The Environmental Protection Agency's Community-Focused Exposure and Risk Screening Tool (C-FERST) and Its Potential Use for Environmental Justice Efforts

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Communities disproportionately affected by pollutants may have higher environmental exposures and health risks than other communities, as well as less access to the information and resources needed to mitigate these risks. The 2004 Environmental Protection Agency (EPA) National Environmental Justice Advisory Committee Cumulative Risk report[1] and the 2009 National Academy of Public Administration review of the Community Action for a Renewed Environment (CARE) program[2] highlighted the difficulties communities and EPA regional offices have with characterizing disproportionate exposures or risks. Community involvement in prioritizing environmental health issues for specific areas or groups of people is crucial; community groups and members can supply local knowledge and interpret results in the context of local decision-making.

To identify risks and prioritize risk mitigation actions, communities need user-friendly tools that provide both environmental exposure and health-related information. At the March 17–19, 2010 Symposium on the Science of Disproportionate Environmental Health Impacts in Washington, DC, EPA administrator Lisa P. Jackson stated that the agency's science and tools should "translate into action." The EPA wants to help address these needs by developing, providing, and applying science tools that (1) assemble and rely on the best available information, (2) identify communities at risk (or conversely, healthy communities) and hot spots or disproportionate impacts within communities, and (3) empower communities to access this information and thereby make their own informed decisions.

The Community-Focused Exposure and Risk Screening Tool (C-FERST) was designed to support communities' environmental justice (EJ) efforts. The tool is being developed by the EPA's Office of Research and Development in the National Exposure Research Laboratory, which is conducting research to provide tools that enhance community-based cumulative risk assessments.[3] This research responded to requests from the Environmental Protection Agency's CARE program, the Office of Environmental Justice, EPA regional offices, and communities themselves, as well as recommendations from the National Academy of Sciences,[4] National Academy of Public Administration,[2] and other agencies. To ensure that these tools are scientifically sound, research is necessary to account for the many factors that may affect human exposure and health risks in a community, including chemical and nonchemical factors.

C-FERST is considered the "flagship tool" of the EPA National Exposure Research Laboratory's cumulative and communities human exposure research program (http://www.epa.gov/heasd/communities) because it incorporates what is known about high-priority environmental issues, provides a venue for communicating cutting-edge science and solutions to communities, and helps to identify knowledge gaps. The program's overall goal is to develop, apply, and provide to communities and individuals tools for advancing the science and understanding cumulative risk (cumulative risk assessment is defined by the National Research Council [NRC, 2009] as "evaluating an array of stressors [chemical and non-chemical] to characterize—quantitatively to the extent possible—human health and ecologic effects, taking into account factors such as vulnerability and background exposures."[4(p224)] One high-priority research area focuses on developing and communicating human exposure and cumulative risk science and

Objectives. Our primary objective was to provide higher quality, more accessible science to address challenges of characterizing local-scale exposures and risks for enhanced community-based assessments and environmental decision-making.

Methods. After identifying community needs, priority environmental issues, and current tools, we designed and populated the Community-Focused Exposure and Risk Screening Tool (C-FERST) in collaboration with stakeholders, following a set of defined principles, and considered it in the context of environmental justice.

Results. C-FERST is a geographic information system and resource access Web tool under development for supporting multimedia community assessments. Community-level exposure and risk research is being conducted to address specific local issues through case studies.

Conclusions. C-FERST can be applied to support environmental justice efforts. It incorporates research to develop community-level data and modeled estimates for priority environmental issues, and other relevant information identified by communities. Initial case studies are under way to refine and test the tool to expand its applicability and transferability. Opportunities exist for scientists to address the many research needs in characterizing local cumulative exposures and risks and for community partners to apply and refine C-FERST. (*Am J Public Health.* 2011;101:S286–S294. doi:10.2105/AJPH.2010.300087)

characterizing sources, concentrations, human exposure, and health risks at the national and local levels for several critical environmental issues.

C-FERST could also provide information for assessments of cumulative impact, defined by the California EPA (2005) as "exposures, public health, or environmental effects from the combined emissions and discharges in a geographic area, including environmental pollution from all sources, whether single or multi-media, routinely, accidentally, or otherwise released. Impacts will take into account sensitive populations and socio-economic factors, where applicable and to the extent data are available."[5]

C-FERST links to and builds on other community-focused tools, and it provides state-of-the-science approaches to characterizing community exposures to environmental contaminants that lead to cumulative risks. Using C-FERST to inform community-based cumulative exposure and risk assessments and communicate related science supports the EPA priorities to clean up communities and work for EJ. Its use also supports multiple EPA initiatives, programs, and activities by asking similar questions related to community-based cumulative exposure and risk. Figure 1 depicts C-FERST's role in the context of actions to improve public health. In addition to being used to identify communities with disproportionate impacts and to prioritize environmental issues in high-risk communities, C-FERST will be enhanced to support evaluation of risk reduction actions (e.g., establishing a baseline for comparison and quantifying performance metrics).

METHODS

The general process of developing C-FERST included reviewing and assessing other community tools and needs in collaboration with partners and potential end users and incorporating feedback through an iterative review, testing, and tool refinement process. C-FERST as an umbrella tool, and the tools included within it, will continue to be refined and evaluated through community case study applications.

The community tools reviewed were community guidance documents, databases, geographic information systems, exposure models, and measurement methods for cumulative and community risk assessments.[6,7] We assessed community needs by reviewing reports such as the 2004 National Environmental Justice Advisory Committee report[1] and a survey of EPA CARE project officers (Barzyk T, Conlon K, Zartarian V, Lakin M, and Schultz B, unpublished data, 2007) and we reviewed the application of selected existing tools both to support community projects (e.g., Detroit, MI, and Holyoke, MA) and to inform the development of the C-FERST.[8]

C-FERST is being developed in collaboration with the EPA's Region 1 and various participants in the CARE program. CARE involves multiple EPA program offices and all regional offices in supporting community-driven projects through grants and technical support, and it offers an innovative way for communities to reduce pollution in their local environment. Many CARE communities have significant EJ issues. The initial version of C-FERST was based on the draft document "EPA Community Screening of Environmental Risks: A Workbook for CARE Communities" (unpublished data, 2006), developed by the Environmental Protection Agency CARE program and agency technical experts. The EPA's National Exposure Research Laboratory consulted with the Environmental Protection Agency's CARE program and various working groups of the EPA's regional and program offices on C-FERST's scientific and usability aspects. A prototype test version of C-FERST was presented at scientific conferences and community meetings, and feedback was elicited. Additional internal EPA feedback on both science and usability aspects was received via an online feedback form and incorporated into version 1.0 of C-FERST.

C-FERST's science and graphical user interface is being developed incrementally and vetted in phases, with feedback solicited through presentations and the online form. Although the Office of Research and Development initially developed this tool with the Environmental Protection Agency's CARE Program's regional project officers, who work closely with community partners, C-FERST is also being enhanced to address needs specific to EJ programs. Future users could include other EPA programs; federal, state, or local agencies working with community partners; health care providers; and community leaders, partners, and individuals. C-FERST is being applied to case studies in pilot communities seeking to identify and prioritize key chemical stressors. The tool will be iteratively refined and populated over time with additional information on community environmental issues. The tool's framework provides opportunities to collaborate with other federal agencies and academia, as well as other community programs within the EPA.

Note. http://www.epa.gov/heasd/c-ferst.
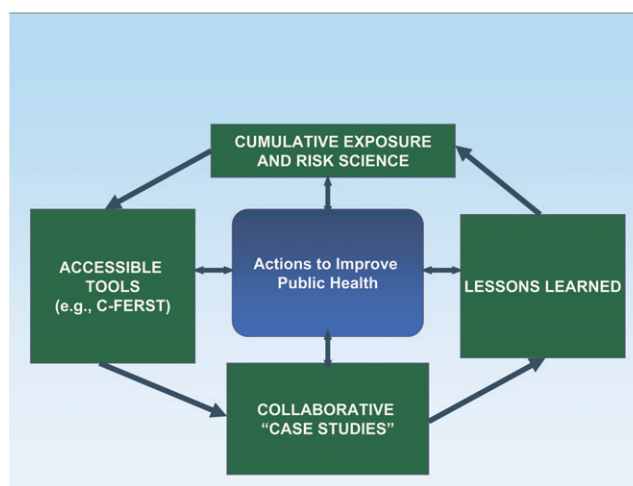
FIGURE 1—Community-Focused Exposure and Risk Screening Tool (C-FERST) in the context of science and tools for improving public health.

A list of principles defined for C-FERST development, to make the tool both scientifically sound and user friendly, follows:

- Provide the best science available on the covered topics.
- Engage the broader research community, including universities, other federal agencies, states, and the international research community to fill the needs for scientifically sound information.
- Organize issues of interest to communities in these categories: individual and cumulative sources, exposure to individual toxic agents, cumulative risks for health effects, and risk-modifying factors.
- Provide information in a manner comparable to that of other issues in the same category.
- Provide information in a manner suitable for cumulative assessments, including toxic substance and nontoxic substance stressors.
- Partner with appropriate EPA regions and program offices and external groups to research and communicate issues.
- Provide information on how regions and communities may follow up with their own more detailed analysis or data collection.
- Provide information on how to improve the community's health and well-being in a sustainable manner.
- Develop clear criteria for inclusion of information in C-FERST.
- Provide tools for estimating or modeling the benefits or likely benefits of their risk reduction activities.
- Provide a venue to better use the wisdom of the broader scientific community and public.

Selection of Environmental Issues for Inclusion in C-FERST

We selected the environmental issues included in C-FERST on the basis of a review of EPA and community documents (Hammond D, Lakin M, Schultz B, Zartarian V, unpublished data, 2010). The initial focus is on toxic agents identified in EPA risk-ranking reports,[9–13] the CARE program[14] (2005–2009 CARE projects), and the EPA Environmental Justice program.[15] Future versions of C-FERST could also include information on chemical mixtures and the

interactions and effects of risk-modifying factors (e.g., nonchemical stressors such as noise and psychological stress) on environmental stressors, on the basis of ongoing and planned research.

Addressing Multiple and Cumulative Environmental Issues

C-FERST will contain exposure-based cumulative risk[16] characterizations based on the best available information and science. Communities facing EJ issues frequently encourage the EPA and the scientific community at large to perform cumulative risk and impact assessments to more realistically assess the risks they face. Northridge et al.[17] and others argued that targeted research in exposure science, epidemiology, and health, addressing the social determinants of exposure, population susceptibility, and cumulative risk, is necessary to address the complexities of community exposure assessment and achieve environmental equity. C-FERST will incorporate research being conducted by the EPA and others on chemical mixtures and the interactions and effects of risk-modifying factors on environmental stressors. This cumulative approach will be used to estimate exposures and risks for the different categories of issues in C-FERST: sources (e.g., diesel exhaust from traffic), individual toxic substances of concern (e.g., benzene, lead, mercury), and health

effects from cumulative exposures (e.g., onset and exacerbation of childhood asthma, early neurotoxicity effects from toxic agents, and lung cancer from radon and secondhand smoke). It can also be used to identify vulnerable populations (e.g., sensitivities, unique exposure pathways, disease disparities). Where cumulative research is not yet available, C-FERST will contain the best available information and science on environmental sources, concentrations, exposures, and risks for individual issues of concern.

RESULTS

The C-FERST is a geographic information system and resource access Web tool that supports multimedia community-scale human exposure and risk screening assessments and incorporates the best available science. C-FERST balances innovative, high-quality science with a user-friendly interface to assist with characterizing the cumulative impact of multiple stressors and identifying communities at risk; assessing environmental issues and disproportionate impacts within communities; and, ultimately, assessing effectiveness of risk reduction actions (accountability; Figure 2).

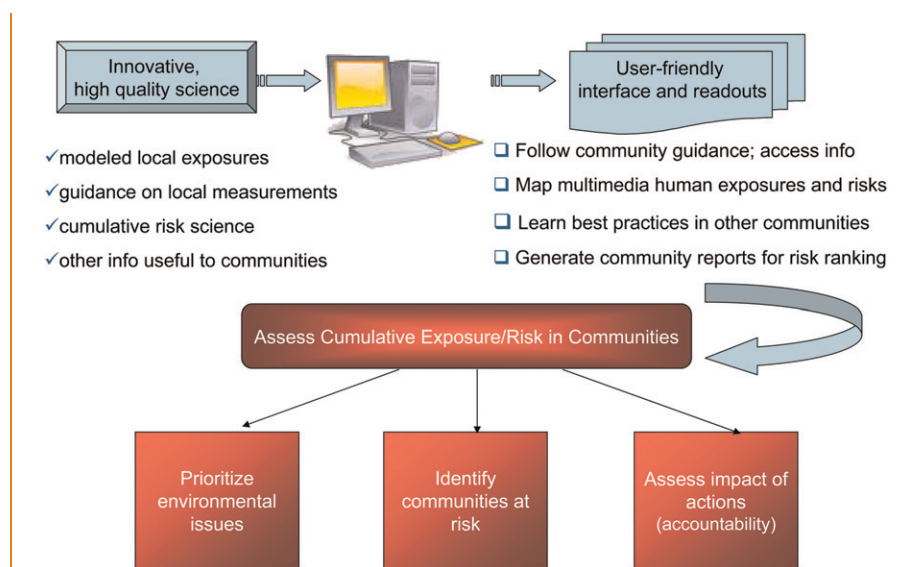As C-FERST continues to be refined and populated with available information, users will be able to:

FIGURE 2—Community-Focused Exposure and Risk Screening Tool conceptual framework.

- Compare information across communities at a fine geographic scale (i.e., census tract or finer) and compare local information with national averages.
- Follow available community guidance roadmaps (e.g., EJ Toolkit[18] [Figure 3], CARE Roadmap,[14] PACE-EH,[19] EPA Office of Research and Development cumulative risk resource document[20]).
- Link to fact sheets about community environmental issues.
- Access guidance on collecting local data.
- Upload and overlay locally collected data onto C-FERST geographic information system maps of publicly available EPA data (under development).
- Generate maps of sources, concentrations, human exposures, and cumulative risks, with overlays about EJ factors or health outcomes. (Figure 4).
- Generate C-FERST issue profile reports containing available fact sheets, Web links, and maps for more than 40 community environmental issues.
- Generate a community table with best available data for indicators of interest.
- Explore risk reduction actions with an emphasis on sustainable actions.
- Learn about communities with similar issues and solutions implemented.
- Access other tools for community assessments.
- Identify vulnerable populations.

C-FERST issue profile reports can assist in completion of available community assessment guidance documents such as the CARE Roadmap or the EJ Toolkit,[18] and they contain information (e.g., Web links to fact sheets, Web sites, maps, other tools, publications) on each environmental issue and report category (general information, health outcomes, exposure and risk reductions, population affected, sources, environmental concentrations, human exposures, health risks, reduction actions, other communities focusing on this issue, solutions implemented by other communities), thus providing community partners with information on environmental issues of concern in a consistent report format and also highlighting information gaps and research needs. The C-FERST can be used as a communication tool for collaborative research.

Status of and Plans for C-FERST-Related Exposure and Risk Science

C-FERST version 1.0 includes information on more than 40 environmental health issues identified by EPA and community program documents[9-13] for which data are currently available to model local-scale human exposures and risks. Reference material is provided (fact sheets) for community issues of concern for which the science may take longer to develop.

The EPA is conducting modeling research to characterize exposures and risks (cumulative, where possible) at the national and local scale. C-FERST version 1.0 includes maps of modeled ambient concentrations, human exposures, and risks at the census-tract level for 12 air toxics and also for cumulative cancer and noncancer risks, based on the EPA's National Air Toxics Assessments (http://www.epa.gov/ttn/atw/natamain). EPA scientists are working on additional research that can populate C-FERST: developing a new census-tract-level, multimedia childhood lead exposure screening tool; expanding previous research[21] to generate local-scale estimates for dietary arsenic ingestion, residential pesticide, and methyl mercury from fish consumption exposure; characterizing community exposure and risk for secondhand smoke on the basis of previous[22] and future work; and a new near-road exposure model (being developed through a Boston, Massachusetts, area case study) to help identify potentially affected communities and provide exposure reduction recommendations. In addition, the Office of Research and Development is conducting cumulative assessments for asthma, early neurotoxicity effects (combining research on lead, methyl mercury, and other factors), and lung cancer (from radon and secondhand smoke).[23] All of these community-level modeling efforts rely on availability of local data, and C-FERST developers seek to evaluate all modeled estimates with measurements data.

Research on community-focused exposure measurements includes a review of measurement methods available to communities,[7] a methodology for collecting and analyzing community duplicate diet measurements for dietary exposure estimation,[24] and methods for measuring molds in living areas.[25,26]

Source apportionment research is also underway to identify likely sources of air pollutants in a community using uploaded local measurements data and models.[27] After identifying local sources, the tool will help answer "what-if" questions about source reductions.

Overview of Initial Case Studies

Case study applications allow C-FERST to be tested and refined, to explore data gaps, and to evaluate requirements for future tool development while addressing individual community needs. C-FERST development was informed by 2 case study neighborhood areas in Milwaukee, Wisconsin: one associated with a CARE partnership especially interested in poor air quality, chemical releases, lead exposure, poor water quality, and health issues such as asthma; and the other an EJ Showcase Community (http://www.epa.gov/compliance/ej/grants/ej-showcase.html) primarily interested in land redevelopment and historical exposures (Barzyk TM., White BM., Millard M., et al., unpublished data, 2010).

Other case studies are being conducted to answer different science questions. For example, research is underway to populate a community data table of indicators for comparing information across communities in C-FERST that can be applied to EPA regionwide healthy communities assessments. C-FERST, in conjunction with the CARE Roadmap and PACE-EH guidance, is currently being piloted by several new CARE Level 1 project partners, including Springfield, Massachusetts; Portland, Maine; Brooklyn, New York; and Minneapolis, Minnesota, to help refine the tool and identify and prioritize several multimedia environmental issues including asthma, ambient air pollution, indoor air quality (e.g., from pesticides, radon, mold), lead, and drinking water quality. The indicator categories in the C-FERST community data table currently include vulnerabilities and human health risks; in future versions, ecosystem services and well-being indicators can be incorporated to consider community assets.

DISCUSSION

Assessing health risks from multiple sources is challenging on the basis of the level of information available and difficulties in

Community-Focused Exposure and Risk Screening Tool

You are here: EPA Home   C-FERST   Using EPA's EJ Toolkit with C-FERST

Using EPA's 2004 Toolkit for Assessing Potential Allegations of Environmental Injustice with C-FERST

1. **"Problem Formulation:** Establishes context, management goals, and scope of the entire assessment; identifies the participants in the process, the endpoints that are going to be assessed to inform the decision-making process, and which environmental justice indicators will be used to assess those endpoints. During this step, an affected area also is identified in at least a general way, as are potential reference communities or statistical sources (e.g., national or statewide values)."

   +*In C-FERST you can...*

2. **"Data Collection.** Collect situation-specific data needed to conduct the analysis of whether the affected area is likely to or is already experiencing disproportionately high and adverse effects or impacts from the situation. In this phase, two types of data are collected:

   1. Data on the environmental sources of stress and likelihood of exposure

      −*In C-FERST you can...*

      * generate Environmental Issue Profiles for your community that contain information on exposures, concentrations, and sources;
      * research factsheets on specific environmental issues (organized alphabetically and by substance, media, health effect, and misc.)
      * view maps of exposures, risks, and sources;
      * access additional tools for community assessments (guidance documents, databases, exposure models, and measurement tools) for additional environmental information; and
      * view guidance on data collection and methods and enter local data* for mapping.

   2. Health-related, demographic, social, and economic data on the affected area and on the potential reference communities.

      +*In C-FERST you can...*

3. **"Assessment of the Potential for "Adverse" Environmental and Human Health Effects or Impacts.** In this phase, the Assessment Team uses the information collected above to determine whether the proposed actions or existing situation might cause adverse impacts on the environment in which the community members live or work and on the health and welfare of community members."

   +*In C-FERST you can...*

4. **"Assessment of the Potential for "Disproportionately High and Adverse" Effects or Impacts.** The final question to determine the extent of an environmental situation is whether the potential for adverse effects on the environment or human health and welfare is disproportionately high in the affected area compared with the reference community. This involves a comparison of the likelihood, magnitude, and severity of potential effects in the affected area with the likelihood, magnitude, and severity of potential effects in the reference population(s)."

   +*In C-FERST you can...*

Source: EPA's EJ Toolkit
(http://www.epa.gov/environmentaljustice/index.html)
Methodology for Assessing Potential Allegations of Environmental Injustice (167pp, 1.3MB, About PDF)
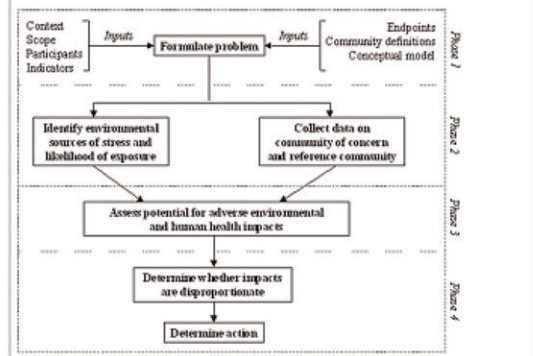
Return to C-FERST Home

Click here to email comments on the C-FERST application

FIGURE 3—EJ Toolkit implemented within Community-Focused Exposure and Risk Screening Tool (C-FERST). Users can step through the 4 major stages for assessing potential allegations of environmental injustice using C-FERST.
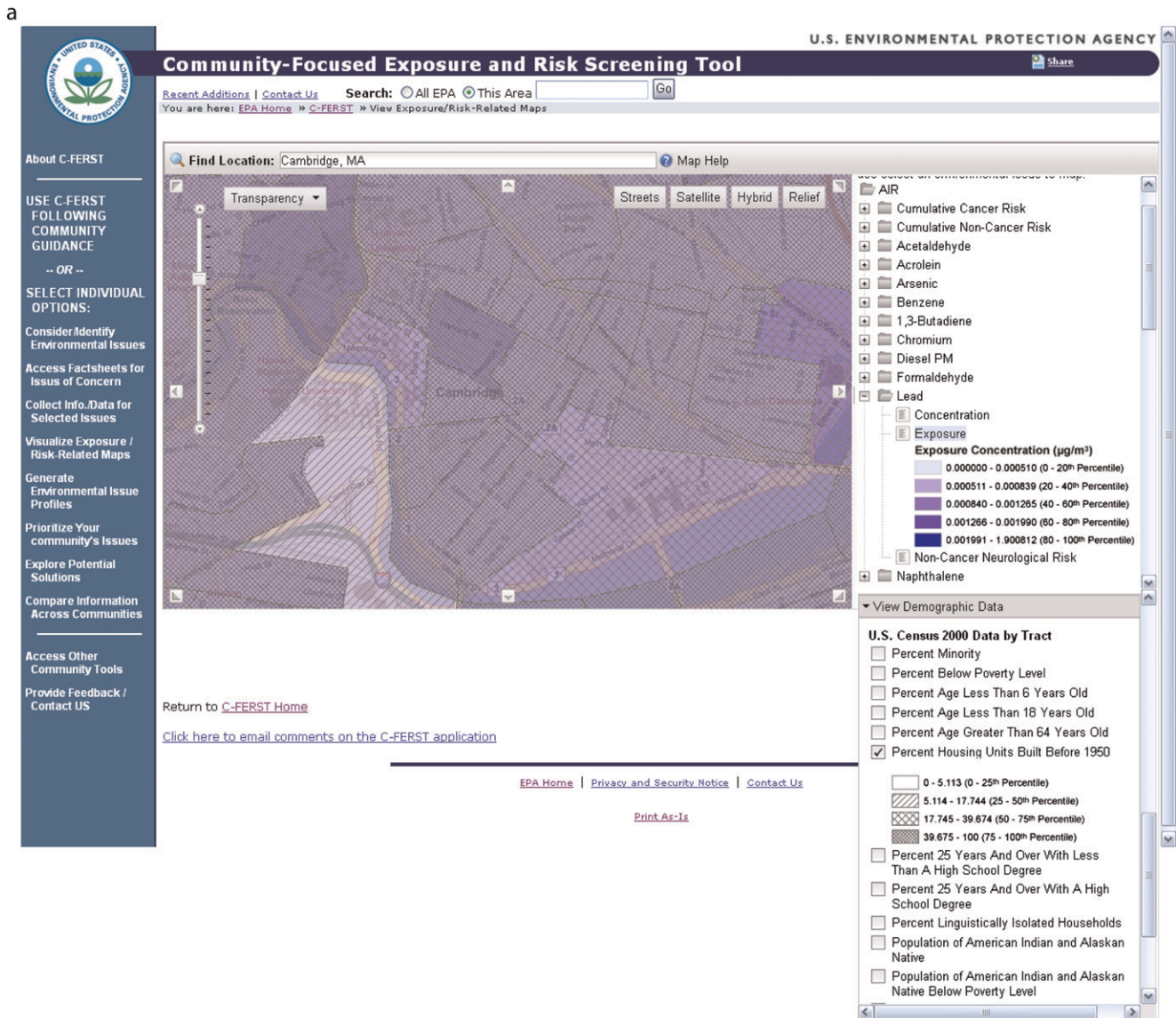
FIGURE 4—Example C-FERST Screenshots.

accessing, integrating, and interpreting data. Although many tools have already been or are being developed to support community environmental assessments, some important needs remain unmet. The available tools that support community assessments include step-by-step guidance documents, data-viewing tools focused on demographics and environmental information, computer models to predict ambient environmental concentrations or human exposure, Web sites and fact sheets, and vulnerability indexes. These tools are located

in many different documents and Web sites, and technical assistance in identifying and using them varies across regions and communities.

C-FERST is different from these tools in 2 ways: (1) it is an umbrella tool that organizes EPA information and science by linking to, building on, or including these other tools to assist with conducting community environmental assessments (including within-the-interface "cross-walks" with available step-by-step community assessment guidance[14,18,19]; Figure 3);

and (2) it is, at its core, a human exposure and risk screening assessment tool, a repository for providing and communicating the EPA's best available information and exposure science and for highlighting data gaps to facilitate collaborative research within and outside the EPA in the area of community-based cumulative risk.

Future Needs

Information for community and environmental justice assessments on many issues is still considerably lacking. Given the many EJ and

other communities in the United States, assessing each issue in detail in each community through EPA-run efforts is not feasible. Screening-level estimates, however, could be developed for many more issues across the United States and elsewhere to make basic exposure and health impacts information available to all communities. To fully develop C-FERST to inform EJ assessments, researchers need to

- research and disseminate cumulative risk approaches and nonchemical stressors' impacts on environmental stressors for vulnerable populations;
- research approaches for fostering sustainable improvements to communities to address disproportionate impacts;

- incorporate or link to ecological and ecosystem services information;
- facilitate uploading and mapping locally collected data;
- quantify concentration, exposure, and risk data for disproportionately affected communities (i.e., subset data for the general population);
- develop and incorporate cumulative assessment and risk-ranking approaches;
- link to the Centers for Disease Control and Prevention, states, and local health databases;
- incorporate fact sheets specific to EJ issues;
- link more with other EJ-related geographic information system tools and databases; and
- apply, test, and refine C-FERST for community case studies (e.g., through the Environmental Protection Agency's CARE and EJ

programs or the National Institute for Environmental Health Science's Partners in Environmental Public Health program).

Given the amount of research still needed to understand community-level exposures and cumulative risks, various collaborators are conducting research to address these needs. As these needs are addressed, information will be added to future versions of C-FERST. Thus, the communication and coordination aspects of C-FERST are needed to expand the research on cumulative community exposure and risk.

Anticipated Impacts

One goal for C-FERST is to enhance access to data and data interpretation tools for use by

both government and external stakeholders, especially community-based organizations, in the decision-making process. By incorporating the best available information, science, and research on characterizing community-based cumulative risk from exposure to toxic substances in the environment, C-FERST can assist communities with the challenge of identifying and prioritizing community environmental health issues. The anticipated outcome of this effort is a transparent, accessible tool that enables end users to understand local exposure information so that they can make better-informed, more cost-effective, and sustainable risk reduction actions. An EPA beta-test version is currently available for CARE project officers, communities piloting C-FERST application, and others within the EPA. C-FERST is a work in progress; it will be regularly updated. Once the tool is refined and further populated through case study applications, it will be provided to other external partners and potential end users.

The C-FERST can aid in improving public health in communities by facilitating identification of at-risk communities, hot spots, or disproportionate impacts within communities and providing information needed to develop solutions. It provides regions and communities with a user-friendly tool to understand local exposure information (based on solid science) so that they can make informed, cost-effective decisions and take action, thus addressing National Environmental Justice Advisory Committee, National Research Council, National Academy of Public Administration (NAPA), and other recommendations for improving risk prioritization tools and approaches.

C-FERST is intended to aid in the development of transferable tools to help build sustainable communities. Environmental stewardship requires devolving critical decisions affecting community environmental health to the communities. Our guiding principle is that communities' capacity and engagement in addressing their own environmental health issues can be built by providing tools, data, potential solutions, and a venue for sharing community-level solutions. In this respect, C-FERST is a transdisciplinary tool; that is, one that not only engages traditional and multiple scientific disciplines but that interfaces and

builds on the societal application and evolution of these approaches.

Our goal is for C-FERST to assist in advancing the science of cumulative exposure and risk science and facilitate its use to enhance community-based decision-making, as well as provide a framework for collaborative research and information sharing to support community assessments. C-FERST can benefit communities facing disproportionate environmental impacts and those with more limited resources. Brulle and Pellow[28] argued that long-lasting reductions of exposure disparities to environmental pollution occur when EJ advocates, policymakers, and exposure scientists synergize their efforts to address community environmental concerns through a combination of better science and political advocacy. C-FERST bridges the gap between the emerging community-based cumulative risk science and its actual use by, first, the EPA's regional offices and then community groups at large. ∎

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At the time of the study, Valerie G. Zartarian, Bradley D. Schultz, Timothy M. Barzyk, Davyda M. Hammond, Myriam Medina-Vera, and Andrew M. Geller were with the Environmental Protection Agency (EPA), Office of Research and Development, National Exposure Research Laboratory, Research Triangle Park, NC. MaryBeth Smuts was with the EPA's New England (Region 1) office, Boston, MA.

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Contributors

V.G. Zartarian and B.D. Schultz led conceptual development of the Community-Focused Exposure and Risk Screening Tool (C-FERST) and writing of the article. T.M. Barzyk, D.M. Hammond, and M. Medina-Vera led the review of other tools and community case studies that informed C-FERST. M. Smuts contributed significantly to C-FERST development from an end-user perspective. A.M. Geller contributed significantly to C-FERST refinements. All authors reviewed drafts of the article.

Human Participant Protection

Institutional review board approval was not needed for the C-FERST tool discussed in this article.

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