Identification of Polychlorinated Biphenyl (PCB) Source in Sediment Data from the Spokane River

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Introduction

Polychlorinated Biphenyls (PCBs) are organic, manmade persistent pollutants of chemical formula $C_{12}H_{10-x}Cl_x$ (Figure 1). The various configurations of chlorine atoms give rise to 209 possible PCB congeners, some of which have higher toxicity than others. These molecules where mass produced in the United States between 1930s and 1977 for various industrial applications, prior to their ban in 1977[1]. Their intentional production has been banned globally because of their high toxicity, but they are still generated inadvertently through the production of certain pigments[2]. Identifying the source of environmental hazards is a crucial step to be able to properly treat contaminated areas and shut off sources

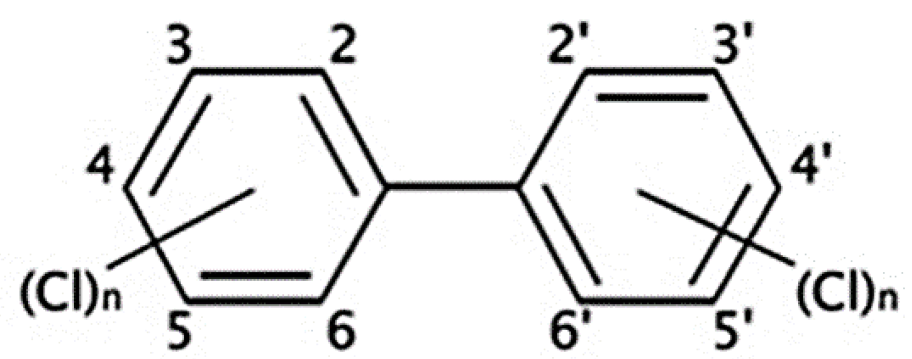

Figure 1. General Structure of Polychlorinated Biphenyls

Abstract

Our current study is based on PCB data collected from the Spokane River where stormwater and sediment were contaminated with PCBs. The city of Spokane in Washington is alleging that commercially produced Aroclors are the main source of PCB contamination. Our main goal was the study of congener patterns in sediment samples to determine the sources of PCBs in the Spokane River. To answer these questions, we employed data mining, including Positive Matrix Factorization (PMF) model. With this model, we can reconstruct PCB concentration data from the sediment samples into sources (fingerprints) and their contributions to total PCBs in each sample. Finally, these PMF results can be used to study if there is any correlation between Aroclor fingerprints and the sediment data under study.

Project Goals

Study of congener patterns in sediment samples to determine the sources of PCBs in the Spokane River

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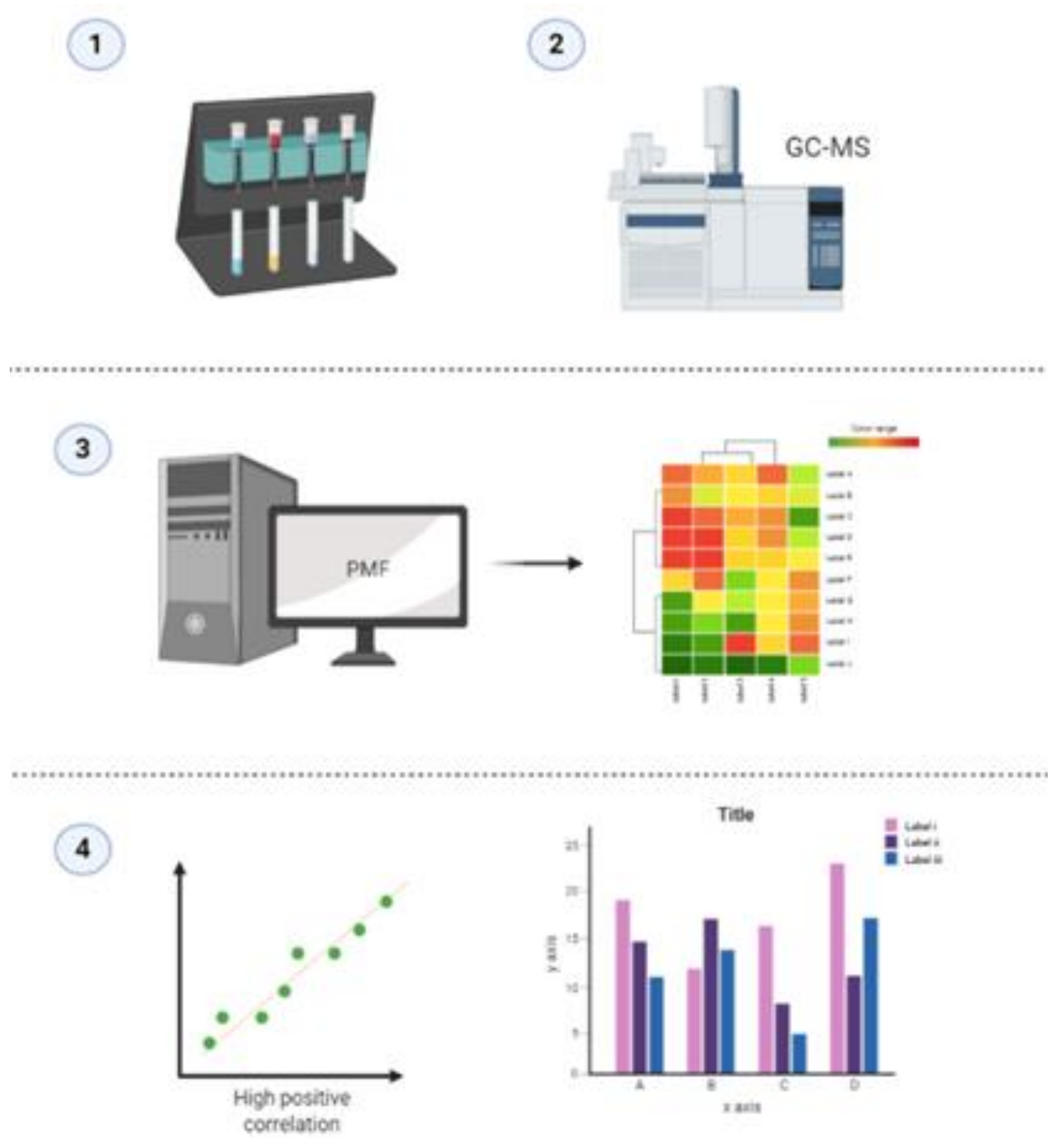
Determine if there is a relationship with PCB data from the Spokane River and commercially produced Aroclors

Methods



Results

	Agreement (R^2) between PCB fingerprints			
	Sediment Data			
	F1	F2	F3	F4
AROCLOR 1221	0.008	0.027	0.006	0.010
AROCLOR 1232	0.003	0.014	0.025	0.042
AROCLOR 1016	0.130	0.015	0.031	0.041
AROCLOR 1242	0.215	0.015	0.026	0.038
AROCLOR 1248A	0.203	0.009	0.010	0.005
AROCLOR 1248B	0.209	0.009	0.010	0.005
AROCLOR 1248C	0.210	0.009	0.010	0.004
AROCLOR 1254	0.006	0.019	0.006	0.003
AROCLOR 1260	0.010	0.065	0.008	0.025
AROCLOR 1262	0.009	0.047	0.003	0.000
AROCLOR 1268	0.010	0.004	0.000	0.006

Discussion

- The PMF analysis generated four factors (F1, F2, F3, F4). None seem to resemble commercially produced Aroclors. Agreement (R^2) between Aroclors and sediment data was significantly lower than the accepted 0.8 correlation value[3].
- The matrix analyzed was composed of 39 samples and 37 congeners. The PMF program performs best when there are at least as many samples as PCB congeners in the input data set. The program cannot find a stable solution if there is such a low margin of difference between number of samples and congeners.
- Pre-processing of data to fit the PMF model lead to an inevitable loss of information. Not all the 209 PCB congeners were considered in the analysis, and therefore some of the PCB mass was not considered.
- The source of PCB contamination for sediment samples under study could possibly arise from non-commercial sources. Because the PMF analysis could not produce a stable solution, further studies must be conducted to make a definite conclusion. Multiple Linear Regression (MLR) analysis as an alternate method of analysis that can be employed for future studies.

References

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