

Evaluation of post-Katrina flooded soils for contaminants and toxicity to the soil invertebrates *Eisenia fetida* and *Caenorhabditis elegans*

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Abstract

This research evaluated soil samples from a New Orleans neighborhood in the Chalmette, Saint Bernard Parish, that had been inundated by flooding associated with Hurricane Katrina. The goal was to determine if ecological risks persisted from flood waters that had come in contact with hazardous surface chemicals before inundating this low-lying neighborhood for a prolonged period. Research objectives were to establish the presence or absence of volatile organic and heavy metal contaminants, and then assess the toxicity of this soil to *Eisenia fetida* in a soil exposure assay and *Caenorhabditis elegans* in a simulated porewater exposure assay. Soil analysis revealed detectable levels of metals and organics in the surface soil at each location. No contaminant was detected in concentrations above human health screening values. Chromium and mercury were detected at levels in excess of typical ecological risk values. Soil extracts revealed concentrations of nitrate, sulfate, and chloride above those from an unflooded background sample. Toxicity testing resulted in no acute effects to either test species, but did show bioaccumulation of arsenic, cadmium, and lead in *E. fetida* exposed to several samples. The combination of mercury and sulfate provide the potential for mercury methylation should flooding and prolonged inundation occur again.

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1. Introduction

Hurricane Katrina and its associated flooding due to storm surge and levee breaches in the greater New Orleans area allowed large volumes of flood water to come into contact with hazardous surface chemicals then inundate low-lying neighborhoods for prolonged periods. This permitted surface waters to saturate the underlying soils, possibly leaving behind contaminants. The specific objectives of this research were to: sample potentially contaminated soil in a previously flooded New Orleans neighborhood; establish the presence or absence of volatile organic and

heavy metal contaminants; and assess the toxicity of this soil to invertebrates in the laboratory. Toxicity tests were conducted with the earthworm, *Eisenia fetida*, in a soil exposure assay and the nematode, *Caenorhabditis elegans*, in a simulated porewater exposure assay. This was part of a larger study to evaluate soil contaminants along a vertical distribution and to investigate the potential for sediment recovery through natural attenuation.

2. Materials and methods

Surface soil was sampled from a location in the Chalmette, Saint Bernard Parish (Fig. 1) and was chosen due to its proximity to both industrial and residential areas, as well as its proximity to locations previously sampled by the US Environmental Protection Agency (US EPA).

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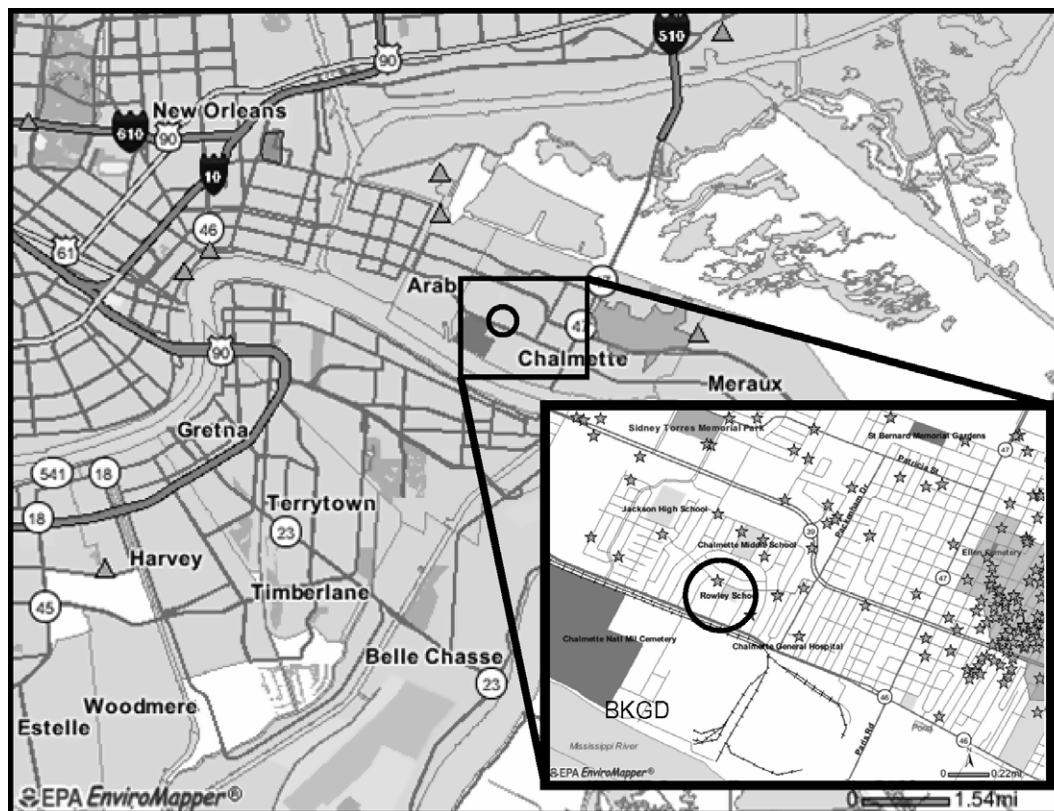


Fig. 1. The study area in St. Bernard Parish, Louisiana. The stars on the inset figure represent local US EPA sampling locations, most of which were associated with the Murphy Oil Spill east of the study location. Sampling locations for this study are within the circled area. The neighborhood where the study occurred was locally known as “Chalmette Vista”. The study area was chosen due to its proximity to a school, playground, local housing, public use areas, and to industrial facilities. Map is courtesy of the US EPA.

This area is characterized by an average elevation ranging from mean sea level to 1.5 m below sea level. Flood waters first inundated this area on the morning of August 29, 2005, and remained for a period of 12 days. The Federal Emergency Management Agency recorded maximum flood water mark depths at 3.3 m at a measurement site (KLAC-07-67) immediately adjacent to the study area (FEMA, 2006), and water marks on the buildings in the study area supported this measurement. This area was also associated with the Murphy Oil Spill that occurred on September 4, 2005, when flood-related events caused a breach of an above-ground storage tank within Murphy Oil’s nearby Meraux Refinery. Approximately 1,050,000 gallons of mixed crude oil were released, impacting local canals and neighborhoods (US EPA, 2006a). Sampling sites were all located near Rowley Elementary School and the surrounding neighborhood. Samples 1, 2, 3, 4, and 7 were taken from a field near the school; sample location 5 was in the school’s playground; and location 6 was in the residential area. Sampling also included a nearby background site on unaffected (unflooded) federal property approximately 1.250 km south-southwest of sample location 1. The sample study area was approximately 200 × 300 m in size.

Sampling began 45 days post-Katrina flooding and approximately 26 days after the rainfall events of Hurricane Rita on September 23–25, 2005.

At each sampling location, 2 kg of soil for toxicity testing was collected from the top 10 cm using a stainless steel hand trowel, bagged, sealed, and returned to the laboratory on ice. Subsamples for metals and volatile organic compounds (VOCs) were taken in the field using disposable scoops modified from plastic syringes. Ten-gram subsamples for VOC analysis were placed in glass VOC vials provided by the analytical laboratory; approximately 50 g of soil were placed in separate containers for metals analyses. Analytical samples were shipped on ice to a laboratory (Microseeps, Inc., Pittsburgh, PA) approved by US EPA and the Louisiana Department of Environmental Quality (LDEQ). Standard trip and temperature blanks were included. The trowel was thoroughly rinsed with deionized water between sampling locations. Plastic scoops and gloves were changed between sampling locations to prevent cross-contamination. All samples were analyzed within 10 days; this was well within acceptable holding times for the methodologies described below (6 months for metals; 14 days for VOCs). Toxicity testing was begun within the standard 14-day holding time prescribed by ASTM (1995).

Soils were analyzed via purge and trap gas chromatography/mass spectrometry (GC/MS) following US EPA Method 8260 (US EPA, 1996a) for 31 organic contaminants from the Resource Conservation and Recovery Act (RCRA) Target Compound List. Metals (As, Ba, Cd, Cr,

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