (DeP)	New non-carcinogenic	302
Dibenzo[a,l]pyrene (DlP)	New carcinogenic	302
Dibenzo[a,i]pyrene (DiP)	New non-carcinogenic	302
Dibenzo[a,h]pyrene (DhP)	New non-carcinogenic	302

Results and Conclusions

- **Orlando**: Benzo(a)pyrene (BaP) equivalent concentration in 60% samples were higher than residential Florida soil cleanup target level (FSCTL) and 20% samples were higher than industrial/commercial FSCTL in soil samples; **Tampa**: BaP-eq concentration in 62.5% samples are higher than residential FSCTL and 25% samples are higher than industrial/commercial FSCTL (Figure 1 & 2).
- Tampa soils had relatively higher PAHs concentrations than Orlando soils. Both cities' soils were dominated by high molecular weight PAHs (Figure 3 & 4).
- All trace metals concentrations were lower than corresponding FSCTLs except one Tampa sample's Ba concentration (Figure 5 & 6).
- No correlations were found between metal and PAHs, only V-Ni had a strong correlation in both Orlando and Tampa soils.
- Major sources of PAHs in both cities based on molecular diagnostic ratios were the same: pyrogenic, petrol emissions, traffic emissions, and grass, wood, and coal combustion (Figure 7 & 8).
- GIS maps showed the concentration of PAHs in central business district and the areas near high traffic roads were significantly higher than the other areas in both cities (Figure 9 & 10).

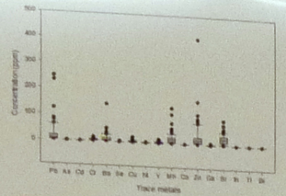

Figure 5. Trace metals concentrations in 64 Tampa urban soils

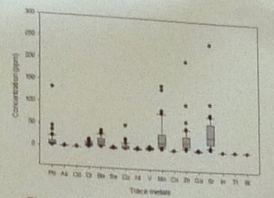

Figure 6. Trace metals concentrations in 50 Orlando urban soils

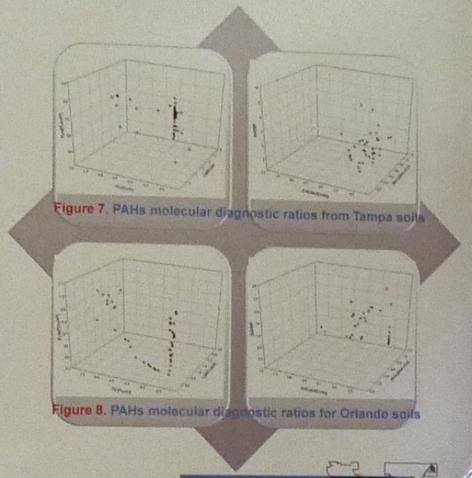

Figure 7. PAHs molecular diagnostic ratios from Tampa soils

Figure 8. PAHs molecular diagnostic ratios for Orlando soils

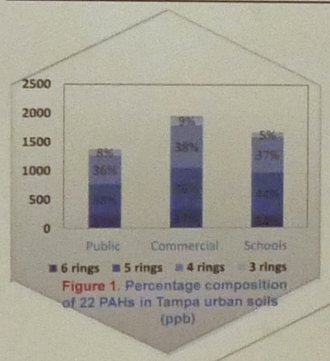

Figure 1. Percentage composition of 22 PAHs in Tampa urban soils (ppb)

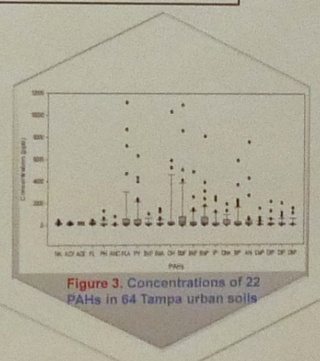

Figure 3. Concentrations of 22 PAHs in 64 Tampa urban soils

Figure 9. BaP equivalent distributions

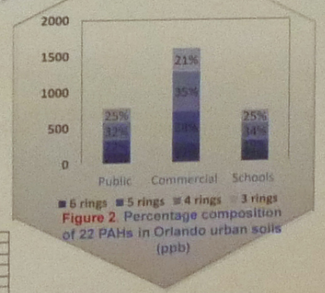

Figure 2. Percentage composition of 22 PAHs in Orlando urban soils (ppb)

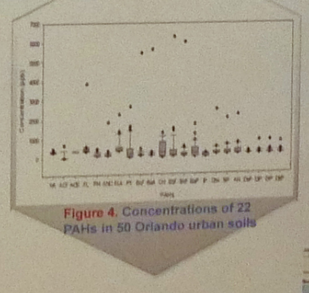

Figure 4. Concentrations of 22 PAHs in 50 Orlando urban soils

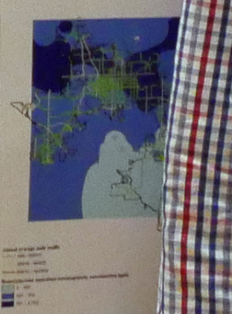

Figure 10. BaP equivalent distribut

Acknowledgements

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