Environmental Pollution 156 (2008) 944–950

Contents lists available at ScienceDirect

Environmental Pollution

journal homepage: www.elsevier.com/locate/envpol

# Distribution of toxic trace elements in soil/sediment in post-Katrina New Orleans and the Louisiana Delta

Tingzhi Su [a,b,c], Shi Shu [a,b], Honglan Shi [a], Jianmin Wang [a,b,*], Craig Adams [a,b], Emitt C. Witt [d]

[a] Environmental Research Center (ERC), Missouri University of Science and Technology, Rolla, MO 65409, USA
[b] Department of Civil, Architectural and Environmental Engineering, Missouri University of Science and Technology, Rolla, MO 65409, USA
[c] College of Environmental Science and Engineering, Tongji University, Shanghai 200092, China
[d] United States Geological Survey, Mid-Continent Geographic Science Center, Rolla, MO 65401, USA

*This article provides an in-depth assessment of the contamination of As, Pb, V, Cr, Cd, Cu, and Hg in post-Katrina greater New Orleans region.*

ARTICLE INFO

*Article history:*
Received 12 October 2007
Received in revised form 8 May 2008
Accepted 11 May 2008

*Keywords:*
New Orleans
Hurricane Katrina
Toxic trace elements
Contamination
Soil

ABSTRACT

This study provided a comprehensive assessment of seven toxic trace elements (As, Pb, V, Cr, Cd, Cu, and Hg) in the soil/sediment of Katrina affected greater New Orleans region 1 month after the recession of flood water. Results indicated significant contamination of As and V and non-significant contamination of Cd, Cr, Cu, Hg and Pb at most sampling sites. Compared to the reported EPA Region 6 soil background inorganic levels, except As, the concentrations of other six elements had greatly increased throughout the studied area; St. Bernard Parish and Plaquemines Parish showed greater contamination than other regions. Comparison between pre- and post-Katrina data in similar areas, and data for surface, shallow, and deep samples indicated that the trace element distribution in post-Katrina New Orleans was not obviously attributed to the flooding. This study suggests that more detailed study of As and V contamination at identified locations is needed.



## 1. Introduction

Hurricane Katrina was one of the worst natural disasters in U.S. history (CDC, 2006a). The storm caused by Katrina damaged coastal Mississippi, Louisiana, Alabama, and as far east as the Florida panhandle (CDC, 2006b). The consequences induced by Katrina were catastrophic in southeastern Louisiana, especially in the greater New Orleans region, including Orleans Parish, St. Bernard Parish, Plaquemines Parish and Jefferson Parish. After Katrina made its landfall in south Plaquemines Parish, the entire Mississippi Delta was almost devastated, including much of the fleet that supported the state's fishing industry (Adams et al., 2007). Approximately 80% of the New Orleans city was flooded after the storm-induced levee breaches in Lake Pontchartrain, with water reaching 20 feet (6 m) in some locations (CDC, 2006b; Pardue et al., 2005). The torrent removed homes from their foundations, scattered fuel oil tanks and their contents, damaged oil refineries, and created large piles of moving debris (Adams et al., 2007).

Southeastern Louisiana held 21 oil refineries and accounted to a total of 47% of U.S. distillates. During Katrina, most of the refineries were severely affected or damaged and more than 7 million gallons of oil were estimated to spill from industrial plants, storage depots, hundreds of rigs and other damaged facilities, and scattered at sites throughout southeastern Louisiana (McCaskill, 2006). Lake Pontchartrain, which greatly contributed to the catastrophic flooding in New Orleans, was also a historic environmental sink. It received the agricultural runoff from north shore, poorly treated or untreated sewage from many communities throughout the Pontchartrain Basin, and the storm water runoff from New Orleans metropolitan area during rain events (Anonymous, 1995; Williams, 2002). The contaminated water and associated sediment from Lake Pontchartrain mixed with a great variety of other contaminants, and was spread all over the flood-affected areas. The concern was that these contaminants may have significantly degraded the environmental quality in New Orleans. Pardue et al. (2005) reported that Pb, As, and in some cases, Cr concentrations in the flood water exceeded the drinking water standards. Extensive mud deposits left in some areas of New Orleans had the potential to carry contaminants from Lake Pontchartrain to the affected neighborhoods. Because metal contamination in Louisiana has been a serious health problem since the early 1970s (Brown et al., 2000), it was necessary

* Corresponding author. Environmental Research Center (ERC), Missouri University of Science and Technology, 223 Butler-Carlton Hall, Rolla, MO 65409, USA. Tel.: +1 573 341 7503.
*E-mail address:* wangjia@umr.edu (J. Wang).

0269-7491/$ – see front matter © 2008 Elsevier Ltd. All rights reserved.
doi:10.1016/j.envpol.2008.05.016

to assess the amounts of major toxic trace elements of concern in the soil/sediment across the entire area affected by Hurricane Katrina and associated flood in southeastern Louisiana, to determine the extent of toxic trace elements contamination in these areas.

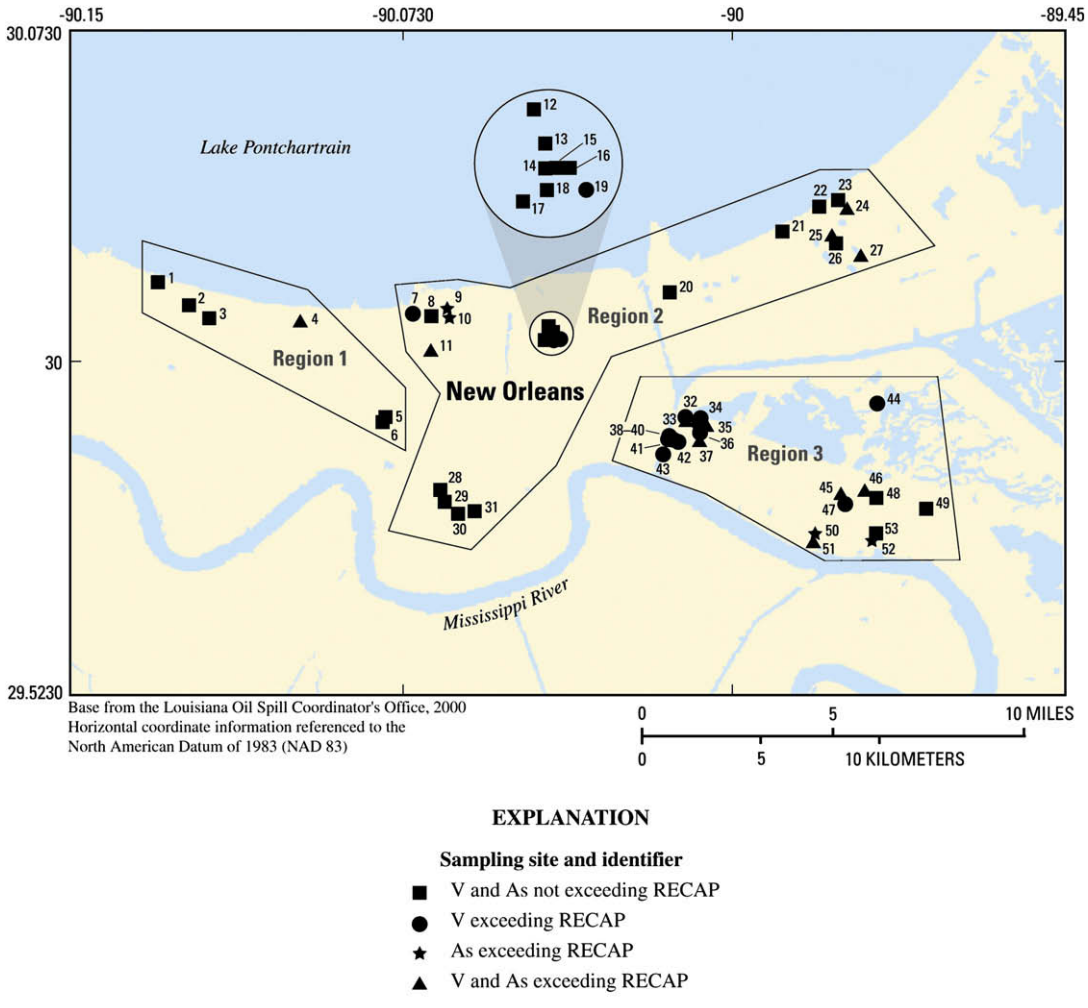
Several researchers have studied the post-Katrina toxic element concentrations in soil/sediment and water samples from New Orleans (Cobb et al., 2006; Dubey et al., 2007; Mielke et al., 2006; Presley et al., 2006; Wang et al., 2004), and concluded that Pb and As contamination could be a great concern. However, samples in these studies were mainly collected from very limited areas along major thoroughfares. These included areas between the 17th Street Canal and the Industrial Canal in Orleans Parish, around the Superdome, and along St. Charles Avenue on the Mississippi River front. Although a broader area, in both Orleans Parish and St. Bernard Parish, was also investigated (Schwab et al., 2007), the study only focused on As and Pb contamination in the soil/sediment.

Very little information is available concerning the presence of a group of high-priority toxic trace elements in the flood-affected areas in Jefferson Parish, the refinery region in St. Bernard Parish, the northeastern region of Orleans Parish along the lakefront area, and the Mississippi Delta in Plaquemines Parish through where the eye of Hurricane Katrina passed, except some preliminary leaching data published by us recently for a subset of 46 samples (Adams et al., 2007). To further provide a more comprehensive assessment of Hurricane Katrina's impact on toxic trace element contamination, this research analyzed the extended 157 soil/sediment samples collected from Katrina and flood impacted greater New Orleans region, including Jefferson Parish, Orleans Parish, St. Bernard Parish and Plaquemines Parish (64 sampling sites), using an approach that is consistent with the current regulations, i.e. the determination of total concentration of seven high-priority toxic trace elements, As, Pb, Cd, Cu, Cr, V, and Hg.

## 2. Materials and methods

### 2.1. Sample collection

During the period October 6–18, 2005, a total of 238 soil/sediment samples were collected from 64 sampling sites (Figs. 1 and 2). The sampling area covered the most seriously damaged places, and was divided into four regions. Region 1 was in Jefferson Parish, close to the lakefront and along Esplanade Avenue, including neighborhoods at the 17th Street Levee breach, and southward to the river front along Woodvine Avenue. Region 2 was in Orleans Parish, including the 17th Street Canal breach and the Industrial Levee breach-affected area along Lake Pontchartrain, the London Avenue Canal breach-affected neighborhoods (east), the northeast region of Orleans Parish along the lakefront area, and the neighborhoods between Highways 90 and 3139 at the Mississippi River front. Region 3 was in St. Bernard Parish, from the Industrial Canal to the refineries in eastern New Orleans along the Mississippi River. Region 4 was along Highway 23 on the Mississippi Delta in Plaquemines Parish, including Empire (near the location where the eye of Hurricane Katrina passed through) and Venice, LA. Specific locations of the 64 sampling sites are shown in Table S1 in the supporting information.




Sampling sites in Region 1, 2, 3, New Orleans, Louisiana.

**Fig. 1.** Sampling sites in New Orleans, Louisiana – sampling regions 1 (Jefferson Parish), 2 (Orleans Parish), 3 (St. Bernard Parish). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)