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Interface between Sustainability, Public Health, and Environment: Indicators for Measuring and Tracking Impacts of Brownfields Redevelopment

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Abstract

This manuscript provides an overview of the Agency for Toxic Substances and Disease Registry's Action Model and Action Model Toolkit. Through a simple 4-step brainstorming process, the Action Model engages a diverse array of community members, the Development Community, in community revitalization plans. The Action Model's fourth step results in community-driven indicators associated with redevelopment. This manuscript discusses the consolidation of over 200 Action Model indicators from 40 communities, resulting in the Action Model Toolkit, which highlights 69 redevelopment indicators common to 20% or more of the communities. The indicators are in nine categories: built environment, community involvement, economy, education, environmental improvement, environmental resources, housing, physical health, and safety and security. Example indicators from a redeveloped former United States Air Force base are featured. Any community may use the Action Model Toolkit to implement their own Action Models and encourage the selection of common indicators or to derive their own unique indicators through sustainability, public health, and environmental lenses.

Keywords

Brownfields; Action Model; Public Health; Sustainability Indicators; Environmental Indicators; Community Revitalization Models

1 Background: Brownfields and Public Health

The Agency for Toxic Substances and Disease Registry (ATSDR) includes brownfields as a type of land reuse site. These sites are potentially contaminated properties that could be revitalized or redeveloped. Land reuse sites include previous industrial sites that are now vacant; brownfields; sites permitted to treat, store, or dispose of hazardous waste that may have violated their permit (e.g., Resource Conservation and Recovery Act corrective action sites); landfills; and sites that might be on the U.S. Environmental Protection Agency (EPA) National Priorities List for remediation—commonly referred to as Superfund sites (ATSDR, 2023, September 20). The different types of land reuse sites have different regulatory steps for redevelopment. For example, Superfund sites are prioritized and undergo rigorous investigation under the EPA Superfund program, but this step often requires years of litigation and remediation before reuse can be achieved. Some brownfield sites, such as former industrial sites, have a more complex contamination footprint than others but are not

designated Superfund sites. These sites often need varied and costly remediation, requiring more resources and time than less contaminated sites. In contrast, some brownfields have less extensive contamination and can be cleaned up and redeveloped in a short amount of time. In one EPA study, approximately 30% of brownfields had contamination present that was below regulatory concern levels (Jenkins et al., 2006). However, it is important to fully review all available records, such as photos and site uses, and to interview former site owners before determining that brownfields do not require cleanup. Specific to military brownfields sites, namely Formerly Used Defense Sites, the United States Government Accountability Office (GAO) (2002) found that the United States Army Corps of Engineers may have underestimated the number of military sites that did not require cleanup by as much as 38 percent. This occurred due to incomplete review and investigation of potential hazards percent (United States Government Accountability Office, 2002, August).

Living with contamination from brownfields can adversely impact public health. In the U.S., brownfields tend to disproportionately impact communities with higher rates of poverty and a higher percentage of people of different races or cultures. Brownfields exist everywhere, from rural areas to indigenous lands, to urban areas. As brownfields increase in communities, so do health disparities and inequity, particularly from disinvestment and other conditions related to blight (deLeon and Schilling, 2017). It is well documented that people living near hazardous sites may have adverse childhood or adult health effects, such as elevated blood lead levels (Missouri Department of Health and Senior Services, 2001), reproductive health effects (Austin, 2011), or higher rates of respiratory disease (Liu, 2012). Mapping tools, such as ATSDR's Environmental Justice Index (EJI) (2023) or EPA's Environmental Justice Screening Tool (2024), indicate overall environmental and socioeconomic impacts in communities, such as proximity to hazardous waste sites, combined with factors such as poverty and race.

When people live among high numbers of brownfields, it is important to consider potential impacts of these sites on community health. As public health practitioners, our mission is protecting the public who live near or among brownfields areas to reduce potential exposures to harmful chemical contaminants while focusing on improving health outcomes overall. In 2006, ATSDR was interested in measuring changes in overall community health outcomes associated with brownfields redevelopment. We began to search the literature for brownfields models, research, or community projects that highlighted environment, sustainability, and public health indicators associated with redevelopment. We found few publications on sustainability or public health indicators associated with redevelopment.

In response, we developed the ATSDR Brownfields/Land Reuse Action Model (the Action Model). The Action Model engages the Development Community (e.g., community residents, city governments, public health departments, planners, and developers) in finding ways to make measurable health improvements part of the revitalization process.

1.1 Developing the Action Model to Engage the Public and Create Brownfields and Public Health Indicators Associated with Redevelopment

The Action Model is a 4-step framework that asks the following questions:

1. What are the community issues?
2. How can redevelopment address the community issues?
3. What are the associated health benefits?
4. Can we measure any changes in health status over time (indicators)?

We created the following criteria for indicators, featured in Step 4 of the Action Model, which are organized in this manuscript as “smart” and direct, or SMART-D:

- **Specific** – provides a clear description of what will be measured, such as children’s blood lead levels
- **Measurable** – can be quantified and reported numerically, such as the number of contaminated sites cleaned up or the amount of contaminated material removed
- **Attributable** – demonstrates the connection of results to activities, such as lowering potential exposures to chemical contaminants by remediating soil
- **Relevant** – aligns with the community vision and intended outcomes, such as creation of a community garden to improve access to healthy food
- **Tangible (Practical)** – can be feasibly collected, i.e., a data source exists, such as property tax values
- **Direct** – measures the intended result, such as increase in the number of jobs as a result of site reuse

To expand and vet the Action Model indicators (Step 4), we sought expert input from 11 brownfields and sustainability practitioners. We then piloted the Action Model in Milwaukee, Baraboo, and Kenosha, Wisconsin. In 2013, we published details on the three Action Model pilots in *An Indicator Framework to Measure Effects of Brownfields Redevelopment on Public Health* (Berman & Forrester, 2013).

By 2018, 45 communities across the U.S. had used the Action Model in community revitalization projects. We consolidated their Step 4 indicators and created a data set of community-derived public health indicators associated with land reuse and redevelopment that would be available to the public through an interactive website with an “indicators scorecard” as a supplement. Ultimately, we consolidated Action Models used in 40 communities to produce 69 public health indicators associated with land reuse and redevelopment that are commonly tracked by 20% of the 40 Action Model communities. We grouped the indicators in nine community health categories:

- **Built Environment:** 17 indicators
- **Community Involvement:** 4 indicators
- **Economy:** 16 indicators
- **Education:** 4 indicators
- **Environmental Improvement:** 6 indicators
- **Environmental Resources:** 5 indicators

- Housing: 11 indicators
- Physical Health: 4 indicators
- Safety and Security: 2 indicators

The 69 indicators, organized by health categories, are available in the ATSDR Build Your Own Community Health and Land Reuse Scorecard Toolkit at https://www.atsdr.cdc.gov/land-reuse-health-program/php/action-model/?CDC_AAref_Val=https://www.atsdr.cdc.gov/sites/brownfields/model.html. In 2019, we described the development of the indicators and Scorecard Toolkit in the publication, *Public Health Indicators Associated with Land Reuse and Redevelopment: Results of a 40-community Analysis* (Berman, Hall, & Omoh, 2019).

The Action Model Indicators and Community Health and Land Reuse Scorecard

The Action Model Indicators, grouped in nine health categories, are shown in Figure 1. The Development Community members can brainstorm indicators that best fit their redevelopment vision and plans. Some or most of the indicators may be selected from the nine categories shown. Once indicators are selected, the community can fill in the Community Health and Land Reuse Scorecard Toolkit, which is shown as a truncated version in Figure 2.

As examples of Action Model Indicators, the Community Involvement Indicators are provided in Figure 3. These include the number of city-community events and meetings; participation rates in events and meetings; number of public/outreach documents; type of public/outreach documents. The Environmental Improvement Indicators are provided in Figure 4. These include an inventory to characterize land reuse sites; pre- and post-redevelopment list of site contaminants; pre- and post-redevelopment media impacts; pre- and post-redevelopment levels of contamination; number of lead abatements/remediations; and the number of asbestos abatements/remediations.

1.2 Action Model Example: K.I. Sawyer, a Former U.S. Air Force Base

ATSDR facilitated an Action Model process in the K.I. (Kevin Ingalls) Sawyer community in Marquette County, Michigan. K.I. Sawyer was a former Air Force base that had operated from 1956 – 1995. At the time of closure, the population plummeted, and the base was redeveloped into a small city of about 3,000 people. However, the city still looked like a military base. K.I. Sawyer's local community group, Sawyer Community Alliance (SCA), had a vision, "From Base to Place: Building a Healthy Sawyer." Their primary goals were to improve health, economy, and social disparities by establishing a stronger sense of community; remediating blighted buildings; providing community services; and improving public services (water, transportation, etc.) (Agency for Toxic Substances and Disease Registry, 2021).

ATSDR partnered with SCA from 2013 – 2019 to envision community revitalization, hosting their first Action Model workshop in April of 2013. The SCA focused on addressing community concerns related to former base activities that still impacted the redevelopment. These included topics of beautification; community services; governance; recreation; and

food access. An excerpt of SCA's Action Model showing the topics of Recreation and Food Access is shown in Table 1. As shown in the table, expanding recreation was important to the community. Indicators to measure success included the number and types of trail projects; a sidewalk survey and the number of efforts to maintain and repair sidewalks; and the number and types of community events. Increasing access to quality food and grocery stores was also important to the community. Indicators related to Food Access included the number and types of food services and the size and location of the community garden.

2 Conclusion

The Action Model has proven to be a useful resource for communities with concerns about brownfields and hazardous exposures. The Action Model can be used to start a conversation about community revitalization and emphasizes the importance of putting the community needs and vision first. The expertise of the community in terms of knowing the history and locations of brownfields and yet-to-be-discovered brownfields, is also invaluable. Using the Action Model as part of redevelopment planning can lead to a health-focused, sustainable redevelopment project, supported by an informed community, which may increase stakeholder participation and sharing of resources. In addition, the Action Model's fourth step encourages the Development Community to develop and track indicators to measure changes in environmental and overall health of the community, which can maintain community motivation to stay involved in redevelopment planning.

Any community may use the Action Model Toolkit to implement their own Action Models and encourage the selection of common indicators or to derive their own unique indicators through sustainability, public health, and environmental lenses.

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Fig. 1.
Screenshot of the Action Model Indicator Toolkit's Nine Health Themes (ATSDR, 2019).



Community Health and Land Reuse Scorecard

for [enter your community below]. This is a fillable form.



Indicator	Pre	Mid	Post	Goal	Start Date	End Date
<i>Example: Number of lead abatements</i>	0	8	18	15	11/01/2019	12/31/2020

Fig. 2.
Excerpt of the Action Model Indicators Scorecard (ATSDR, 2019).

 Community Involvement Indicators		
Community involvement indicators: Measure the implementation of community outreach and involvement activities to populations of interest associated with land reuse and redevelopment activities.		
Indicator	Definition	Data Source
Number of city-community [redevelopment] events and meetings	Count/number of events and meetings related to redevelopment.	Event/meeting flyers or agendas Internal county/city/town or non-profit data
Participation rates in city-community [redevelopment] events and meetings	Number of people participating in events and meetings involving the city and the community and related to redevelopment.	Sign-in sheets Internal county/city/town or non-profit data
Number of public/outreach documents, e.g., publications, flyers, and readership statistics	Count/number of public/outreach documents created related to redevelopment.	Numbers of publications/flyers/Infographics that are distributed or counted by web hit counters-Internal county/city/town or non-profit data
Type of public/outreach documents, e.g., publications, flyers, and readership statistics	The description of public/outreach documents created related to redevelopment, e.g., publications, flyers, and readership statistics.	Examples of publications/flyers/Infographics that are distributed or counted by web hit counters Internal county/city/town or non-profit data

Fig. 3.
Community Involvement Indicators (ATSDR, 2019).

 Environmental Improvement Indicators		
Environmental improvement indicators: Measure the implementation of activities and achievement of outcomes related to hazardous chemical reduction.		
Indicator	Definition	Data Source
Inventory to characterize land reuse sites (Brownfields, cleanup sites, and under-used or polluted sites) through a public health lens (e.g., size, sensitive populations, frequency of access, etc.)	The description of land reuse sites in a community from a public health/exposure perspective	ATSDR Site Screening Tool Internally-generated inventory, such as a spreadsheet maintained by a city
Pre- and post-redevelopment list of contaminants at sites	The list of contaminants suspected or confirmed to be at sites before and after redevelopment	Internal county/city/town or non-profit data
Pre- and post-redevelopment media impacts (e.g. air, soil, water, etc.)	The environmental media, such as soil, air, water, or sediment that is suspected or confirmed to be impacted by chemical contamination before and after redevelopment	Internal county/city/town or non-profit data
Pre- and post-redevelopment levels of contamination	The quantitative levels of contamination measured in environmental media before and after redevelopment (e.g. soil lead levels in parts per million)	Internal county/city/town or non-profit data
Number of lead abatements/remediations	Number of lead abatements or remediations that occur during redevelopment, such as the removal of lead-based paint from a structure slated for reuse	Internal county/city/town or non-profit data
Number of asbestos abatements/remediations	Number of asbestos abatements or remediations that occur during redevelopment, such as the removal of asbestos containing material from a structure slated for reuse	Internal county/city/town or non-profit data

Fig. 4.
Environmental Improvement Indicators (ATSDR, 2019).

Table 1.

An Excerpt of Sawyer Community Alliance's Action Model

COMMUNITY ISSUES/ REDEVELOPMENT NEEDS	REVITALIZATION APPROACH	COMMUNITY HEALTH BENEFIT	MEASUREMENT INDICATOR TO TRACK CHANGE
RECREATION			
Walking trails and trailhead development.	Locate, identify, and renovate trails, including fitness trails and walking trails. Kids/volunteers can help develop trails. Look into using snowshoe and cross-country trails and coordinate with snowmobile association(s).	Access to trails may increase physical activity and draw people to Sawyer for recreation.	# and types of trail projects
Walkability	Address walkability and sidewalks by assessing the condition of sidewalks, cleaning up and trimming sidewalks, remove snow in winter, and investigate the repair of poor condition sidewalks.	Walking may improve overall health.	Sidewalks survey # of efforts to maintain and repair sidewalks
Community events	Have community events, such as a soap box (airplane) derby, food fairs, a book exchange, movie night, and local concerts.	Events may promote Sawyer as a place to be, creating a sense of place for existing and potentially new residents.	# and type of community events
FOOD ACCESS			
Quality food	Encourage mobile vendors, such as a taco truck, ice cream, mobile grocery buses.	Access to healthy food may increase overall health.	# and types of food services
Grocery store/convenience services	Create a grocery store/co-op/deli that is community run/not-for-profit and may draw in the business community.	Access to healthy food may increase overall health.	# and types of food services
Food coop, farming	Expand the community garden to a 15-acre site.	Access to healthy food may increase overall health. More people may join the community garden.	Size and location of community garden