

Engaging Communities in Research on Cumulative Risk and Social Stress-Environment Interactions: Lessons Learned from EPA's STAR Program

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ABSTRACT

Studies have documented cumulative health effects of chemical and nonchemical exposures, particularly chronic environmental and social stressors. Environmental justice groups have advocated for community participation in research that assesses how these interactions contribute to health disparities experienced by low-income and communities of color. In 2009, the U.S. Environmental Protection Agency issued a request for research applications (RFA), "Understanding the Role of Nonchemical Stressors and Developing Analytic Methods for Cumulative Risk Assessments." Seven research projects were funded to help address this knowledge gap. Each engaged with communities in different ways. We describe the community engagement approaches of the seven research projects, which ranged from outreach through shared leadership/participatory. We then assess the experiences of these programs with respect to the community engagement goals of the RFA. We present insights from these community engagement efforts, including how the grants helped to build or enhance the capacity of community organizations in addition to contributing to the research projects. Our analysis of project proposals, annual grantee reports, and participant observation of these seven projects suggests guidelines for the development of future funding mechanisms and for conducting community-engaged research on cumulative risk involving environmental and social stressors including: 1) providing for

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flexibility in the mode of community engagement; 2) addressing conflict between research timing and engagement needs, 3) developing approaches for communicating about the uniquely sensitive issues of non-chemical stressors and social risks; and 4) encouraging the evaluation of community engagement efforts.

INTRODUCTION

THE ENVIRONMENTAL JUSTICE MOVEMENT has raised awareness that many communities are disproportionately exposed to multiple sources of environmental contamination including industrial operations, active and legacy waste disposal sites, and high traffic roadways.^{1,2,3,4} As scientific understanding of environmental contributors to lifelong health has grown, such cumulative exposures have been increasingly linked to health disparities.^{5,6,7,8,9,10} In addition, there is increasing concern that exposures to “nonchemical” stressors (e.g., psychosocial stressors) may exacerbate the effects of environmental chemical exposures on health.^{11,12,13,14,15,16,17,18} Researchers, funders, and communities agree on the need for more research on such interactions and use of this knowledge to inform community problem-solving.

Community engagement has been promoted as a strategy to integrate communities’ knowledge into research on environmental exposures, as well as to build community capacity to address environmental health problems.^{19,20,21,22,23,24,25} Community engagement is particularly important for research on cumulative environmental risks because communities have unique knowledge about exposures experienced by residents. Also, communities can play crucial roles in planning, advocating for, and implementing the strategies to reduce exposures.^{15,26,27}

For these reasons, community engagement is an increasingly vital component of the U.S. Environmental Protection Agency’s (EPA’s) work, particularly research efforts to support environmental justice objectives.^{28,29,30} In 2009, the EPA built community engagement into a request for applications (RFA) for research on cumulative risk assessment (CRA) called “Understanding the Role of Nonchemical Stressors and Developing Analytic Methods for Cumulative Risk Assessments,”³¹ through the Science To Achieve Results (STAR) extramural research program. The objective of the RFA was to develop epidemiological, toxicological, statistical, and other analytic techniques for evaluating the combined effects of multiple nonchemical^a and chemical

stressors on human health.³² The EPA awarded seven CRA grants with a total investment of \$7 million in 2010. The RFA required a “Community-based Participatory Research (CBPR) Plan” as part of every proposal. Brief overview of each grant is presented in Table 1.^b

The EPA’s decision to require a CBPR Plan as part of the CRA proposals was an innovative approach to supporting community engagement in extramural research.²⁹ In this article, we describe the range of community engagement approaches utilized by the grantees and assess the experiences of these programs with respect to the community engagement goals of the RFA to: 1) involve community members in the research process, 2) enhance capacity of the community to address cumulative risks, and 3) improve the science of cumulative risk.^c Using examples from the projects’ CPBR Plans, grantee annual reports to the EPA, and the authors’ roles as participant observers (several of the authors served as the community engagement leads), we illustrate the program’s progress toward these goals. We then present our reflections on the challenges of community engagement in these projects and implications for promoting community engagement in future environmental health research funding programs. We conclude by offering recommendations for how future funding mechanisms and community-academic partnerships can most effectively promote community engagement in environmental health research to support problem solving in the area of cumulative risk and nonchemical stressors.

COMMUNITY ENGAGEMENT IN THE STAR-CUMULATIVE RISK ASSESSMENT 2RESEARCH PROGRAM

The first goal of community engagement in research reflects a rights-based approach and the democratic and ethical principle that communities should be involved in decisions that affect their well-being.^{20,23} In the RFA, the EPA acknowledged that CBPR is generally defined as a “collaborative approach to research that equitably involves all partners in the research process and recognizes

^aWhile the term “nonchemical stressors” could have been interpreted to mean physical and biological exposures such as noise, radiation, and infectious agents as described in the 2003 Environmental Protection Agency (EPA) Framework for Cumulative Risk Assessment, this solicitation defined “nonchemical stressors” as social conditions contributing to chronic psychosocial stress. For the purposes of cumulative risk assessment (CRA), the EPA broadly defines “nonchemical stressors” as biological, radiological, and other physical stressors; socioeconomic stressors; and lifestyle conditions.⁴²

^bScholars and practitioners have recognized that the extent of community engagement may vary from providing limited input to being community-driven.^{29,33,34,35,44} The EPA chose to use the term “CBPR” in the CRA request for research applications (RFA); however, since the extent of community engagement was, in fact, broadly interpreted by grantees, we use the term “community engagement” in this article except where referring specifically to the requirements of the RFA and the projects’ “CBPR Plans.”

^cThese goals were imputed from a close reading of the sections of the RFA referring to the CBPR Plan component, as well as discussions with EPA program staff.

the unique strengths that each brings.³³ However, the EPA allowed applicants to propose a range of approaches to community engagement. As part of the proposal, each applicant was required to submit a CBPR Plan that addressed elements outlined in Table 2. The applicants' CBPR Plans were peer-reviewed according to specific community-engagement criteria listed in Table 3. These criteria were added to the standard STAR peer review criteria template for the CRA RFA.³¹

The resulting community engagement programs were diverse and multi-faceted. Yuen et al. characterizes a continuum of community engagement approaches in terms of four different modes: outreach, consultation, involvement, and shared leadership.^{29,34,35,36} We apply Yuen's continuum²⁹ to the CRA grants. Most grantees included several elements of engagement, ranging from seeking feedback from community groups on communication of research results to equally participating with researchers in project planning. Below, we characterize these modes of engagement in greater detail and present representative examples from each of the projects.

Outreach

"Outreach" means communication that flows from the academic partners to the community rather than bi-directional engagement. Many projects included outreach to the community. For example, the Boston University School of Public Health (BUSPH) and the NorthStar project recognized the community's need for basic health information as a foundation for understanding research results. Before engaging residents about cumulative risks or nonchemical stressors, NorthStar conducted community outreach about relevant health conditions (e.g., hypertension).

The University of Rochester outreach adopted a different approach because the research involved an animal model, resulting in limited opportunities to directly engage community groups in design or implementation. Consequently, the Rochester CBPR team focused primarily on informing strategies for community outreach. They team began by eliciting from community stakeholders how they "made meaning" of the hypothesis being tested. This input was used to inform future strategies to communicate results on environment-stress interactions. For example, a focus group of prenatal health care providers noted that they viewed lead poisoning prevention as the responsibility of pediatricians. However, CRA findings on lifelong impacts of combined prenatal lead and stress convinced them to increase prenatal counseling on lead hazard reduction. Based on this insight, the outreach team developed obstetrics and gynecology (OB-GYN) grand rounds presentations on resources that prenatal care providers could share to reduce perinatal lead exposure.

Consultation

In the "consultation" function, community input informs the research. The BUSPH and NorthStar project consulted with the community in identifying important social and cultural variables and interpreting research findings. The University of Texas School of Public

Health project on hypertension, air pollution, and psychosocial stressors among individuals of Mexican origin conducted community focus groups in which residents shared their observations about social and physical situations of stress in their daily lives and their perceptions of the effects of these stressors on well-being and health. These perceptions directly informed the development of a questionnaire which was then pilot tested in the community by the university researchers. Similarly, the University of Pittsburgh and West Harlem Environmental Action (WE ACT) project established the New York City Clean Air Network (NYCCAN) to bring together community, agency, and academic stakeholders around air pollution and susceptibility issues across New York City (NYC). NYCCAN annual meetings provided a forum to present STAR research findings and gather feedback around interpretation of research results.

Involvement

Involvement includes ongoing cooperation and more substantive participation by the community. One example of "involvement" was found in the Rutgers University collaboration with the Ironbound Community Corporation (ICC) in Newark, NJ. Community and academic primary investigators (PIs) worked together, beginning in the initial and planning stages to develop a plan to use personal monitoring to measure the effects of diesel air pollution on childhood asthma exacerbation. Rutgers and ICC staff were trained and worked together to plan and execute complex study protocols, including collecting, organizing, and interpreting exposure and health outcome data. As another example, NorthStar spearheaded the implementation of a community survey, including identification of survey sites/populations and deployment of the instrument throughout New Bedford.

Shared leadership/participatory

In the "shared leadership" mode of participation, decision making is equally shared between academic researchers and community partners during each aspect of a project, and might also be appropriately called "community-based participatory research." This approach was exemplified in the BUSPH /Chelsea STAR project. Academic and community partners jointly hired staff and trained volunteers who worked out of the Chelsea Collaborative. The community and academic PIs communicated about staff management, participated in weekly staff meetings, and volunteered on other collaborative projects. The Chelsea Collaborative project coordinator and researchers also met with local government officials, health care organizations, and community groups to discuss findings, data sharing plans, and use of research results in local decision-making processes (e.g., advocating for parks, comments on a home inspection ordinance, promoting immigrant rights, etc.). In another example of shared decision making, the ICC-Rutgers collaboration was initiated by community leaders who approached Rutgers environmental health scientists for technical assistance assessing the impact of neighborhood truck traffic on childhood asthma. Through an ongoing

TABLE 1. EPA STAR—2009 CUMULATIVE RISK RESEARCH PROJECTS

<i>Research project title</i>	<i>Institution(s)/community partner</i>	<i>Research project description</i>	<i>Community engagement description</i>
Community Stressors and Susceptibility to Air Pollution in Urban Asthma	University of Pittsburgh; West Harlem Environmental Action (WE ACT)	Characterized spatial distribution of community psychosocial stressors and air pollution levels across New York City, and examined their separate and synergistic effects on childhood asthma exacerbation in epidemiologic models.	Community and research team members collaboratively developed community data collection methods and conducted analysis of both focus group data and community survey on perceived stressors. Reports of perceived stress, and exposures to key stressors, were used to validate administrative (GIS-based) stressor indicators.. Community co-PI, WE ACT led efforts for dissemination of research results to local agency, academic and community stakeholders.
Effects-Based Cumulative Risk Assessment in a Low-Income Urban Community near a Superfund Site	Boston University School of Public Health (BUSPH); NorthStar Learning Centers	Developed novel methods for cumulative risk assessment, focusing on a low-income community (New Bedford, MA) living near a Superfund site. Models were developed to estimate exposure to multiple chemicals (lead, PCBs, etc.) and non-chemical stressors, and to associate these exposures with blood pressure and ADHD-like behavior outcomes.	Feedback from community partners informed survey design, analytical model development, and interpretation of model results. Survey implementation was led entirely by the community partner, NorthStar, as were development strategies for dissemination of results within the community.
Combined Effects of Metals and Stress on Central Nervous System Function	University of Rochester School of Medicine and Dentistry	Tested the hypothesis that stress and chemical stressors that act on the same biological systems (the hypothalamic-pituitary-adrenal (HPA) axis) produce greater effects when they co-occur. Rodent models were used to assess the effects on offspring of perinatal exposure to lead and mercury in combination with stress.	University staff convened focus groups including community group members, advocacy groups, and health care providers to elicit their interpretations of the implications of results for community education, policy, and practice.
Effects of Stress and Traffic Pollutants on Childhood Asthma in an Urban Community	Rutgers, the State University of New Jersey; Ironbound Community Corporation (ICC)	Developed and tested a plausible biological mode of action by which psychosocial stress may worsen asthma responses to air pollution among children. Researchers hypothesized that stress modifies the effects of acute exposures to traffic-related air pollutants by blunting the normally protective roles of the hypothalamic-pituitary-adrenal (HPA) and/or sympathetic-adrenal-medullary (SAM) axes in acute asthma exacerbation.	Community groups, including the Ironbound Community Corporation (ICC), were equal partners in decision making, planning, and executing the project. Trained ICC staff were directly engaged in the research through planning and executing study protocols. Research findings were shared and interpreted with community members in ways that can be useful to achieve community goals.

(continued)

TABLE 1 (CONTINUED)

<i>Research project title</i>	<i>Institution(s)/community partner</i>	<i>Research project description</i>	<i>Community engagement description</i>
Analytical Strategies for Assessing Cumulative Effects of Chemical and Nonchemical Stressors	University of Texas School of Public Health	Evaluated how the spatial distribution of ambient chemical exposures across neighborhoods interacts with nonchemical stressors at both the neighborhood and individual levels to account for differences in adverse cumulative health effects. These adverse effects are represented by biologic markers of allostatic load, cardiovascular risk, hormonal stress response, inflammation, and organ dysfunction.	CBPR Plan involved the Texas City Community Advisory Panel (TCCAP), a pre-existing citizen/government advisory panel created when the primary data was gathered in Texas City from 2004–2007. They reviewed the University researchers' modelling results and provided feedback on interpretation.
Hypertension in Mexican-Americans: Assessing Disparities in Air Pollutant Risks	University of Texas School of Public Health; Mano-a-Mano Community Advisory Board	Examined the association between fine particulates and other air pollutants and hypertension, with a focus on quantifying modifying effects of nonchemical stressors on air pollutant effects among Mexican Americans in Houston, TX. Developed novel methods for addressing interactions between chemical and non-chemical stressors in a logistic regression context.	University researchers consulted with the Mano-a-Mano Community Advisory Board which is associated with an ongoing cohort study of the Mexican American community from which this project drew data. In addition the University researchers established a Neighborhood Council of Advisors to provide guidance, validation and feedback on all project activities. Community focus groups helped identify chemical and nonchemical stressors that are of concern to community residents, participated in dissemination of the research findings to communities, and development interventions to reduce disparities.
New Methods for Analysis of Cumulative Risk in Urban Populations	Boston University School of Public Health (BUSPH); Chelsea Collaborative	Used qualitative research methods and quantitative structural data analysis techniques to characterize environmental burden on an individual and community level in the City of Chelsea, MA, and to share results of analyses with community members and public health officials.	The Green Space Committee of the Chelsea Collaborative shared in management and decisions regarding research directions: such as writing the grant proposal; defining the recruitment area and procedures; hiring and training bilingual (English and Spanish) project coordinators and interviewing teams; developing the interview guide; analyzing the data; and reporting results at community meetings.

TABLE 2. COMMUNITY-BASED PARTICIPATORY RESEARCH (CBPR) PLAN REQUIREMENTS

“A CBPR Plan will be required for each proposed project. Although a range of levels of community involvement can be considered CBPR, CBPR is characterized by substantial community input in the project. In the application, the applicant will need to justify the level of community involvement that he or she has proposed. For additional information on CBPR, see Minkler and Wallerstein (2008). At a minimum, each applicant must:

- Focus on research issues of significance to a community that is interested in the proposed work.
- Identify the role of community members in the proposed research plan (i.e., the degree of community input or engagement in the conceptualization, design, methods, analyses, or dissemination of research).
- Describe how this research will enhance the capacity of the community.
- Include resources for partnership development (e.g., to hire community liaisons or to provide participant support costs for community involvement).
- If a host organization (any organization/institution other than the applicant) is used to facilitate community participation or partnerships, evaluate the organization’s mission and practices concerning community partnerships (e.g., how the staff has or can develop skills to sustain community participation).
- Determine how to disseminate research findings to the identified community as well as the scientific community.
- Provide evidence of community support.” (USEPA2009)

dialog, community members and scientists developed a research plan in which complementary community and academic resources were shared under joint leadership.

As these examples show, the STAR-CRA projects incorporated community engagement using diverse approaches that resulted in different modes of engagement.

IMPACTS OF COMMUNITY ENGAGEMENT PROJECTS ON COMMUNITY CAPACITY

The second rationale for the CBPR Plan requirement in the STAR CRA RFA was that community engagement in

TABLE 3. PEER REVIEW CRITERIA FOR STAR COMMUNITY-BASED PARTICIPATORY RESEARCH (CBPR) PLAN

“Demonstration that the focus is on research issues of significance to a community that is interested in the proposed work and that the role of the community members is appropriate for the research; the ability of the research to enhance community capacity; the plan for disseminating research findings to the community; if a host organization is used to facilitate community participation, evaluation of the organizations community partnership mission and practices; and evidence of community support” (USEPA2009).

research can increase their capacity to change conditions that affect community health. The CRA CBPR projects yield several examples of increased community capacity. In the University of Texas’s grant on air pollution, psychosocial stressors, and hypertension among individuals of Mexican origin, community participants began to see themselves and their experiences as sources of information that can contribute to the understanding of the relationship between cumulative exposures to environmental contaminants, psychosocial stress, and health outcomes. For the NorthStar organization, involvement in research on cumulative risk allowed an expansion of their comprehensive communitywide responses to the array of stressors burdening children, youth, and families. The collaboration between the University of Pittsburgh and WE ACT built community capacity among NYCCAN members and WE ACT staff to interpret spatial patterns in multiple exposures, with the intention to inform efforts to integrate social and environmental factors and community health promotion initiatives.

IMPACTS ON CUMULATIVE RISK RESEARCH

The third rationale embodied in the CRA RFA was that community engagement would enhance research on cumulative risks. The seven CRA projects yielded a range of instances in which engagement influenced research aims, methods, and analysis. In several projects, community input had a significant impact on questions included in community surveys. In other projects, community engagement enhanced the science on cumulative risk by identifying additional neighborhood stressors. For example, after residents in Chelsea raised concerns about noise, a BUSPH doctoral student analyzed noise and depressive symptoms and found that sleep disruption caused by noise was associated with increased odds of self-reported depressive symptoms among study participants (manuscript in progress). Similarly, stressors identified through focus groups in the University of Pittsburgh/WE ACT project informed more comprehensive assessment of perceived stress across diverse NYC communities. Locally relevant stressors, such as community-police dynamics, public transportation access and quality, vermin, and sanitation were added to a stress survey. In this project, community partners additionally influenced the interpretation, communication, and application of results. This contribution could have important implications for future research priorities or directions. In Houston, community members who participated in a pilot of a questionnaire identified stressors outside of neighborhood life, specifically financial, safety, and legal concerns about family living in Mexico and contact with government officials. These issues had not been raised in earlier focus group discussions. This input inspired the development of additional questions for the final study questionnaire that was administered to approximately 2,400 individuals of Mexican origin in an epidemiologic study of the combined effects of psychosocial stressors and air pollution on hypertension.⁴⁵

CHALLENGES OF COMMUNITY ENGAGEMENT IN CUMULATIVE RISK RESEARCH

The examples presented above suggest that the program yielded progress toward the community engagement goals set out by the RFA. However, we note several challenges including the short time-frame for communities to develop research aims in response to the research solicitation, research funding timing differing from engagement support needs, academic administrative requirements, unique difficulties of communicating research results of this nature, and limited evaluation of the CBPR Plans.

1. Institutionalized focus on scientists' research aims

The structure and timeline of the RFA did not encourage input by community partners in research planning. While some community partners were engaged during the grant-writing phase, the scope of work was largely predetermined by the research teams that responded to the RFA. Those community-academic partners who were successfully able to respond as a team had previous research relationships. The timeline of the RFA allowed little time for building community relationships, which posed a challenge to developing structures for extensive involvement. Again, the projects which had engagement on the higher levels of Yuen's community engagement continuum,²⁹ tended to build on pre-existing research-community partnerships.

2. Timeline for research funding versus opportunities for engagement

In several projects, the timeline for the research funding period constrained engagement. Many partnerships included a role for community groups to communicate research results to communities. There was a considerable time lag between the start of the projects and when results were available for dissemination. NorthStar, partner with BUSPH, noted that community members were surprised by how long analysis and model development took and that the desire to minimize pre-publication release of original research articles further postponed release of research findings. The most appropriate time for community action occurred after the grant period, when there were no longer resources to support community partners' activities.

3. Academic administrative requirements place burden on community groups

A third challenge related to administrative requirements for documentation by the community partner. For example, the Boston University Medical Campus Institutional Review Board required training of community-based recruiters on how to respond to disclosure of domestic violence; mandatory reporting of abuse of a child, disabled, or elderly person; protection of confidentiality; and personal safety. They also required every staff

member of the Chelsea Collaborative to sign a statement assuring knowledge of the importance of keeping data confidential. Some community partners sometimes felt the university was being overly paternalistic, and inappropriately dictating the policies of the community partner beyond what they felt was warranted under the regulations protecting human subjects.

4. Unique challenges of communication about social stressors and cumulative risks

Several of the CRA grantees identified particular challenges of communicating with communities about stress-related physiological susceptibility to environmental hazards in ways that did not induce stress or stigma. Partners mentioned that increased discussion of potential environmental exposures in a community could itself cause stress. In Rochester, health care providers said they would prefer not to share information about effects of prenatal lead and stress with high-risk pregnant women because the women might experience more stress thinking about factors they could not control. Instead, they focused on communicating constructive messages about how to avoid pre- and post-natal exposures to lead. As cumulative risk assessment methods begin to address more nonchemical stressors as recommended by the National Research Council and others,^{15,16,38,39,40} this issue of discussing nonchemical stressors appropriately with communities will become a critical topic to address.

5. Lack of structure for evaluation of CBPR Plan progress

A final challenge is related to the lack of clear evaluation processes for the community engagement component of the projects. Although the community engagement activities were summarized in annual reports at the request of the National Center for Environmental Research (NCER) project officer as an additional component, there were not established criteria for evaluating progress. Individual projects were free to build process evaluation into their agreements with community partners, as did the BUSPH/Chelsea project, but absent these project-initiated innovations, there was limited incentive or guidance to do so. This may in turn have limited the research teams' incentives to sustain and support relationships and to solve problems when community engagement programs faced unexpected challenges. None of the annual reports reflected a lack of support for community engagement, but these reports are limited. There were institutional disincentives for investing in evaluation of the projects. For example, projects were not required to budget for travel for community liaison staff or community partners to annual meetings, so PIs had to decide whether to support this or devote more funds to research or researchers' travel. Future RFAs should examine ways to systematically support constructive evaluation, support, and sustainability.

Despite these challenges, these projects made progress with respect to involving communities, informing research, and building capacity.

LIMITATIONS

This review of the community engagement activities under the CRA CBPR Plans is limited by several factors. First, we relied on the project proposals, grantee annual reports, and observations of the authors. A thorough evaluation would require longitudinal, multi-method approaches.³⁷ Nonetheless, we gained several insights into the effects of requiring community engagement as an element of an RFA on cumulative risk research and building community capacity to address environmental justice. We conclude with lessons learned for future efforts to support community engagement in research on chemical and nonchemical exposures.

DISCUSSION AND CONCLUSIONS

Our analysis of project proposals, grantee annual reports to the EPA, and authors' observation of these seven programs suggests guidelines for development of future funding mechanisms and for conducting community-engaged research on cumulative risk involving environmental and social stressors. A full evaluation of impacts on community capacity would require extensive interviews with all parties involved over an extended period of time. However, our analysis of the experiences of the STAR CRA community engagement programs shows it is important for research funders, academic, and community partners to allow for flexibility in community engagement; to address the disjunction between research timing and engagement funding needs; to develop greater understanding, approaches, and tools for communicating about the sensitive issues of cumulative environmental and social risks; and to support the evaluation of engagement efforts. Each of these four areas for development is discussed below.

First, it is important to provide for flexibility in the role of communities in research. Depending on the nature of research and existing community capacity, different modes of engagement may be appropriate. Engagement on a complex topic such as cumulative risk assessment may require a variety of partnership activities depending on the type of research, immediacy and relevance of research results to local concerns, and the community's existing capacity, resources, and organizations. Community and academic partners should consider these parameters as they plan their cumulative risk research activities. Proceedings from the 2012 STAR CRA grantee progress review meeting reinforced this flexibility point, suggesting that "definitions and attributes of community partnerships should be less prescriptive and allow for variations in the manifestations of partnerships, acknowledging that not all productive partnerships may fall within a rigid conceptualization."³² The existence of engagement functions across the entire spectrum of roles and levels of engagement defined by Yuen²⁹ in the seven STAR CRA projects emphasizes the importance of supporting diverse modes of partnership in cumulative risk research.

Second, funders should recognize that the bulk of translation, communication, and dissemination may hap-

pen after the scientific research funding period concludes and results are published. Challenges such as these have been documented across diverse community partnerships in the past.⁴¹ The typical funding mechanism that provides for level funding maintains engagement over time but may not match project needs. This particular issue was raised at the 2012 CRA progress review meeting as well. STAR CRA grantees proposed longer-term funding to provide adequate time for partnership development, community capacity-building, project planning, and dissemination of project results.³² Future funding mechanisms should explore alternatives that better support the CBPR process.

Third, particular attention should be paid to the challenges of interacting with communities about the sensitive, complex, and potentially stress-producing implications of CRA research. Environmental justice advocates have been strong voices in support of developing understanding of the health effects of cumulative risks. However, findings that emerge from this research have the potential to be anxiety-producing for these communities. Additional efforts to develop messages, communication tools, and appropriate forums for discussion of these issues are essential as research continues to shed light on potential health consequences of multiple chemical and nonchemical exposures on communities.

Finally, expectations for community engagement need to be explicitly spelled out in the RFA and relevant review criteria. Funders should require evaluation of community engagement components and allow for metrics that are consistent with those goals, but also flexible. Evaluation of community engagement should be required under the terms and conditions of the annual progress reports typically required by federal funders. Evaluation approaches could be adapted from the National Institutes of Environmental Health Sciences (NIEHS) Partnerships for Environmental Public Health (PEPH) evaluation manual.⁴² Future efforts should ask grantees to establish specific community engagement outcome goals, build in appropriate evaluation metrics throughout the life of the grant, and provide financial support for evaluation. Funders also should allow for flexible goals and peer support/mentoring for community engagement and CBPR. Providing for interactions between community partners (e.g., an online community, designated track at grantee meetings, or staff-facilitated webinars, etc.) as well as fostering interactions between community and academic partners at grantee progress meetings hosted by the funder may also help support these programs, much as research presentation, professional meetings, and peer-reviewed publication support the progress of scientific research.

This analysis of the STAR CRA community engagement projects suggests that they made significant progress toward goals of engaging communities, partnering to inform the research, and developing community capacity to utilize research results. The STAR CRA RFA's inclusion of community engagement is an important first step towards focusing research on community needs and governmental efforts to promote environmental justice. However, the experience suggests that additional development of criteria for planning, review, communication,

and evaluation of such efforts is essential to fully realize the potential of these investments.

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