Atmospheric Transport and Deposition of Pesticides within the Choptank River Watershed and the Role of Riparian Buffers in Pesticide Delivery to Streams

Laura L. McConnell, Clifford P. Rice, Cathleen J. Hapeman, Ahnuba Goel, Alba Torrents, Krystyna Bialek and Gregory W. McCarty

USDA-ARS, Beltsville Agricultural Research Center, Beltsville, MD & Department of Civil and Environmental Engineering, University of Maryland, College Park, MD

Air & Rain Concentrations Respond to Agricultural Activity

Pesticide Release to the Atmosphere

- Pesticide volatilization is a loss process that is often ignored in environmental fate studies. In some cases, a large fraction of applied active ingredient can be emitted to the atmosphere.
- During application, losses are influenced primarily by the application equipment, wind speed, and formulation. These immediate losses are often referred to as pesticide drift and may represent a significant mass of pesticide movement over a relatively short distance (10-100 m) with spray droplets.
- After application, pesticide volatilization continues, generally with the largest fluxes occurring within the first 24-48 hours, followed by an exponential decline over the next 4-5 days.

Approach

- During the period 2000-2003, weekly air samples (n=129) and event-based rain samples (n=242) were collected within the Choptank River Watershed.
- Samples were analyzed for ~30 commonly used pesticides using GC-MS.
- Factors which govern the presence of these chemicals in the atmosphere were investigated.

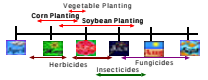
Air and Rain Samplers

Sampling Media

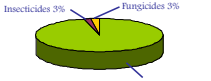
Choptank River Watershed

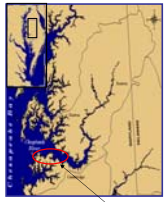
The Choptank River is an estuary located on the Delmarva Peninsula of the Chesapeake Bay. Its watershed is 1756 km^2, and a large fraction of this area is dedicated to crop production. There are also small to medium AFOs and CAFOs consisting primarily of poultry operations.

Regional Agricultural Activity

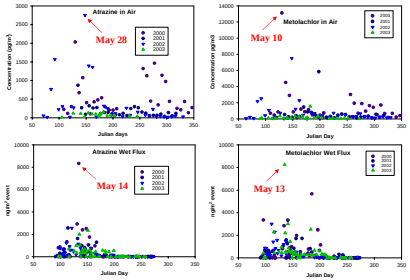


Agricultural Pesticide Usage in Maryland in 2000 (Eastern Shore Counties)





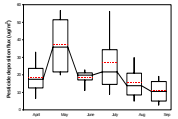
Herbicides in Air and Rain



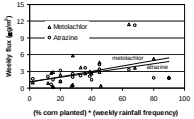
Conclusions

- Atmospheric concentrations respond rapidly to pesticide use in the watershed
- Atrazine and metolachlor are detected in the air throughout the year suggesting that concentrations are influenced by a combination of immediate drift followed by slower volatilization from surfaces.
- Wet deposition is dominated by herbicides (46-61%) with the greatest fluxes occurring during the time of herbicide application on corn and soybeans.
- Our analysis suggests that, the extent of wet deposition of herbicides depends on the timing of precipitation relative to herbicide application.

Monthly Distribution of Pesticide Wet Deposition Flux (2000-2003)



Wet Deposition Response to Corn Planting



Riparian Buffers Act as Traps for Pesticide Drift

- Volatilized pesticide residues may be deposited onto nearby tree canopies or transported longer distances from the point of application.
- A small watershed study was carried out in the western region of Chesapeake Bay to evaluate the role of riparian systems in trapping and delivering pesticide residues to a first order stream during rain events.

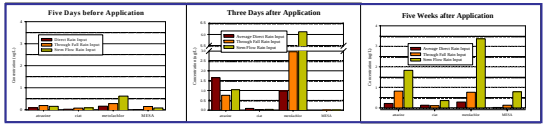
Pesticides and Degradation Products in Riparian Well and Stream

Rainwater passing through the forest canopy is a source for parent compounds in the riparian stream.

Time	Sample Source	Concentrations (ng/L)			
		Atrazine	CIAT	Metolachlor	MESA
Pre-application	Riparian Well (0 cm)	15	41	5	12,200
	Riparian Well (60 cm)	0.5	2.0	2.0	7,410
Rain event 3-days post-application	Stream (flow = 22 L/sec)	2,300	27	1,823	550
	Stream (flow = 14 L/sec)	927	27	794	744

- Pre-application: Groundwater near upwellings that feed stream contain higher concentrations of degradation products.
- Post-application: Rains wash parent material off canopy and into streams; degradation products are from ground water.

Rain: Direct, Through-Fall, and Stem Flow



- Pesticide concentrations were measured in rain collected outside the riparian area (**Direct Rain**) and compared to rain collected within the riparian area, i.e., through the canopy and/or washed off the leaves (**Through Fall Rain**), and the collected rain captured from the tree trunks (**Stem Flow**).
- Concentrations in Stem Flow and Through Fall Rain were generally higher than Direct Rain.

How Do Atmospheric Processes Influence Riparian Functionality within the Watershed?

Research Approach

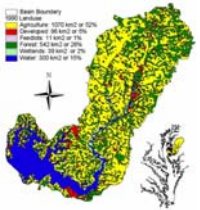
- Pesticide inputs to subwatershed streams will be determined. Data collection is underway (see below).
- Passive air samplers will be deployed in each subwatershed to measure pesticide and other important VOC concentrations.
- Intensive investigation of riparian function will be conducted within selected subwatersheds.
- Remote sensed, land use, and other water quality data will be utilized to discern differences in pesticide loads between subwatersheds.
- The data sets acquired in this effort and in previous air quality projects will be coupled with modeling efforts to further calibrate and validate REMM and to discern the atmospheric inputs of pesticides to the watershed.

Expected Outcomes

- This effort will be provide an evaluation of the effectiveness of riparian areas in mitigating pesticide and VOC inputs especially from drift and volatilization.

Results will be utilized by producers and policy decision makers to improve mitigation capacity of riparian buffers.

Choptank River Subwatersheds



Subwatershed Sites

- Fifteen subwatersheds have been chosen in the upper part of the Choptank.
- Each varies from 58 – 84% agriculture and 10 – 40% forested.
- Monthly stream samples are collected under baseflow conditions.

Initial Analysis

- Two subwatersheds (#2 – Cordova; #3 – Norwich) have consistently higher pesticide concentrations.
- These two watersheds have higher ag use and have somewhat lower forested lands compared to the other subwatersheds.
- Correlation coefficients between pesticide concentrations and ag and/or forested lands are 0.5 or less indicating that other factors are involved, such as, type of agriculture, agronomic practices (tillage, irrigation, etc.), proximity to the stream, soil type, and size of the riparian area.