Passive sampling devices (PSDs) and GC-MS screening tools to assess a suite of 1,000 contaminants in agricultural areas in Western Africa

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BACKGROUND

Organizations and developing countries that attempt to assess pesticides and other environmental contaminants face many challenges of how to measure them, such as, the remoteness of sites and subsequently the difficulty of transportation and stability of chemicals in samples from these sites. The Sahel region of Western Africa has many highly engineered agriculture-based irrigated systems that generally have three cropping cycles per year.

The need to assess changes in contaminants at these sites requires tools that can characterize contaminants at high spatial and temporal resolution. Modification of farming pest management practices face the challenge of how to measure success; how to assess the changes in bioavailability of contaminants. They need quantitative tools that can characterize contaminants and predict their risk to local organisms and humans. To address these issues we have further developed passive sampling devices (PSDs) that can sequester thousands of bioavailable chemicals.

These devices can help organizations and developing countries to evaluate changes in pest management that may produce or release chemicals. PSDs can help organizers characterize exposure more accurately. We are using PSDs to capture relevant non-polar and semi-polar pesticides and other chemicals of interest at multiple sites in Western Africa. PSDs do not require power, transport easily and are easily extracted with organic solvent.

We deployed PSDs in irrigation canals at seven agricultural sites in Senegal, Mali, and Mauritania agricultural stations. We were able to screen the PSD extracts for over 1,000 potential contaminants with gas chromatography mass spectrometry through the use of libraries we have further developed based on software, including automated compiled mass spectral deconvolution and identification system libraries that contain numerous classes of chemicals of concern (pesticides, PCBs, PAHs, pharmaceuticals, industrially related chemicals, etc.).

OBJECTIVE:

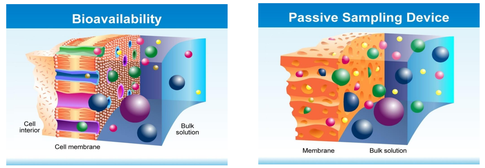
Utilize passive sampling devices, GC-MS analysis, and deconvolution reporting software to identify contaminates in engineered agricultural systems along the Senegal and Niger Rivers in Western Africa.

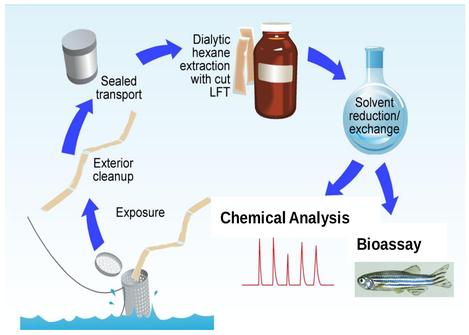
MATERIALS & METHODS

Passive Sampling Devices

Lipid Free Tubing

- Made from low-density polyethylene
- Sequesters freely dissolved thus bioavailable organic contaminants
- Concentrates semi and non-polar organic contaminants
- Low technology, easy to transport over large grab water sampling

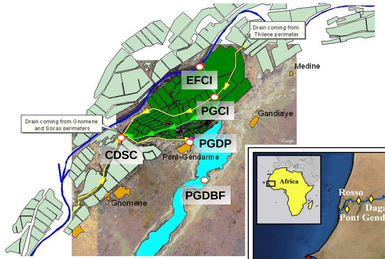




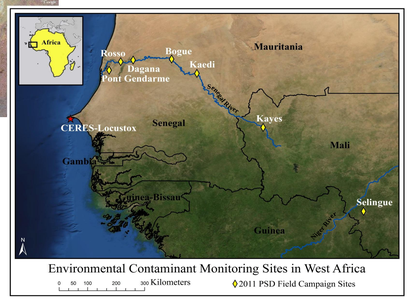
Sampling Locations

Samples from 29 sites in engineered agriculture based irrigated systems, collected on seven field campaigns during 2011 in Mali, Mauritania and Senegal.

Pont Gendarme : Spatial Layout



To learn more about how PSDs are deployed in the field, scan here



Sampling Method:

- PSDs deployed in engineered agricultural irrigation systems for ~21 days
- PSDs cleaned and extracted according to Anderson et al[1]
- Analysis by GC-MS utilizing Agilent DRS software and compared against combined libraries totaling over 1000 known chemicals of concern

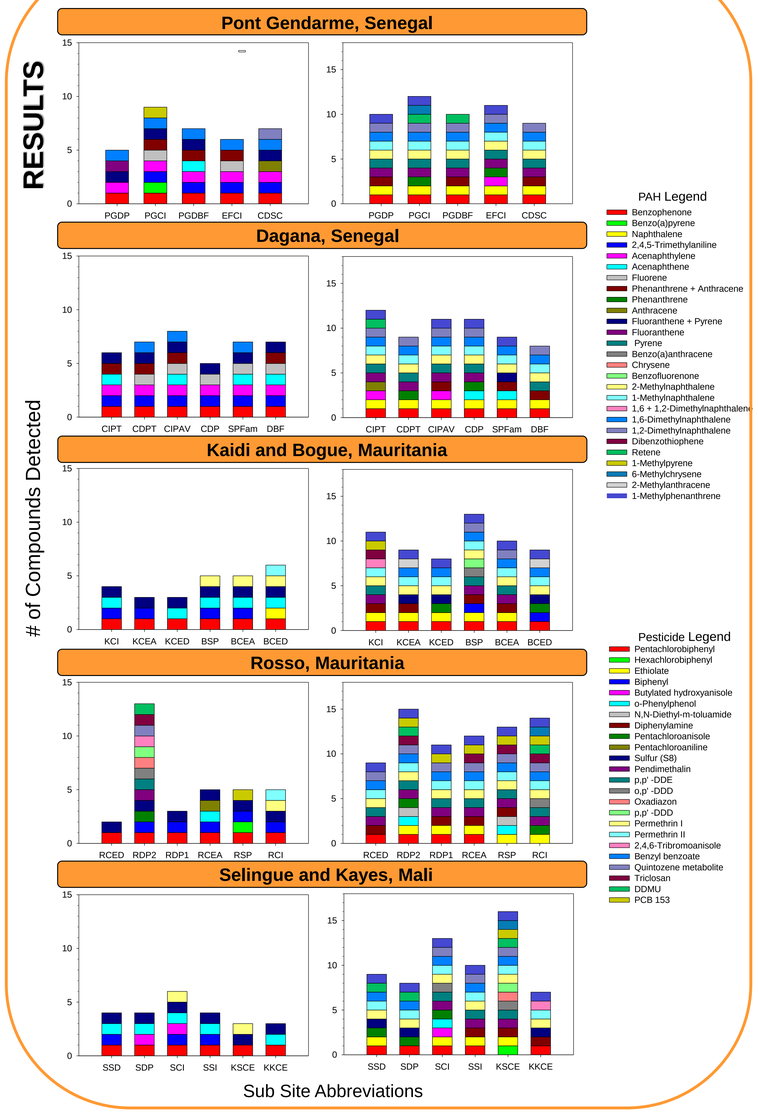
Chromatographic Analysis: Automatic Mass Spectral Deconvolution and Identification System

- PSD extracts analyzed by Agilent 6890N GC with Agilent 5975B inert XL MSD
- Screening method uses retention time indices and mass spectral data to verify compounds in an extract[2]
- Our AMDIS library contains over 1000 compounds including:
  - 926 Pesticides and Endocrine Disruptors
  - 209 PCBs
  - 66 Parent and substituted PAHs

Scan to view the full analyte list

RESULTS

PAHs Detected Pesticides Detected



DISCUSSION

- The results for all sites combined showed positive hits of six PCB congeners, 11 pesticides, 21 PAHs and two legacy pesticides including ethiolate, p'p' DDT and its breakdown products.
- Tonalide, a musk common in person care products was detected in all samples at Pont Gendarme, Bogue, and Rosso.
- The greatest number of chemicals of concern were detected in samples from Rosso (RDP2) including:
  - Pentachloroanisole a breakdown product of pentachlorophenol.
  - Triclosan, a common antibacterial and antifungal compound.

CONCLUSIONS

- PSDs coupled with GC-MS screening tools offer a powerful technology to identify persistent organic pollutants present at agricultural sites in Western Africa.
- The combined technologies identified 10 to 28 additional chemicals not previously quantified at these sites
- This dataset provides this region of West Africa with its first glimpse of potential chemicals of ecological concern and can direct future research efforts.

Future Work

- Continued field sampling of water and air at sites along the Senegal and Niger Rivers
- Continued technology and laboratory capacity building in Western Africa
- Co-deployment of non-PRC fortified PSDs for use in the bioassays
  - Effects directed analysis
- Co-deployment of complimentary PSD devices to target a wide range of compounds

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2. Peter, D. A.; Mallard, W. G., Automated Mass Spectral Deconvolution & Identification System - User Guide. U.S. Dept of Commerce. National Institute of Standards and Technology: Gaithersburg, MD, 2004.

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