SPECIAL REPORT/INTERNATIONAL PERSPECTIVES

Brownfields in Romania and the United States: A Visual Tour

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Abstract **This third article in a series of three on land reuse describes brownfield sites in Romania and the U.S. In 2018 and 2019, four of the authors toured brownfield areas in Romania (including Bucharest, southern Transylvania, and Oradea) and the U.S. (Southeast Missouri [called the Missouri Bootheel], Northern Arizona and Navajo Nation, and Northwest Indiana). We were interested in similarities and differences among brownfields in various urban and rural settings in both countries. This article describes these sites through a visual perspective as well as site characteristics and commonalities. Ultimately, potentially contaminated or land reuse sites such as brownfields are common in many parts of the world. We hope to advance the understanding of brownfields and site transformation options through our collaboration.**

Introduction

We authors are members of the Brownfields & Reuse Opportunity Working Network (BROWN), a consultative collaboration that provides free assistance related to land reuse and public health concerns (Agency for Toxic Substances and Disease Registry [ATSDR], 2020). BROWN was created and is facilitated by the National Land Reuse Health Program within the Agency for Toxic Substances and Disease Registry (ATSDR, 2022). We are also part of the North American European Brownfields Working Group, a special initiative of BROWN.

In the U.S., brownfields are defined as property where the expansion, redevelopment, or reuse can be complicated by the presence of hazardous substances, pollutants, or contaminants (U.S. Environmental Protection Agency [U.S. EPA], 2022a). While Europe does not have a common definition of brownfields, the concept generally is associated with land contamination (Cobârzan, 2007; Grimski & Ferber, 2001). Brownfields reuse and redevelopment in Europe and the U.S. present many opportunities for community design, reduction of sprawl, taking pressures off green or undeveloped land, and improving community and environmental health outcomes through safe and sustainable reuse practices and community design.

To enhance our collaborative research on brownfields redevelopment practices, regulations, and policies in Europe and the U.S., we examined the nature and type of a number of brownfield case study sites in Romania and the U.S. During the summers of 2018 and 2019, our team toured brownfield sites in both countries. Through our intercontinental collaboration, we intend to broaden the technical and policy knowledge related to brownfields redevelopment and restoration. Further, we plan to disseminate best practices among policy makers and the various stakeholders including developers, regulatory personnel, academicians, and the public.

Brownfields in Romania

Bucharest

Romania is the 12th-largest country in Europe, with a population of approximately 22 million, and is the 6th-most populous member state of the European Union. Our brownfields tour commenced in the capital city of Bucharest. Located in Southern Romania, Bucharest (population of 2,143,132) is the nation's economic, political, administrative, and cultural center. As shown in Table 1, the city of Bucharest has an unemployment rate of 0.7%, approximately one half that of the country of Romania; employed people make up 45.9% of the population, which is approximately double the percentage of employed people in the country (Romanian National Institute of Statistics, 2020).

The development and planning of this urban and densely populated capital city was strongly influenced by various historical periods. At the end of the 19th century and beginning of the 20th century, Bucharest was known as the Little Paris because of its unique and extravagant architecture. During this period, the National Theater, Bucharest Academic Society, Bucharest Philharmonic Orchestra, University of Bucharest, Grand Hotel du Boulevard, Romanian Athenaeum, and National Bank of Romania were constructed.

After World War II, Romania became a communist country. For almost one half a century, industrialization was the most important episode in the economic and political history of the country, aiming to transform the mainly agrarian state in to an industrial one. The city of Bucharest grew rapidly and became the national center of economic production and population growth. In addition to industrial expansion, the communist regime designed large, imposing buildings to project a sense of its power. Many of these buildings

TABLE **1**

Demographic Indicators for Romania and Select Cities

Indicator	Romania	Bucharest	Oradea
Population (total)	22,193,286	2,143,132	221,473
Employed (total)	5,164,471	984,014	94,612
Unemployed (total)	257,865	15,248	629
Employed (%)	23.3	45.9	42.7
Unemployed (%)	1.2	0.7	0.3

Source: Romanian National Institute of Statistics, 2019.

FIGURE **1**

Radio House in Bucharest

FIGURE **2**

Dunărea Hotel in Bucharest

FIGURE **3**

Old Farm Buildings in the Historical Region of Transylvania Bounded by the Carpathian Mountain Range

are now vacant and deteriorated, leaving a trail of brownfields across the country.

Our tour of brownfields in Bucharest included former communist-era sites and other historical buildings. Sites featured in this article include a former communist-era Romanian museum and a former mid-20th century hotel.

The Radio House (or the Dâmbovița Center) is an example of a typical communist-era building (Figure 1). It was built in the late 1980s as a Romanian Communist Party museum. From one of the building's balconies on August 23, 1989, former Romanian dictator Nicolae Ceaușescu watched the last communist-style parade in Romania, dedicated to Romania's National Day. Currently the unfinished building is abandoned, but there are plans for converting it in to a large residential and commercial center (OfficeRentInfo.RO, 2022). The contaminants of concern are lead-based paint and asbestos.

The second featured site is the former Dunărea Hotel (Figure 2). It was built in the interwar period (1935–1940) and for several decades was one of the most famous hotels in Bucharest. An earthquake in 1977 severely damaged the building—it is now in an advanced stage of decay and has been vacant for over 30 years. As the hotel is in a prominent location in the city, it is a priority for redevelopment. Plans for rehabilitation and transformation of this historical building exist, but no project has been implemented yet (Neagu, 2018). Contaminants of concern include lead-based paint and asbestos.

Transylvania and Oradea

Prior to a tour of Oradea, coauthors Dr. Laurel Berman and photojournalist Lloyd DeGrane independently hiked over 50 miles through the Carpathian Mountains in Southern Transylvania. Brownfields there were primarily rural and consisted largely of abandoned and deteriorated former farmhouses (a typical rural site is shown in Figure 3), which based on their age could have lead-based paint, asbestos, and mold contamination. In some of the villages, former communist-era vacant factories loom over the landscape.

During our visit in Oradea, our tour included historical military brownfields and communist-era industrial sites. Sites included a former fortress and a former aluminum production industrial site. The city of Oradea is in Northwest Romania and has an approximate population of 221,473 (Romanian National Institute of Statistics, 2019). Because of its geostrategic importance (a combination of political and geographic locations that are primed for strategic planning on various levels), Oradea played a significant historical role in its 1,000-year history as a bridge between the West and East in Europe. Oradea declined, however, during the 20th century. In the last 10 years, Oradea has received $150 million Euros from the European Union (EU) to improve urban infrastructure and increase the quality of life for its residents (Simic, 2018). Although the city has begun a revitalization process with EU funds (Morar, Lukić, et al., 2021), many brownfield sites remain that need remediation and restoration, similar to many other cities in Romania.

Like Bucharest, Oradea has a low unemployment rate of 0.3%, approximately one quarter that of Romania. Employed people make up 42.7% of the population, which is approximately double the percentage of employed people in the country (Table 1; Romanian National Institute of Statistics, 2019). The city of Oradea had its greatest urban transformation and economic growth during the communist period (1948–1989), with the implementation of the central planning and economic development model, primarily based on heavy industry (Morar et al., 2019). Over time, this model proved to be economically inefficient. The political and

economic changes during the last decades of the 20th century led to the transition to the free market economy that is currently in place. Many communist-era industries could not adjust to the new economic environment, however, leaving behind large urban areas of derelict, abandoned, and underused brownfields (Morar et al., 2016).

One of the brownfields case studies in Oradea is the Fortress of Oradea (Figure 4), which represents the initial medieval urban nucleus of Oradea. It was built as early as the 11th century under the rule of King Ladislaus I. The medieval fortress consisted of a circular inner castle, highlighted by a pentagonal outer castle. The fortress was rebuilt in the 16th century to represent Renaissance architecture and center-oriented urban planning. Military use of the fortress ended by the middle of the 19th century, after which it served only as auxiliary facilities. Between 1947 and 1952, the northern section of the fortress was used by the former Romanian Secret Police (i.e., the Securitate). The fortress also housed military units between 1945 and 1989, but after 1975 the structure entered a deterioration phase and was used mainly as military warehouses.

Renovation work on the fortress occurred between 2010 and 2021 to remove lead-based paint and mold and to redevelop the site. Now the renovation efforts are focused on the surrounding defensive walls, which are scheduled to be done during the next 2 years. The fortress currently functions as a multicultural place for the city, offering tourist sights, cultural programs, concerts, festivals, and various events. As a traditional military site incorporated in a city's urban architecture, this site's heritage as a Renaissance structure in Transylvania is a valuable regional asset.

In Oradea, industry began to develop after 1950. During the communist era, large industrial areas were developed, many of which are now brownfields. The former aluminum factory in Oradea that began operating in 1965 is part of a typical communist-era site (Figure 5). For several decades, the factory was one of the first nonferrous metallurgy sites in Romania. This industrial development was based on the availability of local bauxite deposits (Brejea et al., 2019).

The reduced demand for raw material in the 1990s led to closure of the bauxite mining unit in 1999, leaving behind contaminated land including an open pit mine and abandoned processing facilities (Dragastan et al., 2009). The factory was permanently closed in 2006. The massive amounts of bauxite residue saturated with caustic soda resulted in an 800,000 m^2 surface of "red mud" from decades of aluminum processing. The historical operations at this site released highly alkaline compounds including trace amounts of toxic compounds, heavy metals, and radioactive materials that produce radon, which resulted in environmental pollution of air, groundwater, and soil. Such pollutant exposures potentially can result in adverse population health impacts such as respiratory illness (Economic Commission for Europe, 2001; Kovacs et al., 2017; Totorean, 2019). The aluminum factory and other industrial sites from the communist era left a landscape of large, abandoned, and contaminated sites throughout Romania. Often, these sites are contiguous, which complicates the contamination profile.

FIGURE **4**

Exterior (Left) and Interior (Right) of the Fortress of Oradea, Romania

FIGURE **5**

Former Aluminum Factory (Left) and Bauxite-Contaminated Soil on the Former Aluminum Factory Site (Right) in Oradea, Romania

Brownfields in the United States

The Missouri Bootheel

Our first U.S. brownfields tour was the Missouri Bootheel. The Bootheel is in the far southeast corner of the state, which looks like the heel of a boot, hence the name "Bootheel." It is a largely rural area that is bisected by Interstate 55 and Highways 60 and 61. Historically, the Bootheel was a swampy wetland area formed by flooding from the Mississippi and Ohio Rivers. The area is referred to as the Mississippi Alluvial Basin (Missouri Department of Conservation, 2005). The five primary counties within the heel shape of the boot include Dunklin, Mississippi, New Madrid, Pemiscot, and Scott counties. These Bootheel counties have the lowest health rankings among all 115 Missouri counties (Missouri Bootheel Regional Consortium Inc., 2019).

Howardville, in New Madrid County, was founded by Travis Howard in 1953, who

FIGURE **6**

Exterior of Howardville High School (Left) and Interior of the Howardville High School Gymnasium (Right) in Howardville, Missouri

FIGURE **7**

Inactive Cotton Gin in the Missouri Bootheel (Left) and Drums Stored Outside an Inactive Cotton Gin Undergoing Demolition (Right) in the Missouri Bootheel

FIGURE **8**

Active Gas Station With Old Fuel Tanker Trucks in Portageville, Missouri

FIGURE **9**

Vacant Historic Sharecropper Home in Homestown, Missouri

established an African American community and a school to provide a higher-quality education for African Americans than what was available at the time. Howardville is centrally located in the Bootheel, with a reported census population of 346 that is 96.2% Black or African American (U.S. Census Bureau, 2020a). The household median income for Howardville residents is $30,577 and 14.5% of the population is below 100% of the poverty level (U.S. Census Bureau, 2020a). In contrast, the total population of New Madrid County is 17,275, of which 81.0% of the population is White and 15.8% is Black or African American. The household median income in New Madrid County is $40,129 and 20.7% of the population is below 100% of the poverty level (U.S. Census Bureau, 2020b).

In the 1930s, cotton was the primary cash crop in the Bootheel and many of the farmers were renters or sharecroppers (i.e., farmers who rented land and paid in shares of crops). Many of these farmers were Black who, in the post-slavery times, were paid much less than other farmworkers (Cantor, 1969). In the late 1930s, landowners did not want to share government subsidies with sharecroppers and planned a mass eviction. A local minister, Owen Whitfield, protested the ongoing evictions and organized the Sharecroppers Roadside Demonstration of 1939. Hundreds of sharecroppers camped along the main highways of the Bootheel, drawing national attention to their plight. Ultimately the Farm Security Administration created low-rent housing developments, known as the Delmo Homes, for 500 sharecropper families (Cantor, 1969). Many of these housing developments currently are occupied by family members descended from the sharecroppers. Some of the homes that might have asbestos-containing material and lead-based paint have become abandoned and deteriorated.

The Bootheel area is littered with petroleum brownfields, abandoned cotton gins, and boarded or vacant commercial and residential buildings. While many suspected brownfields and land reuse sites have not yet received assessment or cleanup funding, the U.S. Environmental Protection Agency's (U.S. EPA) My Environment website search of Bootheel counties lists one Superfund (National Priorities List) site in Sikeston (New Madrid County) and 11 brownfields that have received U.S. EPA funding throughout the Bootheel (U.S. EPA, 2020a).

A review of Bootheel brownfields in the U.S. EPA database Cleanups in My Community indicates that contaminants of concern include petroleum, solvents (e.g., volatile organic compounds), lead, and asbestos (U.S. EPA, 2021). The websites My Environment and Cleanups in My Community only list sites that have received funding from U.S. EPA for assessment or cleanup, including Superfund or National Priorities List sites, or sites that are required to report emissions into the environment (e.g., emit permitted amounts of hazardous waste). Sites featured

TABLE **2**

Demographic Indicators for Navajo Nation and Holbrook Areas of Arizona and New Mexico

Indicator	Chinle, Arizona	Apache County, Arizona	Holbrook, Arizona	Navajo County, Arizona	Navajo, New Mexico	McKinley County, New Mexico
Population	4,291	65,623	5,073	108,147	1,818	71,780
Median household income (in 2020 dollars)	$30,667	$33,967	$45,106	$43,140	$25,323	$36,179
Persons in poverty (%, below 100% of poverty level)	53.5	32.4	20.9	23.3	60.5	32.0
Race (%)						
White	3.5	22.6	50.6	51.1	0.6	15.7
Black or African American	0.7	0.6	7.1	1.1	0.1	0.6
American Indian and Alaska Native	91.8	74.5	27.9	44.6	95.4	79.9
Hispanic or Latino	0.4	7.1	30.0	12.1	1.3	14.6

Source: U.S. Census Bureau, 2020c, 2020d, 2020e, 2021a.

in this article include the old Howardville High School (Figure 6); an inactive cotton gin (Figure 7); an active auto gasoline and service station with old fuel tank trucks stored behind the facility (Figure 8); and a vacant historic sharecropper home that is typical of many abandoned residential structures in the Bootheel (Figure 9).

Brownfields in Navajo Nation and Northern Arizona

Our second U.S. brownfields tour was in the Navajo Nation Chapters of Chinle and Red Lake and in Holbrook, in Northern Arizona. Navajo Nation extends across the Four Corners region of Arizona, New Mexico, Utah, and Colorado and encompasses 27,000 mi^2. Also known as Diné Bikéyah, or Navajoland, the Navajo Nation reservation is larger than 10 of the 50 states in the U.S. (Navajo Nation Government, 2022). Demographic information for the Navajo Nation and Holbrook communities is summarized in Table 2.

Chinle, Arizona

The Chinle Chapter is a small city in Apache County that is home to Canyon de Chelly. The canyon historically was home to Puebloan and Hopi before Navajo settled there (National Park Service, 2021). As shown in Table 2, approximately 54% of Chinle residents are in poverty (U.S. Census Bureau, 2020c) compared with 32% of Apache County residents (U.S. Census Bureau, 2021a). Chinle residents have a median household income of $30,667 (U.S. Census Bureau, 2020c), which is comparable to that for Apache County ($33,967) (U.S. Census Bureau, 2021a).

The My Environment website from U.S. EPA for Chinle, Arizona, in Apache County did not indicate any known land reuse or brownfields sites (U.S. EPA, 2020b). As previously discussed, however, the My Environment website only lists sites that have received funding from U.S. EPA for assessment or cleanup. Navajo tribal officials are aware of several brownfields in Chinle that have not received funding to perform assessments or cleanup (A. McCabe, personal communication, June 19, 2019). Sites we visited in Chinle included vacant residential and commercial properties, two petroleum leak sites, and a vacant fast-food restaurant. Chinle sites included in this article include vacant parcels that are under consideration for redevelopment as a crafts village for artist vendors (Figure 10).

Navajo, New Mexico

The Red Lake Chapter is in Navajo, New Mexico, in McKinley County. It is rural and was developed as a company town around the now-defunct 103-acre Navajo Forest Products Industry (NFPI) site. Approximately 60.5% of Navajo residents are in poverty (U.S. Census Bureau, 2020e), compared with 32.0% of McKinley County residents (U.S. Census Bureau, 2021a; Table 2).

The My Environment website indicated two brownfields in the city of Navajo, New Mexico, including the NFPI site that is featured in this article (U.S. EPA, 2020c; Figure 11). The NFPI site currently is undergoing extensive site assessment by the Navajo Nation Environmental Protection Agency. Debris has been removed from the site, but there are large areas in and around the site that have wood chip fill that could be contaminated with asbestos. Much of the soil is also contaminated with benzene and naphthalene (P. Maples, personal communication, June 19, 2019).

Holbrook, Arizona

The City of Holbrook, Arizona, in Navajo County is along Route 66 and is considered the gateway to the Petrified Forest (City of Holbrook, n.d.). Holbrook is a former tourist town that has a large corridor of vacant gasoline and automobile service stations, along with old residential and commercial buildings. As shown in Table 2, Holbrook's median household income is $45,106—slightly higher than the overall Navajo County median ($43,140)—and 20.9% of residents are in poverty, which is slightly lower than the rest of Navajo County (23.3%). Sites that we visited in Holbrook included petroleum brownfields and vacant commercial and residential buildings, including an old automo-

FIGURE **10**

Fenced Structure Within Proposed Vendor Village Site (Left) and Proposed Vendor Village Site Tour and Phase I Environmental Site Assessment Conducted by Licensed Environmental Professional Dave Laney (Right) in Chinle, Arizona

FIGURE **11**

Landscape of the 103-Acre Navajo Forest Products Industry Site in Navajo, New Mexico

FIGURE **12**

Vacant Automobile Service and Repair Station in Holbrook, Arizona

FIGURE **13**

Vacant and Deteriorated Hotel in Holbrook, Arizona

bile gas and service station and a vacant, deteriorated hotel (Figures 12 and 13).

The My Environment website indicated three brownfields in Holbrook (U.S. EPA, 2020d). Our tour host in Holbrook was Dave Laney, an experienced licensed environmental professional. Laney indicated that the city has been unsuccessful in securing U.S. EPA brownfields funding to clean up significant petroleum contamination in the groundwater from numerous automobile service and gasoline stations that are vacant. Laney also relayed that there are numerous vacant commercial and residential properties suspected to have lead-based paint and vapor intrusion issues due to the petroleum plume at a shallow depth below ground level (D. Laney, personal communication, June 18, 2019).

Holbrook is one of the communities in the Route 66 Partnership organized by the Arizona Department of Environmental Quality. Launched in 2004, the partnership is a network of local, state, and federal agencies and organizations that helps communities identify resources for assessment, cleanup, and redevelopment at current and former leaking underground storage tank sites, abandoned gas stations, and other underutilized sites along Route 66 in Northern Arizona (U.S. EPA, 2011).

Brownfields in Northwest Indiana

We concluded our U.S. brownfields tour in Northwest Indiana, visiting the former industrial cities of Gary and East Chicago in what is known as the Calumet Region in Lake County, Indiana (Figures 14 and 15). Despite its industrial past that was heavily focused on steel production and chemical plants, the Calumet Region is home to the Indiana Dunes National Shoreline, several wetlands, and rare natural areas (Calumet Heritage Partnership, 2022).

Demographic indicators for Gary, East Chicago, and Lake County are summarized in Table 3. Gary is nearly 3 times the size of East Chicago. Both cities are racially diverse. Gary's majority population is 78% Black, and East Chicago's majority population is 58% Hispanic or Latino and 36% Black. In contrast, the population of Lake County is primarily White (71%). The median household income in Gary and East Chicago is approximately $35,000 and $31,000, respectively, which is below the county's median household income of approximately $57,000. In Gary, 33% of the population is in poverty; in East Chicago, 31% of the population is in poverty. In Lake County, 16% of the population is in poverty (U.S. Census Bureau, 2021b).

The Grand Calumet River runs throughout the Calumet Region. It is one of the Great Lakes Areas of Concern (AOC) under the Great Lakes National Program Office within U.S. EPA (U.E. EPA, 2022b). AOCs have experienced significant environmental degradation. The Grand Calumet AOC has legacy contamination that includes polychlorinated biphenyls (PCBs); polycyclic aromatic hydrocarbons (PAHs); heavy metals including but not limited to mercury, cadmium, chromium, and lead; and oil and grease (U.S. EPA, 2022c).

The My Environment website indicated 2 Superfund and 34 known brownfield sites in Gary and 1 Superfund and 16 known brownfield sites in East Chicago (U.S. EPA, 2020e, 2020f). There are, however, additional numerous vacant sites, including old gas stations, multiunit residential buildings, schools, parking structures, and homes in both cities.

Coauthor Lloyd DeGrane began photographing land reuse sites in the region in 2009 and continues to document and archive the

TABLE **3**

Demographic Indicators for Gary, East Chicago, and Lake County in Indiana

Indicator	Gary, Indiana	East Chicago, Indiana	Lake County, Indiana
Population	68,325	26,099	498,558
Median household income (in 2020 dollars)	$31,315	$35,396	$57,530
Persons in poverty (%, below 100% of poverty level)	33.1	30.6	15.8
Race (%)			
White	14.5	24.5	71.0
Black or African American	77.9	36.0	24.5
American Indian and Alaska Native	0.1	0.1	0.6
Hispanic or Latino	8.9	57.5	20.4

Source: U.S. Census Bureau, 2021b.

FIGURE **14**

Marktown in East Chicago, Indiana

area for brownfield sites. In July 2019, we revisited several sites he documented. There had been few to no environmental improvements at these sites in the last decade. Sites we visited in Gary included old schools, churches, businesses, and residential areas. Photos include a vacant multiunit apartment building (Figure 16) and two vacant businesses including a dry cleaner and an old tire facility (Figure 17).

Discussion: Brownfields in Romania and the United States

Brownfield sites can occur in any location in the world where people have conducted work that involves use or storage of hazardous materials. As illustrated in this article, sites can be in the middle of a bustling metropolis such as Bucharest or quietly situated along a forgotten highway such as Route 66, or they can be in rural or remote areas. While it is easy to point to abandoned industrial sites as potential areas of concern, it is often more difficult to identify and document old, abandoned farmhouses—such as those in the Missouri Bootheel or the Carpathian Mountain—as sites with the potential to pose health risks. Many of the same hazards, however, can exist in both locations due to sources of environmental pollution and the similar fingerprinting of chemical constituents in the polluted environment.

When specifically comparing Eastern European brownfields with those in the U.S., urban areas in Romania such as Bucharest and Oradea have high employment rates and nearly all-White populations. These demographics are very different from the urban areas with the heaviest brownfields burden in the U.S., mainly those with predominant populations of color or lower socioeconomic status (e.g., Gary and East Chicago, Indiana). Often, many of the brownfield sites in the U.S. are more isolated geographically (e.g., Chinle, Arizona, and the Missouri Bootheel), lessening the visual exposure of the sites to larger numbers of people. The rural, mountainous areas of Transylvania in Romania are similarly isolated, bringing the saying "out of sight, out of mind" to consciousness.

This varied landscape of geographic locations of brownfields, the environmental impacts of pollution at the sites, and their proximity to human populations play a significant role in the source-to-receptor paradigm and the extent and scope of potential adverse public health effects associated with exposure to pollutants emanating from brownfield sites. These factors necessitate proper training of local scientists, policy makers, and the public about brownfield issues from a local perspective to advance a successful brownfields restoration program that is responsive to local, ecological, and public health concerns of all stakeholders.

We should note that when examining contaminants at brownfield sites, many similar contaminants of public health concern exist regardless of geographical location—these contaminants include mold, lead, asbestos, petroleum products, solvents, volatile organic compounds, PCBs, PAHs, and heavy metals. The industrial sites often have a more complex pollution profile that includes various pollutants in air, water, and soil. The sites visited, whether the communist-era factories in Oradea compared to industrial sites in Gary and East Chicago, or the old farm buildings in the Carpathian Mountains compared to sharecropper cottages in the Bootheel, told similar stories regardless of their country of origin. Similar human industrial activity conducted around comparable areas can produce similar contaminants of concern that threaten human health across the globe.

Once the source and constituents of environmental pollution are identified via initial site investigation of brownfields, site remediation alternatives can be developed to clean up the site per health-based cleanup standards and return it to productive use. The entire process requires expertise from different disciplines including engineers, geologists, hydrogeologists, chemists, statisticians, toxicologists, public health professionals, and risk assessment experts. In the U.S., under the U.S. EPA Brownfields Program, this process is well-developed, implemented, and administered by state and local agencies from administrative, legal, technical, and financial perspectives. In Romania, however, there is a less developed and formally adopted process that is practiced, serving as a potential impediment to the

FIGURE **15**

Calumet Industrial Canal in East Chicago, Indiana

FIGURE **16**

Vacant and Deteriorated Multiunit Residential Building in Gary, Indiana

FIGURE **17**

Vacant Dry Cleaning Facility (Left) and Vacant Tire Facility (Right) in Gary, Indiana

FIGURE **18**

Historic Sharecropper Home Being Rehabilitated by Owner Robert Robinson in North Lilbourn, Missouri

Note. Robert Robinson died in 2020 due to COVID-19.

development of brownfield sites. Instituting a robust brownfields revitalization program nationally, regionally, and locally may be essential to the successful return of sites to productive use, elimination or reduction of potential adverse ecological and public health impacts, and simultaneous revitalization of the economy.

In Romanian brownfields areas, the unemployment and poverty level are low, and the population is primarily White. In the U.S., brownfields areas we visited were characterized by high unemployment, high poverty rates, and racial and ethnic variability. In the U.S., a high prevalence of predominantly Black, Hispanic, and Native American populations reside within or near brownfield case study sites.

The U.S. brownfields areas we visited could be considered to be environmental justice communities. Environmental justice emphasizes that all people have an equal opportunity to live, work, and play in a healthy environment. Communities with a high percentage of brownfields and hazardous waste sites often have a disproportionate burden of environmental and health hazards. In the U.S., many of these areas are lower income and historically marginalized communities. These factors highlight significant environmental justice concerns regarding the prevalence of brownfield sites in the U.S. being overwhelmingly situated in similarly low-socioeconomic regions with heavier pollution and health-risk burden for the populations living there.

Our ability to use U.S. EPA-developed tools such as My Environment and Cleanups in My Community facilitated our mapping of locations and identifying source profiles and other critical information for brownfield sites and/or other hazardous waste sites within the inventory of the U.S. EPA across the case study areas. These tools are available to the public and not only empower communities about the potential hazards in their own neighborhoods but also allow tracking of improvements in environmental and public health conditions over time in a specific locality. Similar tools are not available in Romania. We suggest the development of similar tools in Europe to share information with the public transparently, to empower communities, and to foster brownfields development and restoration.

Conclusion

While brownfields can lead to poor environmental conditions and disinvestment in the communities in which they are located, they exist throughout the world. Brownfields provide a rich global laboratory to study and comprehensively advance the science and practice of site investigation, remediation, and restoration with stakeholder input from various perspectives: administrative, legal, environmental, public health, economic, and sustainability. Thus, brownfields can be treated as opportunities to foster and re-create communities to improve overall community health—physical, economic, environmental, and public health.

We suggest an international action and global cooperation to adopt similar frameworks and practices for the evaluation and remediation of brownfield sites. Similar environmental pollution profiles and associated hazards and health risks govern the environmental fate of pollutants and their intrinsic toxicity, regardless of country of origin. Further, we suggest an international training and mentoring program to educate the next generation of scientists, scholars, and prac-

titioners who serve as agents of change for community revitalization. This program can incorporate public health and environmental sustainability principles in brownfields development in public agencies and nonprofit organizations such as community advocacy and environmental justice organizations.

Brownfields can be personal. Our team not only explored brownfields in Romania and the U.S. but also shared the historical and current conditions that touch on impacts that go beyond contamination, gaining a small glimpse of the lives of community members burdened by these sites. We met people who are directly working to improve their community and environment by remediating brownfields. We dedicate this article to the memory of one of these local champions, Robert Robinson, a North Lilbourn resident of the Missouri Bootheel, who was passionate about redeveloping his family's sharecropper home (Figure 18).

Editor's Note: This review article is the third in a series of three that examine brownfields redevelopment as a subset of overall land use and reuse practices in Europe and the U.S. These articles are a result of a collaboration of the North American European Brownfields Working Group, a subgroup of the Brownfields & Reuse Opportunity Working Network (ATSDR, 2020). The working group aims to share and highlight best practices to promote healthy, sustainable redevelopment globally. The first article presented the European landscape of brownfields redevelopment through policy and funding frameworks (Morar, Berman, et al., 2021). The second article examined brownfields redevelopment in the U.S. through regulatory, public health, and sustainability lenses (Berman et al., 2022). This third article presents a comparative analysis of brownfields in the U.S. and Romania.

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