Pesticides in water and bottom sediment samples at locations segmented to contrast agricultural and urban upland activities

Marufa Fatema[1*], Annemieke Farenhorst[1], Claudia Sheedy[†]

[1]*Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada*

[†] *Deceased July 12, 2020; Previous Address Agriculture and Agri-Food Canada, Lethbridge Research and Development Centre, Lethbridge, Alberta, Canada*

HIGHLIGHTS

- **Samples from theriver water column (n=162) and bottom sediment (n=54) showed a total of 34 and 32 different pesticide compounds, respectively.**
- **The most frequently detected pesticides in the water column were different from those most frequently detected in bottom sediments.**
- **The detected pesticides in the water column never exceeded Canadian Water Quality Guidelines for the protection of Aquatic life.**

INTRODUCTION

Lake Winnipeg in the Province of Manitoba, Canada has a large watershed-to-lake area ratio (40:1) and at least 60 tributaries enter Lake Winnipeg. For example, before entering Lake Winnipeg in the South, the Red River flows through cropland, then through the City of Winnipeg followed by suburban areas integrated with agricultural lands. Human activities in watersheds can have an impact on river water quality, and therefore lakes. A previous study that collected sediments from Lake Winnipeg, concluded that the concentrations of legacy insecticide DDT (dichlorodiphenyltrichloroethane) were largest in the south basin of the lake because its historical urban and agricultural use was primary in the south, including in the City of Winnipeg. There are a number of pathways by which pesticides can enter surface water, for example by snowmelt runoff or by wet deposition (rainfall, snow). Depending on the physico-chemical characteristics of the pesticide, a pesticide in surface water can reside in the aqueous phase (water column) or in the solid phase (sediments), or both. Knowing whether a pesticide molecule is present in the water column versus sediments is important because it influences both the transport and degradation potential of the pesticide. Pesticides have been widely detected at low concentrations in surface waters of the Canadian Prairies, including wetlands, rivers and lakes. Most studies that monitor for pesticides in rivers focus on water column samples, rather than sediments. Therefore, this study investigated the types and concentrations of pesticide compounds present in water column versus bottom sediments

INTRODUCTION (Cont'd)

at 18 river locations, including the Red River. Segments between two sampling locations were selected so that some segments were flowing through agricultural land, and other segments were flowing through urban land uses, including golf courses. Each of the 216 samples in total were analyzed for about 170 different pesticide compounds. Pesticide compounds were primarily active ingredients but some metabolites were also included. All 18 sampling locations were sampled throughout the growing season in 2017, and 6 of these 18 sampling locations had also been sampled throughout the growing season in 2016.

OBJECTIVES

1) To determine whether the types of pesticides detected in river segments flowing through agricultural land, are the same types of pesticide detected in river segments flowing through the City of Winnipeg.
2) To compare the types of pesticides detected in the water column and in bottom sediments, and compare the pesticide concentrations detected in the water column against the Canadian Water Quality Guidelines for the protection of Aquatic life.

MATERIALS AND METHODS

Water column (n=162) and bottom sediment (n=54) samples were collected from a total of 18 locations from Red River, Assiniboine River, La Salle River and Seine River in the Province of Manitoba, Canada. Samples were taken from May to August in 2017. Water column samples consisted of grab samples (1 L). Bottom sediments (3,375 cm^3) were collected using an Ekman Dredge. Samples were extracted and analyzed for pesticides at the Lethbridge Research and Development Centre, Agriculture and Agri-Food Canada, Alberta.

RESULTS

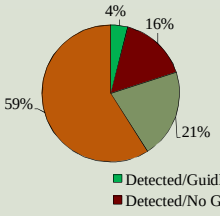

Fig 1: Existence of guideline (CWQG) for 172 compounds monitored in water samples (n=162) 2017

- Some current-use pesticides were detected but all at concentrations below the set Canadian Water Quality Guidelines for the Protection of Aquatic Life. However, 16% of the pesticides detected do not have guidelines developed.

RESULTS (Cont'd)

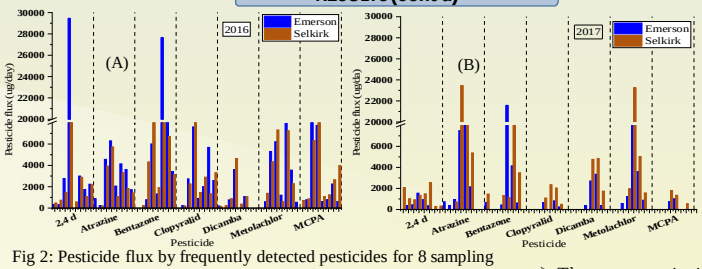

Fig 2: Pesticide flux by frequently detected pesticides for 8 sampling weeks in (A) 2016 and (B) 2017, in the Red River

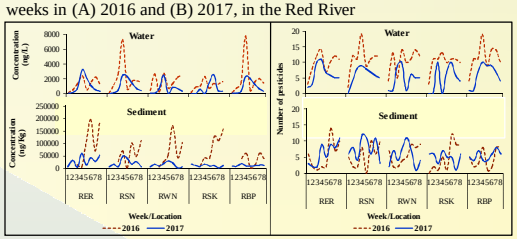

Fig 3: Pesticides as mixture in water and sediments of Red River

- The types of pesticides detected were relatively similar, regardless of sampling location or whether river segments were flowing through agricultural land, land under urban development, or the City of Winnipeg. The concentrations of pesticides detected varied across time, more so than the pesticide concentrations varied across sampling locations.
- Water-column and bottom sediments showed differences in the frequency of detections of a range of pesticides. For example, in 2017, the top five most frequently detected pesticides in the water column were thiamethoxam (78% of total samples), 2,4-D (69%), bentazone (53%), metolachlor (52%) and atrazine (50%). In contrast, the most frequently detected pesticides in bottom sediments were tebuconazole (73%), MCPA (68.51%), boscalid (67%), propiconazole (61%), and glyphosate (56%).
- The most frequently detected pesticides had mid-season loading peaks in Red River, likely reflecting the time of use of these pesticides and also indicating that these pesticides appear to readily dissipate in rivers following their peak detections.
- 7.06% (2016) and 4.93% (2017) of the total samples collected in a given year contained at least one pesticide compound. 77.65% and 90.74% of water column samples collected in 2016 and 2017, respectively, contained pesticide mixtures. 86.76% (2016) and 90.74% (2017) of bottom sediment samples contained pesticide mixtures.
- There was no significant correlation between the pesticide concentrations detected in the water column of the Red River and the Red River discharge rates [m^3/d] However, it appeared that the most frequently detected pesticides had lesser loadings into the Red River in 2017 than 2016. Both precipitation and river flow was less in 2017 than 2016

CONCLUSIONS

Sampling year influenced both the number and concentrations of pesticides detected in water and sediment samples and hence multi-year studies are important to delineate such differences. Water and sediment samples showed different results in the types of pesticides most frequently detected, indicating that such multi-year studies should sample both the water-column and sediments. Current-use pesticides were detected at concentrations below the set Canadian Water Quality Guidelines for the Protection of Aquatic Life, and at concentrations of unknown risks because they do not have established Canadian Water Quality Guidelines for the Protection of Aquatic Life.

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Contact Address: fatemam@myumanitoba.ca