

Arsenic Soil Concentrations in Mississippi River Floodplain Environments and the Influence of Sediment Acquisition and Dissimilatory Fe-Oxyhydroxide Dissolution on Arsenic Accumulation

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How to cite this paper: Aide, M. (2026).

Arsenic Soil Concentrations in Mississippi River Floodplain Environments and the Influence of Sediment Acquisition and Dissimilatory Fe-Oxyhydroxide Dissolution on Arsenic Accumulation. *Journal of Geoscience and Environment Protection*, 14, 244-258.

<https://doi.org/10.4236/gep.2026.1410009>

Received: September 25, 2026

Accepted: October 24, 2026

Published: October 27, 2026

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Abstract

The Mississippi River and its tributaries form a watershed that contains extensive farmland areas and industrial centers. The specter of metal and metalloid impact along the Mississippi River is a growing concern; however, selected areas along the Mississippi River have not been fully characterized for chemical impacts. In southeastern Missouri, two floodplain soil sites, each with two pedons were selected for geochemical analysis. Arsenic concentrations throughout the pedons were within the range for soils having no apparent arsenic accumulation. Na-acetate extractions indicate that most of the arsenic content is not highly bioavailable. Arsenic concentrations are significantly associated with Fe-oxyhydroxide abundance. Soils sampled from adjacent loess-covered uplands exhibit similar arsenic concentrations and are consistent with the likelihood that these uplands are a sediment source area. Additionally, enhanced Mississippi River sediment and erosional transport from loess uplands to the floodplains are understood to be a continuing process, thus environmental stewardship of these floodplain soils is advanced with knowledge of the sediment source areas. Arsenic research may ultimately become a valuable geochemical species for sediment source fingerprints.

Keywords

Soil Arsenic, Sediment Source Fingerprinting, Mississippi River Alluvium, Arsenic Mitigation, Arsenic Fate and Transport

1. Introduction

1.1. Basic Arsenic Chemistry

Arsenic (As) is a metalloid having an $[\text{Ar}] 3d^{10}4s^2p^3$ electronic configuration. Electron removal readily produces two stable valence states: i) arsenite having an electronic configuration $[\text{Ar}] 3d^{10}4s^2$ and (ii) arsenate having an electronic configuration $[\text{Ar}] 3d^{10}$. Arsenite is a Bronsted Lowry acid (H_3AsO_3 with a +3-oxidation state) and arsenate is also a Bronsted Lowry acid (H_3AsO_4 with a +5-oxidation state), both species having well-defined protonation reactions (Aide et al., 2016).

1.2. Arsenic and Drinking Water Standards

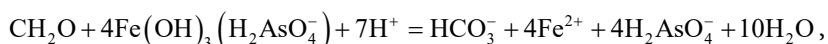
The U.S. Environmental Protection Agency has established drinking water requirements for states and public water systems (U.S. Environmental Protection Agency, 2026) (verified September 2026). Maximum arsenic levels for U.S. public water systems are established at $10 \mu\text{L}^{-1}$. The U.S. Environmental Protection Agency has also established a daily inorganic arsenic oral reference dose of $0.3 \mu\text{g kg body weight}^{-1}$ (U.S. Environmental Protection Agency, 2026) (Verified 2026). Inorganic arsenic is linked to long-term health risks like cancer, type 2 diabetes, and cardiovascular disease (Cubadda et al., 2016).

1.3. Abundance of Arsenic in the Environment

Arsenic is particularly abundant in argillaceous rocks (5 to 13 mg kg^{-1}), whereas sandstones typically range from 0.5 to 1.2 mg kg^{-1} (Kabata-Pendias, 2011). Soils in the United States typically range from less than 0.1 mg kg^{-1} to 93 mg kg^{-1} . Aide et al. (2014) characterized 22 soil series across southeastern Missouri to estimate the arsenic soil profile distributions. Generally, pedons exhibiting argillic horizon expression show Fe-oxyhydroxides and arsenic maxima in the argillic horizon. Soil profiles having cambic horizons with Fe-oxyhydroxide accumulations also feature arsenic accumulation. Conversely, silty-textured Entisols and Inceptisols show somewhat uniform iron and arsenic concentrations throughout their soil profiles. Typically, epipedons have arsenic concentrations ranging from 2 to 12 mg kg^{-1} , whereas argillic horizons have arsenic concentrations ranging from 10 to 30 mg kg^{-1} .

1.4. Basic Arsenic Reactions in the Soil Environment

Investigating arsenic in German rivers, Ackermann et al. (2010) documented that Fe-oxyhydroxide reductive dissolution under water-saturated, anoxic conditions, released co-precipitated or adsorbed arsenic. Particularly important was the conversion of arsenate into the more mobile arsenite species, increasing the toxicity and bioavailability of arsenic. Upon annual flooding of most floodplain soils, dissimilatory Fe-oxyhydroxide dissolution will occur, especially if dissolved organic materials are present. The reductive dissolution of these Fe-oxyhydroxides and the subsequent release of arsenate may be described as:



where CH_2O are organic materials that support oxidation-reduction reactions.

Arsenate may be subsequently reduced to arsenite according to:



Yamaguchi et al. (2011) noted that anaerobic soil environments support the release of the highly mobile and more toxic arsenite species, frequently increasing up to 80% of the soil arsenic pool. Yamaguchi (2025) showed that sorption and oxidation are important chemical reactions influencing inorganic arsenic immobilization. Specifically, ferrous iron and oxygen promote arsenite oxidation. Hussain et al. (2021) noted that anaerobic soils may convert less toxic arsenate into highly mobile and toxic arsenite. They further discussed how microbial activity alters arsenic reduction, oxidation, and methylation. Dissolved organic matter and inorganic arsenic compete for iron oxyhydroxide adsorption sites, which decreases arsenic adsorption and supports mobility (Aftabtalab et al., 2022). Dissolved organic matter may form soluble organic-arsenic complexes or ternary surface complexes (Aftabtalab et al., 2022). In a study using anaerobic microcosms, Qiao et al. (2019) established that humic substances enhanced arsenic reduction and release, especially fulvic acid. Yoon et al. (2023) recently developed an *Escherichia coli* anaerobic biosensor and confirmed that under anaerobic conditions microbial arsenite uptake decreased with greater dissolved organic matter concentrations.

Burton et al. (2014) noted that dissimilatory activities on iron-oxyhydroxides fostered occluded and adsorbed arsenate release of arsenite to the aqueous phase. However, if the Eh is sufficiently conducive for iron sulfite formation, arsenic may be sequestered via co-precipitation or adsorption. Zhang et al. (2024) determined that anaerobic soil conditions foster the microbial induced dissolution of Fe-oxyhydroxides and the release of arsenic into soil porewaters. They also determined that specific microbial genes orchestrate arsenic methylation and volatilization, reducing their toxicity and increasing rhizosphere mobility.

1.5. Association of Arsenic in Floodplains

Research has focused on arsenic in floodplain soils, a feature attributed to the potential toxicity of arsenic and the likelihood that major floodplain regions also support rice production. Connolly et al. (2022) estimated surface flooding of alluvial and deltaic aquifers is a major contributor to arsenic contamination in the Mekong River across Cambodia to the delta of the Mekong River in Vietnam, and the Ganges-Brahmaputra delta in Bangladesh. In the Amazon basin, De Meyer et al. (2023) predicted arsenic groundwater impact is related to the topography and fluvial geomorphology. Groundwater chemistry from tube wells revealed that aquifers in poorly weathered sediments deposited from sediment-rich rivers promote enhanced mobilization and accumulation of arsenic. Aquifers in the channel-dominated positions of the floodplains and aquifers in the overbank deposits of other

floodplain positions frequently exhibited arsenic concentrations, exceeding the World Health Organization standard of $10 \mu\text{g L}^{-1}$ (Podgorski & Berg, 2020). In China and southeastern Asia, Fan et al. (2024) developed a predictive model to assess floodplain groundwater arsenic concentrations and proposed that nitrogen-bearing organic materials promoted dissolution of arsenic bearing iron-oxyhydroxides.

1.6. Fluvial Processes That Impact Arsenic and Sediment Accumulation

The primary components of fluvial processes are i) erosion, ii) transportation, and iii) deposition, resulting in the creation of multiple landforms (V-shaped valleys, wide channels and lateral erosion, meanders, floodplains, natural levees, and deltas). Understanding the sediment source is difficult because of the complexity and interaction of these processes. No one technique will isolate and identify the origins of sediments; however, multiple techniques may provide sufficient evidence to provide a reasonable understanding of the processes responsible for the sediment's deposition. Even then, the sediment deposit may have obtained material from multiple sources.

The Mississippi River has been transformed by engineering projects to reduce flooding of populated regions and stream modification to assist river transportation. Hassan et al. (2017) determined that the Mississippi River basin has been transformed by land use practices, dam construction, and river channeling for navigation. Extensive upland erosion before the development of soil conservation practices exported large amounts of sediment to the valleys and floodplains. Currently sediment is primarily transported from upland regions and from stream bank and channel erosion. In the upper Midwest, Fenton (2012) extensively demonstrated that Mollisols are appreciably eroded, altering the upland landscape, with deposition occurring in drainages, streams and rivers.

Belmont et al. (2011) stressed that excessive loading to rivers and streams is a leading cause of impairment and biodiversity loss. They demonstrated that the dominant sediment has shifted from agricultural soil erosion to accelerated erosion of stream banks and bluffs. Meade & Moody (2010) proposed that dams along the Missouri River trap roughly 100 to 150 million metric tons of sediment per year, accounting for a significant reduction of sediment delivery to the Mississippi Delta. Additionally, upstream soil erosion controls and land management practices limit sediment delivery to the Mississippi River. Ali et al. (2010) identified three trends: i) increasing sediment storage downstream, ii) sediment yields increasing with drainage area infer increased sediment along the main valleys, and iii) sediment yields are also influenced by complex interactions of climate, geology, and land management.

For the Mississippi River system, Li et al. (2020) noted the land to ocean sediment reduction decreasing from 350 Mt year^{-1} between 1952 and 1962 and a reduced sediment delivery of 200 Mt year^{-1} after 1963. They deduced that reservoir construction was the dominant driver influencing sediment flux from the Mississippi River system during 1985-2015, especially because of tributary reservoirs.

Lately, [Bian et al. \(2023\)](#) noted that soil erosion and subsequent sedimentation reduced water quality across the Mississippi River Basin. Their model indicated that total sediment yield increased from 1980 to 2018 because of intensified extreme precipitation. [Smith et al. \(2001\)](#) suggested that the primary fate of eroded soil organic materials were attributed to impoundment trapping and other forms of redeposition. [Smith et al. \(2005\)](#) proposed that erosion moves soil organic carbon from upland areas into three destinations: i) alluvial deposits, ii) water impoundments, and iii) the ocean. Their study determined that the Mississippi Basin is a net carbon sequestration resource, given that the rate of organic matter oxidation is reduced and eroded upland soils experience a net carbon replacement because of land management supporting organic matter accumulation.

Recently, [Yin et al. \(2023\)](#) proposed that increased rainfall accounts for roughly 67% of the total increase in streamflow. [Xu et al. \(2022\)](#) focused on sediment source fingerprinting studies conducted within the Mississippi River Basin. They reported that near-channel sources are frequently the dominant sediment sources.

1.7. Manuscript Objectives

The objectives of this manuscript are i) to discern the abundance of arsenic in selected floodplain soils, ii) to estimate the relative contributions of eroded local upland soils and the Mississippi River sediment deposition to soil development, and iii) clarifying the soil chemistry influencing arsenic soil concentrations and whether arsenic may be an important geochemical marker.

2. Materials and Methods

2.1. Study Area

The study area is in east-central Missouri (Cape Girardeau County and Scott County) and resides in the annual floodplains of the Mississippi River. The climate is humid continental, the annual rainfall averages 1.07 m and average daily annual air temperature is 14°C. Annual flooding durations are generally 1 to 7 days; however, longer flood intervals may occur ([Festervand, 1981](#)).

Two pedons of the Commerce series (Fine-silty, mixed, superactive, nonacid, thermic Fluvaquentic Endoaquepts) and two pedons of the Caruthersville series (Coarse-silty, mixed, superactive, calcareous, thermic Typic Udifluvents) were morphologically described and sampled. The Caruthersville and Commerce soil series were selected because of their large areal extent, and they are located on the Mississippi River floodplain and soil sampling occurred at soil depths of 0 - 15, 15 - 30, 30 - 45, 45 - 60, 60 - 90, and 90 - 120 cm. At each site, the pedon spacing was approximately 15 meters. Sampling locations for the Caruthersville pedons are Lat: 37.1623 and Lon: -89.4432 and for the Commerce pedons are Lat: 37.3160 and Lon: -89.5127.

Two pedons of the Menfro soil series (Fine-silty, mixed, superactive, mesic Typic Hapludalfs) were selected because they occur extensively on the uplands surrounding the Caruthersville and Commerce pedons. The Menfro series con-

sists of very deep, well-drained, moderately permeable soils formed in thick loess deposits on upland positions adjacent to the Mississippi and Missouri Rivers. The soils exhibit ochric epipedons and argillic horizons, featuring A-E-Bt-C horizon sequences. In the study area, the Menfro and other similar soil series contribute erosional material to slack water (backswamp) areas during annual flooding episodes (Bian et al., 2023; Hassan et al., 2017) and inevitably contribute sediment that becomes a portion of the fine-earth fraction of the Caruthersville and Commerce soils.

2.2. Laboratory Protocols

Soil pH in water, soil organic matter content and the cation exchange capacity was determined by the University Missouri-Columbia Soil Testing Laboratory. An aqua-regia digestion was performed to estimate near-total elemental concentrations. In this procedure, 0.25 g of finely ground fine earth fraction was digested in 0.01 liter of aqua regia (1 HCl:3HNO₃) for one hour, followed by 0.45 µm filtering with an aliquot analyzed using inductively coupled plasma—atomic emission spectrometry. A Na-acetate leach protocol was performed to estimate salt extractable arsenic concentrations. For the Na-acetate leach, a 0.75 g soil sample passing a 60-mesh sieve was leached with a sodium acetate matrix at 30°C for one hour. The samples were analyzed using inductively coupled plasma emission—mass spectrometry. The detection limit for the Na-Acetate leach was 1 µg kg⁻¹, well below the actual reported concentrations.

For both the aqua regia digestions and the Na-Acetate leach, two reference samples and duplicate sampling were included for quality assurance. The solutions are analyzed using inductively coupled plasma emission-mass spectrometry. The aqua regia digestion and Na-acetate extraction was performed by Activation Laboratories (Ancaster, Ontario). Simple soil statistics included mean, standard deviation, student t-test, and linear regression analysis using Excel.

3. Results and Discussion

3.1. Soil Morphology and Chemical Properties of the Caruthersville and Commerce Pedons

The moderately well-drained Caruthersville pedons have A-C horizon sequences and exhibit slow or medium runoff and moderate permeability. The A horizons have fine sandy loam textures, whereas the C horizons exhibit very fine sandy loam to silt loam textures. The pH intervals for the soil horizons are slightly alkaline, the soil organic matter contents are rather low and range from 0.4 to 1.3%, and the cation exchange capacity is generally low, ranging from 10 to 23.3 cmol kg⁻¹ (Table 1).

The somewhat poorly-drained Commerce pedons have an A-Bw horizon sequence and exhibit slowly permeable pedons. These soils are formed in fine-textured alluvial sediments. The A horizons have slit loam textures, whereas the C horizons exhibit silty clay to clayey textures. The pH intervals for the soil horizons

are slightly alkaline, the soil organic matter contents are moderate and range from 2.2 to 3.4%, and the cation exchange capacity is generally high, ranging from 23.6 to 38.6 cmol kg⁻¹ (**Table 2**).

Table 1. Chemical characterization of the caruthersville pedons.

Horizon	Depth (cm)	pH	Soil OM (%)	CEC (cmol/kg)
Pedon #1				
A	15	7.7	1.1	16.9
C1	30	7.9	0.6	19.8
C2	46	8.0	0.6	17.8
C3	61	7.9	1.6	23.3
C4	91	8.0	0.8	14.4
C5	122	8.1	1.0	16.5
Pedon #2				
A	15	8.1	1.1	16.6
C1	30	8.1	0.8	15.5
C2	46	8.1	0.6	14.0
C3	61	8.1	0.6	13.5
C4	91	7.9	1.3	14.2
C5	122	8.1	0.4	10.0

Soil OM is organic matter; CEC is cation exchange capacity.

Table 2. Chemical characterization of the commerce pedons.

Horizon	Depth (cm)	pH	Soil OM (%)	CEC (cmol/kg)
Pedon #1				
A	15	7.8	3.4	34.8
Bw1	30	7.8	2.6	26.3
Bw2	46	7.9	2.3	27.5
Bw3	61	7.9	2.5	23.6
Bw4	91	7.6	2.9	29.0
Pedon #2				
A	15	7.9	3.4	24.2
Bw1	30	7.9	3.1	28.0
Bw2	46	7.9	2.3	38.6
Bw3	61	7.8	2.2	40.4
Bw4	91	7.7	2.2	29.4

Soil OM is organic matter; CEC is cation exchange capacity.

3.2. Aqua Regia and Acetate Extractions of the Caruthersville and Commerce Pedons

Aqua regia digestion is a near total elemental extraction protocol. In this manuscript, the focus is on arsenic and its relationship to iron (Fe). The iron aqua-regia digestion concentrations are assumed to be almost entirely attributed to iron-oxhydroxide concentrations because i) the phyllosilicate minerals are only partially degraded by the aqua regia digestion procedure and ii) the upland loess soils of the upper Midwest are commonly dominated by goethite, lepidocrocite, and ferrihydrite (Schwertmann, 1993).

The arsenic aqua regia digestion concentrations from the coarse-textured Caruthersville pedons range from 2.7 to 4.4 mg kg⁻¹ (Table 3), whereas the concentrations from the fine-textured Commerce pedons range from 5.9 to 9.8 mg kg⁻¹ (Table 4). Both soils exhibit arsenic concentrations that are within the natural geochemical baseline for the region (Aide et al., 2014), thus arsenic is not considered a potential contaminant. The student t-test determinations are not significantly different for the two pedons of the Caruthersville soil series ($P = 0.41$) and the two pedons of the Commerce series ($P = 0.43$).

Table 3. Aqua regia and acetate extracted arsenic concentrations (mg/kg-soil) for the caruthersville soil series.

Horizon	Aqua Regia Digestion		Acetate Extraction	
	Pedon #1	Pedon #2	Pedon #1	Pedon #2
A	4.0	4.4	0.25	0.27
C1	4.0	3.9	0.27	0.20
C2	3.2	2.7	0.17	0.18
C3	3.3	3.3	0.27	0.16
C4	3.2	3.4	0.23	0.29
C5	3.6	3.2	0.30	0.22
Mean	3.51		0.23	
Std. Deviation	0.47		0.05	

Table 4. Aqua regia and acetate extracted arsenic concentrations (mg/kg-soil) for the commerce soil series.

Horizon	Aqua Regia Digestion		Acetate Extraction	
	Pedon #1	Pedon #2	Pedon #1	Pedon #2
A	7.4	8.5	0.43	0.38
Bw1	8.4	8.7	0.34	0.32
Bw2	8.1	9.0	0.30	0.31
Bw3	9.3	9.8	0.29	0.34
Bw4	8.0	5.9	0.29	0.23
Mean	8.31		0.32	
Std. Deviation	1.099		0.05	

The arsenic acetate extraction concentrations from the Caruthersville pedons range from 0.17 to 0.30 mg kg⁻¹ (**Table 3**), whereas arsenic concentrations from the fine-textured Commerce pedons range from 0.23 to 0.43 mg kg⁻¹ (**Table 4**). Acetate extractions typically recover elements because of ion exchange; thus, the acetate extraction is a potential indicator of arsenic availability. Further research is required to verify the authenticity of the acetate extraction to credential arsenic's bioavailability. Regardless, most of the soil's arsenic pool is chemically bonded with an affinity greater than salt displacement, especially for the Commerce pedons.

3.3. Association of Arsenic with Iron

Regression analysis of the arsenic aqua regia digestion concentrations (dependent variable) with the corresponding iron concentrations (independent variable) show significant correlation involving the pooled Caruthersville and Commerce series (**Figure 1**). All iron values less than 1.5 (%) are from the Caruthersville pedons and all iron values greater than 1.5 (%) are from the Commerce pedons. The discrete differences in the iron concentrations are attributed to the silt loam to clay textures of the Commerce pedons and the sandy loam to silt loam textures of the Caruthersville pedons. The significant regression correlation implies that the arsenic adsorption intensity is dependent on the soil's iron-oxyhydroxide abundances.

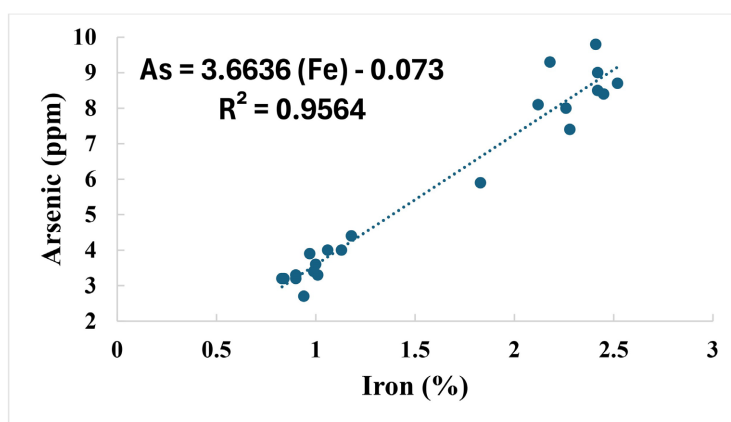


Figure 1. Soil Arsenic relationship with Iron in the Caruthersville and Commerce Pedons.

Given that the pooled Caruthersville and Commerce pedons are entirely separated because of the discrete differences of the independent variable, it is instructive to compare the similarity of the regression lines for the pooled Caruthersville with the pooled Commerce pedons (**Figure 2**). The regression equation for the pooled Caruthersville pedons is: $As = 3.51(Fe) + 0.08$, $r^2 = 0.63$. The regression equation for the pooled Commerce pedons is: $As = 3.82(Fe) - 0.42$, $r^2 = 0.52$. The regression slopes are very similar, suggesting the soil series have a similar adsorption relationship involving arsenic with iron.

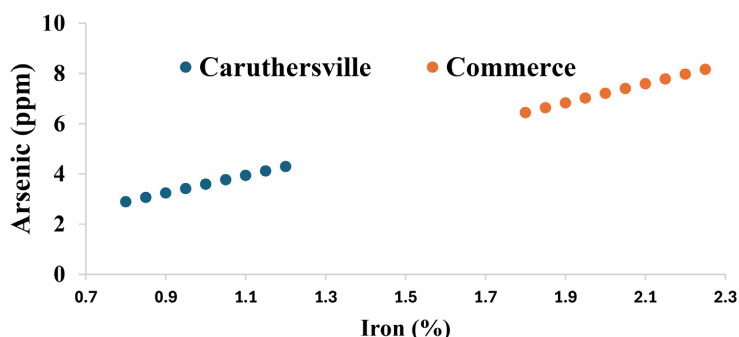


Figure 2. Regression lines for the Caruthersville and Commerce pedons, indicating the similarity of the slopes.

For the two Menfro pedons, regression analysis of the arsenic aqua regia digestion concentrations (dependent variable) with the corresponding iron concentrations (independent variable) show significant correlation (**Figure 3**). All iron values less than 1.5 (%) are from eluvial horizons, whereas all iron values greater than 1.5 (%) are from illuvial horizons. Arsenic concentrations appear to be directly related to the Fe-oxyhydroxide concentrations, with Fe-oxyhydroxide concentrations increasing because of increased clay abundance in the argillic horizons. The similar iron-oxyhydroxide concentrations and the quantity of adsorbed arsenic support the premise the upland erosion provides parent materials to the floodplain soils.

The Menfro pedons do indicate slightly greater arsenic adsorption relative to the iron-oxyhydroxide substrate than either the Caruthersville or Commerce pedons.

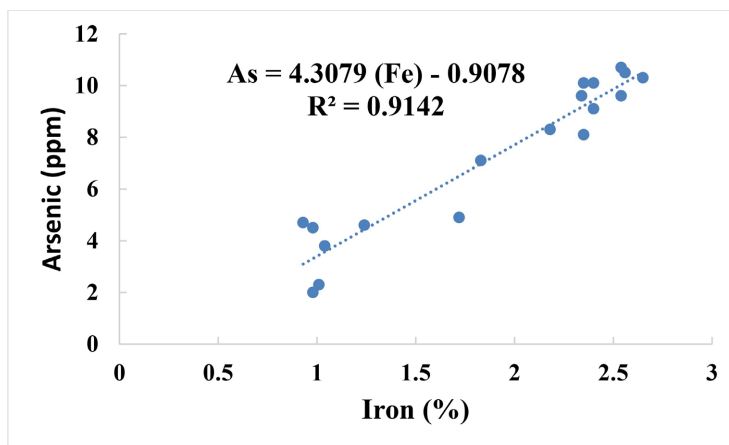


Figure 3. Soil arsenic relationship with iron in two pedons of the Menfro soil serie.

3.4. Arsenic Remediation in Floodplain Soils

The literature noted that the two dominant sediment sources for providing parent material in Mississippi River floodplains are: i) erosional material from upland positions, and ii) fluvial deposition. Fluvial deposition is river transported sedi-

ment, which originated from upstream upland positions, that may have been previously deposited and then resuspended and subsequently transported again. These sediment sources may have inherited elevated arsenic concentrations, or the present floodplain soils may have impacted because of human activity. Many major rice producing floodplains/delta regions are arsenic impacted by tube wells and elevated arsenic groundwater concentrations (Aide & Braden, 2022; Burton et al., 2014; Connolly et al., 2022).

Dissimilatory Fe-oxyhydroxide dissolution and arsenate reduction may lead to increased mobility of arsenite, potentially being re-released to the river and resulting in loss of arsenic from floodplain soils. Arsenite formation and the subsequent transport from floodplain soils is characterized as a first order kinetic reaction, where the time derivative is $d(\text{arsenite loss})/dt = -k_1 * (\text{initial soil arsenic concentration})$. The k_1 is the reaction rate constant. Integration from A_0 to A results in $A = A_0 \exp(-k_1 t)$, where A_0 is the initial arsenic concentration and A is the eventual arsenic concentration and time ranges from 0 to t (Boyce & DiPrima, 1977). The time dependent reduction of the arsenic concentrations follows a Boltzmann distribution (Figure 4).

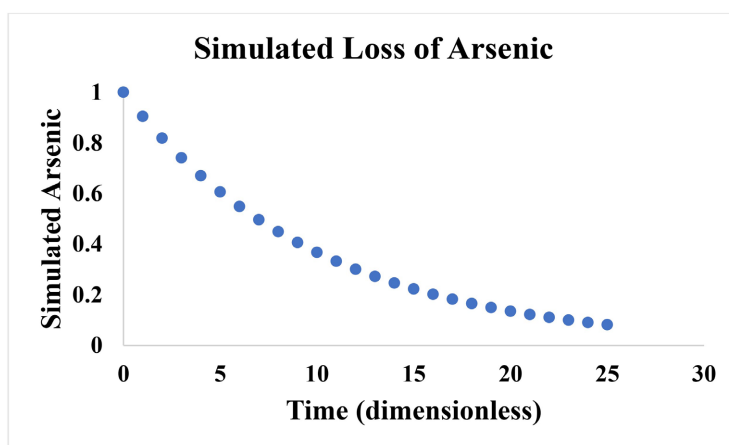


Figure 4. A simulation of arsenic loss from a floodplain soil because of dissimilatory reduction during anaerobic soil conditions.

In this simulation the initial arsenic concentration was standardized to unity, and the time intervals are dimensionless. This simulation is a qualitative estimate, given uncertainties associated with: i) the soil's vertical and horizontal hydraulic conductivity, ii) the likelihood that flooding will produce anoxic soil conditions, iii) the need to research and fully characterize the kinetics of the arsenic loss, iv) the soil's permeability and drainage, v) what will be the fate of the released arsenic, and vi) other factors. The value of the simulation is that floodplain soils that have increased arsenic concentrations may be reclaimed by natural annual flooding and non-problematic floodplain soils may be protected by permitting annual flooding rather than installing engineered flood prevention structures.

3.5. Identification of Sediment Source Areas

Sediment source fingerprinting uses physical and chemical tracers to indicate the source of eroded soil and river sediment in the fluvial environment. The technique matches transported river sediment to potential source areas on land using a combination of tracers, including radionuclides, elemental geochemistry, mineral magnetism, and human generated contaminants (Xu et al., 2022).

For large-scale river basins, Xu et al. (2022) noted the difficulty of isolating sediment sources and their importance because of the locational and historical differences in erosional processes, sediment transport and deposition, and lack of sediment monitoring data. In their review of sediment source fingerprinting across the Mississippi River Basin, they determined the unique information provided by sediment source fingerprinting that is independent of monitoring techniques. In their review, most studies provided credible fingerprinting data indicating that near-channel sources are the dominant sediment sources. Sediment source fingerprinting is deemed to be a reliable sediment source indicator and supports basin-scale management. Recently, centralized fluvial fingerprint databases combine scattered studies into standardized maps for better basin-wide management (Xu et al, 2022).

Bian et al. (2023) improved the Dynamic Land Ecosystem Model to evaluate the influence of climate and land management changes on Mississippi River basin sediment yield. Total sediment yield increased from 1980-2018 intensified extreme precipitation across the cropland-dominated Midwest region. Belmont et al. (2011) incorporated geochemical fingerprinting and selected geomorphic changes with a sediment mass balance for a Mississippi River tributary watershed to demonstrate that the dominant source of sediment is accelerated erosion of stream banks and bluffs. This change in sediment sources is attributed to greater river discharge. With appropriate soil arsenic sampling, arsenic may be indicated as a potential addition to the elemental geochemistry inventory utilized by sediment source fingerprinting protocols.

4. Conclusion

Soil arsenic concentrations at two Mississippi River floodplain sites show limited or no arsenic accumulation, either at the surface or within the soil profiles. The sites composed of the Commerce soil series did exhibit greater arsenic concentrations, a feature attributed to the soil's fine texture. Two pedons of the overlying loess uplands also exhibited incidental arsenic concentrations that were similar to the floodplain soils, a feature consistent with erosional upland sediment constituting a potential sediment source area. Arsenic concentrations in the upland soils were greater in the illuvial horizons, suggesting that iron-oxyhydroxides are responsible for arsenic adsorption.

The parent material for the Caruthersville soils is consistent with Mississippi River bedload deposition. Topographic maps indicate that the drainages from upland positions transport sediment-bearing runoff to the backswamp areas of the

Commerce site, adding to the sediment-bearing floodwater of the Mississippi River. Further research may support arsenic as a geochemical indicator for sediment source fingerprinting. The correlation of the arsenic geochemical with other sediment source fingerprinting may provide a more compelling case for validating the sediment source areas.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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