



BOSC

BOARD OF SCIENTIFIC COUNSELORS

May 23, 2024

H. Christopher Frey, Ph.D.
Assistant Administrator
Office of Research and Development
U.S. Environmental Protection Agency

Dear Dr. Frey:

On behalf of the Board of Scientific Counselors (BOSC), we are pleased to provide you a review report addressing the charge questions posed by the Office of Research and Development to the BOSC Climate Change and Social and Community Science Subcommittees.

The Subcommittees were charged with three charge questions related to ORD's social science, climate change, and place-based research. This report represents the cumulative effort of the Climate Change and Social and Community Science workgroups and the Executive Committee.

We anticipate that this report will assist ORD in reflecting an important shift in research, towards approaches that better incorporate social scientists, integrate climate change research into a broader portfolio of interdisciplinary research, and respect community involvement in place-based research. We will be happy to provide any additional information concerning the review or answers to any questions you may have, and we look forward to working with you in the future on these programs.

Sincerely,

A handwritten signature in black ink that reads "Paul Gilman".

Paul Gilman, Ph.D.
Chair, BOSC

A handwritten signature in blue ink that reads "Lucinda Johnson".

Lucinda Johnson, Ph.D.
Vice Chair, BOSC

**REPORT OF THE U.S. ENVIRONMENTAL PROTECTION AGENCY
BOARD OF SCIENTIFIC COUNSELORS
CLIMATE CHANGE AND SOCIAL AND COMMUNITY SCIENCE
SUBCOMMITTEES**

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A Federal Advisory Committee for the U.S. Environmental Protection Agency's Office of Research and Development

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Tom Tracy, Designated Federal Officer

March 7, 2024

Disclaimer Text. This report was written by the Climate Change and Social and Community Science Subcommittees of the Board of Scientific Counselors, a public advisory committee chartered under the Federal Advisory Committee Act (FACA) that provides external advice, information, and recommendations to the Office of Research and Development (ORD). This report has not been reviewed for approval by the U.S. Environmental Protection Agency (EPA), and therefore, the report's contents and recommendations do not necessarily represent the views and policies of EPA, or other agencies of the federal government. Further, the content of this report does not represent information approved or disseminated by EPA, and, consequently, it is not subject to EPA's Data Quality Guidelines. Mention of trade names or commercial products does not constitute a recommendation for use. Reports of the Board of Scientific Counselors are posted on the Internet at <http://www.epa.gov/bosc>.

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LIST OF ACRONYMS

ACE	Air, Climate, and Energy Research Program
BOSC	Board of Scientific Counselors
DOE	Department of Energy
EJ	Environmental Justice
EJ TCTAC	Environmental Justice Thriving Communities Technical Assistance Centers
EPA	Environmental Protection Agency
eSTAR	Emerging Systems Toxicology for Assessment of Risk
FACA	Federal Advisory Committee Act
GHG	Greenhouse Gas
ICAP	Interdisciplinary Climate Assessment Program
ICSD	Integrated Climate Sciences Division
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NIEHS	National Institute of Environmental Health Sciences
NIH	National Institute for Health
NSF	National Science Foundation
NTP	National Toxicology Program
NOAA	National Oceanic and Atmospheric Administration
OCS	Office of Community Support
OPPPD	Office of Policy, Partnerships and Program Development
ORD	Office of Research and Development
RCAN	Regional Climate Assistance Network
SRPDIO	Superfund Research Project Data Interface Ontology

INTRODUCTION

The Climate Change Subcommittee and the Social & Community Sciences Subcommittee of EPA's Board of Scientific Counselors (BOSC) were established in 2023. They support BOSC's Executive Committee by providing expert review and advice for any purpose consistent with the BOSC's charter. The Executive Committee, in turn, provides advice to EPA's Office of Research and Development (ORD). The two subcommittees met jointly in June 2023 to get an overview of ORD's Climate Change and Social & Community Science Research Programs. In October 2023, the subcommittees were presented with three charge questions related to ORD's social science, climate change, and place-based research. The three charge questions and ORD's work reflect an important shift in research, towards approaches that better incorporate social scientists, integrate climate change research into a broader portfolio of interdisciplinary research, and respect community involvement in place-based research.

Each subcommittee member was assigned to work on one charge question. Between December 2023 and March 2024, members held numerous meetings with others working on the same charge question as well as with the collective subcommittees. This report is the result of these meetings. It assesses the strengths of ORD's work, suggests ideas that ORD may consider to strengthen research programs, and provides specific recommendations that ORD could act upon.

Each charge question contains three parts, structured around a given theme. Charge Question 1 on social science asks for (1) an assessment of ORD's progress in building social science capacity, (2) suggestions for integrating social science into a broader research portfolio, and (3) suggestions for supporting social scientists. This report recommends hiring even more social scientists, but in a more targeted manner to meet agency needs. Social scientists should have leadership roles in structuring ORD's research agendas. The report stresses the importance of interdisciplinary team science where each team member understands the importance of others' work. Both individual and institutional capacity building is needed to support individual social scientists, including building partnerships within and beyond ORD.

Charge Question 2 on climate change research asks for (1) an assessment of progress to build interdisciplinary climate science capacity to address climate and environmental justice, (2) suggestions for better integrating research, and (3) suggestions regarding the Integrated Climate Sciences Division (ICSD) established in the spring of 2023. The report commends the establishment of ICSD and urges ORD to continue cross-cutting research on climate change by establishing and prioritizing specific transdisciplinary research goals for the next few years, and by focusing on environmental justice. Further, the report calls for guidance on translating lessons learned from place-based research.

Charge Question 3 delves more deeply into place-based research, focusing on (1) scaling lessons learned (and respecting where they should not be generalized), (2) using place-based research for climate change adaptation and mitigation, and (3) best practices for working with place-based communities. The report recommends including communities in every step of the research process (ideas for doing this are included in the suggestions). As with Charge Question 2, the report calls for cooperation between ORD and potential partners among other agencies, non-profits, and the private sector.

The overlap between some of the responses to the charge questions reflects the importance of approaches that bring together different disciplines and perspectives, including those of communities

and social scientists, as well as viewing research through a human-oriented environmental and climate justice lens.

Charge Question 1

CHARGE QUESTIONS AND CONTEXT

ORD has continued to implement actions to build social science capacity and integrate social sciences into the overall ORD research portfolio. This includes recent hiring actions to bring in a new cohort of social scientists who will be deployed in multiple Centers and geographic locations.

Charge Question 1

Q.1: What suggestion(s) or recommendation(s) does the Subcommittee offer regarding ORD's progress to date in building social science capacity to address critical environmental challenges?

Narrative

The EPA's mission is to protect human health and the environment. Recognizing that understanding and addressing complex problems at the nexus of human health and the environment necessitate transdisciplinary research approaches, it is important that ORD programs continue to grow social science capacity and deeply integrate such expertise into their activities. We applaud ORD's efforts to build social science capacity to date, and the diversity of disciplines represented by current social science hires from natural resources to environmental policy to sociology. However, our impression is that there is a need for an organizing framework to better inform social science hiring decisions within ORD. This framework should include more clearly defined objectives to guide the hiring and incorporation of social scientists in strategic areas by adding capacity (i.e., personnel and skills) where gaps in the necessary expertise exist and where inequities related to environmental problems have been observed. Examples of strategic hires include senior level social scientists that can more actively help define research priorities, trained interdisciplinary scientists to oversee cross boundary integration, or social scientists with specific skillsets paired to already defined agency needs. Past position descriptions for social science hires in ORD are similarly broad, which may lead to a diverse pool of candidates but may not ensure that the successful candidate is prepared to address a particular disciplinary, methodological or domain specific need. We advise ORD to hire social scientists with expertise conducting research as part of multidisciplinary teams, and with backgrounds in environmental justice or other social determinants of health.

In Maxwell et al. (2019), the authors list key insights for EPA ORD social science initiatives based on efforts of other US federal agencies for integrating social sciences. One such insight includes ascertaining whether the objective of the social science investment is to advance scientific knowledge and/or support programmatic operations. For example, if the priority is for ORD scientists to improve the programmatic operations of the agency, then focusing on building partnerships with regional offices and parallel environmental agencies at the state and city level would be needed (as described in later recommendations). As needed, ORD has hired consultants to help with some of these EPA operations and regulatory activities, but it may be more ideal to grow the permanent research staff to ensure the retention of knowledge and community connections. The types of social sciences in demand would then be more specific to programmatic needs (e.g. governance needs assessments, policy implementation barriers, etc.). If the priority is to advance scientific knowledge, then establishing partnerships with research institutions should be prioritized (as described in later recommendations). The types of social

science needs may then have a wider scope and include longer term research (e.g. ethnographic case studies) that may be difficult to incorporate into time sensitive projects (Maxwell et al., 2019), or research that requires computational capacity or technical skills not present widely within the agency (e.g. large-scale econometric analyses).

More clearly defined objectives for recruiting and hiring social scientists in line with Maxwell et al. (2019) would help determine next steps for the agency. Clearer specification may also help identify what type of social scientists are needed. It is important to recognize that environmental social science, like other broad categories in science (e.g., physical science), is incredibly diverse. For example, environmental social science includes anthropologists conducting ethnographic field work in contaminated communities, geographers mapping environmental risks at a global scale, sociologists conducting nationally-representative surveys on environmental concerns, communication scientists who design and assess campaigns and engagement processes, political scientists studying public support to address climate change, economists modeling potential economic consequences of climate change, and psychologists studying decision-making under conditions of environmental uncertainty. This diversity necessitates an intentional, nuanced approach to “hiring social scientists”. We recommend (Recommendation 1.1) designing a rationale/strategy for hiring social scientists of different disciplines by asking, what are the specific objectives guiding social science integration at ORD and, by extension, what are the skills and expertise needed to meet those objectives? ORD could do this systematically and comprehensively by designing a matrix for which types of social scientists are needed. The axes in the matrix could include disciplines (e.g., economics, anthropology) vs. skills/methods (e.g., big data analysis, focus group methods) vs. context expertise (e.g., water contamination, air pollution). As appropriate, this matrix might also consider community engagement and environmental justice expertise as cross-cutting.

True integration also hinges on hiring practices that extend beyond hiring several dozen social scientists, even if those social scientists are strategically selected to fill identified gaps. For example, hiring at the senior level is also important. More senior level social scientists, preferably with interdisciplinary team science skills, will be better able to navigate the landscape in ORD and effectively advocate for and then implement integration. In addition, it is critical for social scientists to be hired in leadership positions as there needs to be support for social science at all levels of management for true integration to occur. Other ways of narrowing the focus to better suit the scope of those hired would be to focus the efforts of ORD social scientists on research driven by statutory requirements and emergency response, while building collaborations with university social scientists, consultants, and other government and business community partners for anticipatory research needs. This may allow ORD to prioritize programmatic operations while also advancing knowledge through scientific collaborations.

ORD may also need to train Human Resource staff to recognize the different types of social science expertise so that candidates for open positions are not accidentally filtered out as unqualified during the initial screening process. As is this case with other scientists, some social scientists have more experience and interest than others in working as part of interdisciplinary teams. When writing position descriptions, ORD should take care to attract the types of social scientists that they need. They may want to consider requiring previous interdisciplinary, team-based research experience. In addition, it is important for the scientists to be representative of the communities that ORD is serving with their projects. ORD may need to be strategic about hiring more researchers from underrepresented

backgrounds, not just in social science, but across the board in all sciences, in order to better reflect the communities that they serve.

Even if the programmatic and scientific goals are clearly defined, and the types of social scientists needed to meet those goals are explicitly defined, there is still a concern that the investment in social science is not large enough. While hiring some social scientists is a good thing, hiring even more is critical to successful integration into the research portfolio. Of the 1200 ORD scientists, less than 50 are social scientists, representing less than 5% of the workforce. This is not enough to be able to address critical environmental problems that require transdisciplinary approaches (Maxwell et al., 2019). This small representation cannot represent the depth and breadth of human systems/science skills that are needed at ORD, placing even greater limits and stress on the individuals in these positions. Thus, we need to grow the number of social science experts within the agency.

Strengths

- ORD has identified social science as a priority.
- ORD has hired more social scientists.

Suggestions

- **Increasing investment:** The investment in social science is still too small to have the desired impact. Hire even more social scientists who can help expand the scope and extent of expertise. We advise ORD to hire social scientists with expertise conducting research as part of multidisciplinary teams, and with backgrounds in environmental justice or other social determinants of health.¹ More clarity on the needs given the current capacity as highlighted in our recommendation may clarify if the current level of hiring is enough.
- **Target hiring:** Design a rationale/strategy for hiring social scientists of different disciplines by asking, what are the specific objectives guiding social science integration at ORD and, by extension, what are the skills and expertise needed to meet those objectives? ORD could do this systematically and comprehensively by designing a matrix for which types of social scientists are needed. The axes in the matrix could include disciplines (e.g., economics, anthropology) vs. skills/methods (e.g., big data analysis, focus group methods) vs. context expertise (e.g., water contamination, air pollution). As appropriate, this matrix might also consider community engagement and environmental justice expertise as cross-cutting.

Recommendations

The Subcommittee offers the following recommendation:

Recommendation 1.1: Craft an organizing framework that includes clearly defined objectives for social science needs within ORD to better target hiring decisions to the necessary knowledge and skills for maximum impact.

¹ <https://research.noaa.gov/wp-content/uploads/2023/05/OAR-Strategy-2020-2026-14.pdf> for further information.

Charge Question 2

Q.2. What suggestion(s) or recommendation(s) does the Subcommittee offer to improve the effectiveness of ORD's approaches to integrating social science into its broader research portfolio involving physical, chemical, and biological sciences, computational sciences, and engineering?

Narrative

EPA's document EPA-601/R-16-003 led by Hubbell (2016) highlighted the need for social and natural scientists to *jointly collaborate in problem formulation* to advance interdisciplinary social-environmental science within ORD's Air, Climate, and Energy (ACE) Research Program. We view this collaboration as essential, given that the problem formulation stage determines what expertise is needed. Moreover, questions around environmental justice are inherently tied to many social science traditions that have long studied the root causes of power, social stratification, and inequality. Yet, it is unclear the extent to which social scientists are truly integrated into the mission of ORD from start to finish.

When crafting job postings, it is important that ORD keep in mind not only what disciplines and skill sets are needed, but to create a concrete plan about how to include these hires into the agenda setting and prioritization of research program activities. This might include intervening to shape the culture of collaboration with social science among existing non-social scientists, including but not limited to integrating team science training into the collective ORD science community. Critically, this should include hiring or promoting more social scientists into senior positions of leadership within the agency.

The current focus on supporting the social scientists directly is necessary but limited. The efforts of ORD appear focused on what social scientists hired by ORD might need, but less focused on what others within ORD might need to do to be more receptive to social science integration across the broader ORD research portfolio. In other words, ORD should also create a plan to educate other ORD scientists to understand the skill sets, theories, and contributions afforded by the various social science disciplines.

Accordingly, the committee felt that more effort could be put into support for team science training and development. There may be a need to shape the attitudes and knowledge of those already in place, and/or to hire new individuals who are open to this type of collaboration. There may be a need to address a basic lack of understanding about social science, including the diversity of social science perspectives across scales and what social science does and does not do. For example, some disciplines focus on different scales of decision making (e.g., psychology focuses on individuals, sociology/anthropology focuses on communities); while others focus on how specific forces shape decision making at multiple scales (e.g., communication focuses on media effects, human geography on the physical environment). Each of these perspectives may be critical to understanding human system dynamics following a train derailment and contamination event, but some may be particularly important. The report by Hubbell (2016) provides an appendix with more details about the array of social sciences and provides selected examples on how the various disciplines can contribute in insightful and impactful ways.

At the same time, most social scientists from traditional disciplines (e.g. sociology, psychology, economics) are *not* trained in community engagement, nor do they all have cultural humility and understanding. Rather, we feel that all ORD scientists, including those in STEM fields, should have some training in community engagement that is distinct from their own disciplinary expertise.

ORD can build on best practices and precedent around team science and transdisciplinary research. For example, the National Academies has several publications, including [Enhancing the Effectiveness of Team Science](#) which defines team science and addresses how to improve team and group effectiveness.

The National Socio-Environmental Synthesis Center also has resources on the [Science of Team Science](#) ranging from how to build teams, to best practices for interdisciplinary research, to integrating knowledge across disciplines. While Hubbell's report also provides excellent guidance for integrating social scientists into transdisciplinary research teams seeking to address critical environmental challenges within ORD, the committee recognizes that it takes years to build functional interdisciplinary teams, and it is unclear to what extent systems are being built within the agency that foster a common language for co-defining research problems and questions.

Strengths

- ORD has included some social scientists in leadership positions.
- ORD's focus on "solutions driven research approach", which necessitates collaboration between scientists from different disciplines.
- ORD has engaged in reflexive consideration of the social-environmental science integration process.

Suggestions

- Leadership: Hire and promote more social scientists into senior positions of leadership within the agency.
- Awareness: Educate other ORD scientists to understand the skill sets, theories, and contributions afforded by the various social science disciplines. In addition to needing a critical mass of social scientists, it is also important that their non-social science colleagues have an understanding of the distinct language and methods used by the social scientists. It will likely take a long time before the interdisciplinary teams can work at maximum effectiveness--- thus selecting candidates for these teams with prior experience working in multidisciplinary teams will be especially important. Training existing research staff about social science methods and practices will enhance chances for success.
- Team science: Provide support for team science training and development. Develop an approach for social science integration that builds from Hubbell's report and established best practices for transdisciplinary team science.
- Community engagement: Ensure that all scientists (including social scientists) are trained in community engagement.

Recommendations

- **Recommendation 1.2**: Ensure that social scientists play a key role in agenda setting and problem identification within the agency. This includes both creating a plan and hiring process to ensure that social scientists explicitly contribute to the agenda setting process, and to place more social scientists into senior leadership positions.

Recommendation 1.3: Cultivate a more receptive research community by encouraging team science approaches and training STEM researchers to better understand the contributions of different social science traditions.

Charge Question 3

Q.3. What suggestion(s) or recommendation(s) does the Subcommittee offer to support social scientists in ORD?

Narrative

We applaud the ORD for their efforts to support social scientists through efforts like the ORD Social Science Network, linking social scientists within ORD, and mentorship committees. We also recognize that there are opportunities for social scientists to collaborate with social scientists in other federal agencies (e.g., via the Chesapeake Bay Program). While the efforts to date are important and should continue, we also believe there are opportunities for more targeted professional development and internal agency networking for new social science hires, and opportunities to build critical partnerships and networks outside of the agency.

In terms of building social science networks within the agency and across the federal government, more concerted, organized efforts are needed to engage with other branches of EPA and promote social science integration across ongoing agency-wide research programs, priorities, and activities. Part of EPA ORD's mission is to conduct research for EPA that provides the foundation for credible decision-making to safeguard human health and ecosystems from environmental pollutants. In order to do this effectively, ORD needs to primarily engage in interdisciplinary/transdisciplinary work while paying special attention to user-driven research priorities. A consistent, transparent and efficient way of conducting impactful user-driven, participatory research that integrates effectiveness evaluation and iterative learning is by engaging with its own agency's organizational structure and EPA staff outside of ORD. Personnel across EPA programs may face implementation challenges and have research and technology needs that can be informed by EPA ORD social scientists. Personnel across EPA programs also have firsthand knowledge about the context, needs and perceptions of communities and other partners within their region which is important for developing context sensitive research and outputs. Engagement with other branches of EPA may provide key information for the effective design and implementation of ORD social science research. For example, evolving community needs and priorities are difficult to capture through the short timeframe of ORD research projects, or of ORD supplemental hires (i.e., postdoctoral personnel, ORISE fellows, consultants, etc.). Establishing a system of data sharing and information exchange regarding community needs across regions served by different EPA branches should be considered. Examples of EPA offices and programs with potential to provide such information include EPA's Office of Environmental Justice and External Civil Rights; Office of Community Support (OCS) Community Engagement and Assistance Division; Office of Policy, Partnerships and Program Development (OPPPD); and EPA's Regional Offices Laboratory Services and Applied Science Division. These offices and programs could provide extra capacity to ORD social scientists through directly engaging and collaborating with more communities across EPA regions, helping to assess community-level impacts of the agency's activities, and identifying communities with the highest environmental hazard burdens.

If the goals of the hiring are both scientific and programmatic, then partnerships with community members, universities, other government agencies and business communities involved with EPA can aid the desired integration. An advantage of building scientific knowledge while seeking programmatic objectives of healthier communities is the promise of replication and guidance for local adaptations to

heighten the likelihood that social science contributes meaningfully to societal improvement. For example, social scientists in academia can collaborate with EPA to develop ethnographic tools to collect data locally (e.g. for needs assessment, health impacts, knowledge and perceptions, etc.). These may be deployed systematically through EPA regional office liaisons across communities in the US to gather long-term data on community needs. These data can then be integrated into long-term spatiotemporal analysis (e.g. using econometric analysis, social network analysis, and geographic information systems tools, etc.) and then used iteratively to inform programmatic effectiveness, how it varies in space and time, and also to inform our scientific understanding of socio-environmental linkages. These research projects and their linkages could be overseen and facilitated by EPA ORD social scientists.

The examples we provide raise another, higher level suggestion for ORD: The need for a more intentional, long-term vision of how social science can contribute systemically at EPA and not just within ORD. Contributing to the literature is essential, but so is bringing value to communities and building the social science capacity at EPA so that social science is seamlessly integrated with environmental and physical sciences. For other aspects of EPA, there are overarching databases and programs (e.g. nationwide air and water monitoring stations). EPA should aim to build the same infrastructure for social science so that research partnerships become more intentional, tractable, goal oriented, and strategic, especially in terms of integration across the agency.

In terms of identifying and building external partnerships, these strategies are key for developing ongoing collaborations that leverage existing capacity within ORD, and for expanding the scope of the organization's work by engaging external social scientists. Previous guidance to the agency (Hubbell 2016) highlights key strategies to achieve a collaborating network of social scientists, including having a list of existing expertise across ORD, establishing MOUs with universities, participating in networking events such as conferences, establishing a network "club" to which belonging would offer benefits (e.g., career prestige, and access to data, such as the "EPA Social-Environmental Expert Network"), and hosting interdisciplinary weekends, among other events for idea exchanging. It is unclear the extent to which these previous recommendations and feedback are widely known or have been strategically addressed. As mentioned previously, training in social sciences among ORD staff is extremely limited, which can only be partially addressed through short-term appointments, such as post-doctoral fellows and ad-hoc contractor employment (Maxwell et al., 2019). However, it is clear that there is a need for collaboration with external partners to be able to effectively integrate social sciences into EPA-ORD research, especially given the wide breadth of social science disciplines needed (economics, anthropology, policy, etc.) and the complexity of the topics being tackled (e.g. behavioral, governance capacity, public perceptions, environmental justice, etc.).

ORD should ask what key external partnerships are needed for social scientists to be successful. While we would be hesitant to prescribe the most critical partnerships, one such opportunity might include building networks with social science collaborators in academic institutions. One way to do that might be to identify data that a university-based scientist could help analyze, and then identify a student who could work on a joint project between the ORD social scientist and the university-based social scientist. While having access to data and focusing on student projects may be incentives for a university-based scientist to collaborate, other barriers will need to be addressed (e.g., creating MOU templates, defining a process for obtaining grant support letters from the EPA, etc.).

Another potentially important set of external partnerships would be with professional organizations that cater to social scientists in the environmental domain. Identifying these networks and supporting ORD social scientists' participation will be critical to their future success. This could include organizations such as The Society for Risk Analysis, which is a network of risk communication and decision science experts, or the American Sociological Association, which includes sections in both Environmental Sociology as well as Inequality, Mobility and Poverty. Supporting ORD social scientists' involvement in these organizations benefits their career by providing disciplinary support, and ensuring they are connected to cutting-edge research and further opportunities for collaboration.

Longer term, there are partnerships that ORD may want to consider that will support the pipeline of social scientists interested in working for the agency. For example, there may be opportunities for outreach throughout the STEM pipeline. Social scientists should be included in this outreach to broaden future employees' knowledge of the opportunities within the government agency-based science field, which may also help to build workforce participation among scientists from underrepresented racial/ethnic backgrounds down the road.

Finally, ORD needs to continue to engage in capacity building for ORD social scientists as it relates to their own professional development apart from the networks described previously. ORD has been intentional in thinking carefully about mentorship of new social science hires. However, we have several suggestions to improve this mentoring. One, ORD could provide training on 'report back' practices to ensure that results are being shared with communities following best-practices (<https://www.silentspring.org/project/digital-exposure-report-back-interface-derbi>). Two, ORD could provide mentoring/training on building community relationships. This is important as not all social scientists have experience working directly with communities. Three, ORD could consider adding peer mentors to build a network of peer social scientists. Four, ORD could provide additional resources for scientists coming from academia to help them make the transition to ORD.

When it comes to community-based work, which seems to be an implicit if not explicit objective of recent social science hiring, ORD should consider how to build capacity for ORD social scientists (and non-social scientists) to do community-based work that is sustainable and respectful to community members. Related to the previous suggestions regarding partnerships, one idea is to use regional liaisons. Scientists at Regional Offices and within other branches of the agency may be better able to maintain and sustain community engagement as opposed to ORD social scientists doing ad-hoc case study research projects in communities. Related, if community-based and stakeholder-engaged work is a primary focus, there is a need to better define terms like community and stakeholder. There also should be explicit attention to historic issues that might impede community engagement – for example, the term "stakeholder" can be viewed as an insensitive term by some communities. ORD social scientists need to know who they are engaging with and why (e.g., the partner is affected by a pollution issue identified through existing data, the partner is responsible for the pollution issue through their industry, the partner is supposed to regulate the issue locally, etc.).

Finally, ORD should consider establishing clear research guidelines around community-based work to ensure that the integration of social science into community-based research projects is not too extractive and directly addresses EPA regulatory mandates and/or produces beneficial, actionable outcomes that address environmental and human health problems of concern to communities. Specifically, community-based work should be directly tied to an explicit need (e.g. Clean Water Act

violation near a recreational facility). It should also be driven by a specific relevant research question that is tied to actionable outcomes (e.g. evaluating who uses the recreational facility and what economic losses have been experienced, determining who is responsible and why are they not following the rules, developing targeted training opportunities for local agencies, etc.). Communities should also be engaged based on clear objective criteria – for example, the critical partners have been identified through document analysis and existing data and not just convenience, and that process and the rationale for engagement are explained (e.g. they are affected based on maps of hazard exposure, or they are responsible based on violations to permits, etc.).

Strengths

- ORD is thinking carefully and intentionally about ensuring that their new social scientists have multiple mentors
- ORD is holding conferences and creating platforms for fostering collaboration within the social sciences in the agency and between agencies.
- ORD has made conscious efforts to build a network of social scientists.

Suggestions

- Agency capacity building:
 - Expand capacity building related to community engagement and partnership development. This involves engaging with other branches of EPA on designing and implementing ORD social science research, making use of their understanding of community needs and priorities. Establish a system of data sharing and information exchange.
 - Build networks and collaborate with social scientists in academia (including students) and professional organizations to support the pipeline of social scientists interested in working for the agency. Consider establishing a social science/climate change “community of practice” that can share learnings from different types of collaborations. An example is the cross-cutting “Coastal Inundation” community of practice established in 2024 by NOAA, SeaGrant, and the American Society of Adaptation Professionals.
- Long-term vision:
 - Develop a long-term vision of how social science can contribute across EPA, and not just within ORD.
 - Develop ethnographic tools to collect data locally that can be integrated into long-term spatiotemporal analysis.
- Individual capacity building: Help ORD social scientists with their own professional development.

Recommendations

The Subcommittee offers the following recommendations:

- **Recommendation 1.4:** Engage in individual capacity building that is unique to the needs of social science hires and their future success, with a focus on when and how to engage communities in research.
- **Recommendation 1.5:** Engage in institutional capacity building through the development of networks and partnerships within the agency, between the agency and other federal entities, as well as outside of the federal agency structure.

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Charge Question 2

CHARGE QUESTIONS AND CONTEXT

ORD has continued to implement actions to build its climate change research capacity and to integrate climate change as a key cross-cutting topic across the overall ORD research portfolio. This includes recent actions to create an organizational center of gravity for interdisciplinary climate science.

Q.1. What suggestion(s) or recommendation(s) does the Subcommittee offer regarding ORD's progress to date in building interdisciplinary climate science capacity to address the twin critical environmental challenges of climate and environmental justice?

Q.2. What suggestion(s) or recommendation(s) does the Subcommittee offer to improve the effectiveness of ORD's approaches to integrate climate sciences across its broader research portfolio?

Q.3. What suggestion(s) or recommendation(s) does the Subcommittee offer to support the three core initiatives of the new Division, namely: regional support, climate assessments, and evaluation?

Narrative

EPA plays a key role in the Nation's efforts to address the critical environmental challenges of climate change and environmental justice by integrating efforts to protect public health, address disproportionate impacts from historic inequities, reduce greenhouse gas (GHG) emissions, and promote adaptation and resilience to the impacts of a changing climate. EPA's framework for addressing the cumulative impacts of environmental changes and social stressors is guided by a holistic approach toward health, the environment, and climate. EPA's role is especially critical because of the somewhat fragmented nature of climate sciences and services in the federal government.

EPA's ORD supplies science-based information for the Agency's regulatory offices (e.g., air, water, waste, chemical safety) in addition to non-regulatory offices that need information on mitigation, adaptation, and resilience. Because it provides research products and services across the EPA and with outside partners, ORD is able to foster meaningful and necessary connections across programs, media, and scientific disciplines for developing effective and integrated solutions (e.g., enhancing stakeholder awareness, developing tools to evaluate environmental management practices). Two recent examples of ORD's cross-cutting efforts are its work with federal partners on wildfire impacts on air quality, water quality, and waste issues, and its support of regulatory programs to address the multi-media impacts of PFAS.

ORD established the Integrated Climate Sciences Division (ICSD) in spring 2023 through the redirection of existing staff and new positions to form a division of 30-50 people. ICSD advanced two new climate-focused initiatives, the Interdisciplinary Climate Assessment Program (ICAP) and the Regional Climate Assistance Network (RCAN). ICAP assesses the damages and costs of climate change, the benefits of mitigation, and provides input to metrics such as the Social Cost of Carbon used in federal rulemakings. RCAN provides technical support for resilience building (i.e., regional assessment, technical support, capacity building) in communities for the compounding effects of climate change, other environmental factors, and non-environmental stressors. These programs provide support for EPA's GHG mitigation

programs and to EPA's Adaptation Resource Center ([ARC-X](#)) on effective adaptation strategies and the development of case studies to build resilience to climate change impacts at the community level.

Overall, the Subcommittee applauds the establishment of the Integrated Climate Sciences Division and details below strengths, suggestions, and recommendations for improvement. We recognize that some of the suggestions described here may overlap with those for Charge Questions 1 and 3. This is a product of the transdisciplinary and intersectional nature of the challenges associated with climate change and environmental justice. While there may be some overlap in suggestions and recommendations, we think that the range of contributing perspectives offer complementary and holistic advice. We also recognize that the resources allocated to ORD may be small compared to other agencies working on the climate change crisis. Thus, we hope that the suggestions offered here serve to highlight the unique strengths and capabilities that ORD can contribute to the problem at hand and encourage other entities to recognize the value of ORD's work and support it through collaboration.

Strengths

- **Established ICSD**: The Subcommittee applauds the establishment of ICSD in spring 2023 and the progress achieved in building its interdisciplinary climate science capacity. For example, ICSD has augmented its staff with five new permanent social scientists who are now conducting research on the social science aspects of disaster response and new research on impacts to water resources and tribes. ICSD sets its priorities based on the needs of federal partners, states, local agencies, and tribes, and plays a key role in building capacity in communities to tackle the environmental health challenges posed by climate change.
- **Prioritization of environmental justice**: Reflecting the current Administration's priorities and EPA's strategic plan, ORD has prioritized attention both to research on environmental justice concerns (e.g., having environmental justice as a key research focus for regional climate assessments to be done by ICAP) as well as on involving communities in the research process. This involvement extends from identifying priority needs that communities may have for specific climate services information (as identified during extensive listening sessions and reflected in the design of RCAN in particular) as well as interest in co-produced science and solutions (e.g., STAR grants, the EJ Academy). In addition, climate is now also integrated into other environmental justice policies, as for example in the EJSCREEN mapping tool. This focus will put ICSD at the forefront of understanding how climate impacts, mitigation, and adaptation needs all intersect with environmental inequities.
- **Integration of cross-cutting topics**: While other federal agencies have invested in the broad framework of climate action and environmental justice, EPA is uniquely able to integrate environmental stressors and multi-media impacts in this context. The Subcommittee supports efforts by ORD to address air pollution and other environmental and societal impacts associated with the transition to clean energy through [Star Grants](#) and their energy systems modeling work using the COMET and GLIMPSE models.
- **Outreach to user groups**: ORD has a solid history of surveying external partners (e.g., state/local agencies, tribes), meeting with regional offices, and conducting outreach to environmental justice groups and tribes to determine if existing products are meeting their needs and how they can be improved. These include climate/equity listening sessions with states and local agencies and tribes in July 2021, the Climate Change Research Workshop in October 2022, and extensive planning engagement with EPA partners that is undergoing implementation. The Subcommittee

applauds and supports ICSD ongoing efforts to work with EPA's regional and local partners to address user-driven needs.

- New climate-related exposure-response functions: Assessing current and future damage to human health, property, etc. requires an expanding set of exposure response functions relating climate exposures to impacts on cardiovascular disease, mental health, other health indicators, and a range of ecosystem damages. The Subcommittee applauds EPA's efforts in recent years to expand the set of available exposure response functions and to demonstrate their application to assessing ongoing climate-health risks. Further work to generate damage functions at local scales will help in decision-making around disproportionate impacts and adaptation planning.

Suggestions

The Subcommittee offers suggestions for each of the subparts of Charge Question 2.

Q.1. What suggestion(s) or recommendation(s) does the Subcommittee offer regarding ORD's progress to date in building interdisciplinary climate science capacity to address the twin critical environmental challenges of climate and environmental justice?

- Compounding climate risks: There is a concerted effort at EPA to understand cumulative health impacts at the intersection of chemical and non-chemical stressors, climate change, and environmental justice. This is evident from recent grantmaking activities (see EPA-G2021-STAR-H1) as well as from the report, *Cumulative Impacts Research: Recommendations for EPA's Office of Research and Development*. The Subcommittee applauds these efforts and encourages EPA to continue building expertise on cumulative impacts, seeking to develop a consistent, comprehensive framework for assessing cumulative exposures and their associated health risks. Relatedly, there is an increased recognition that multiple climate-driven extreme events may occur together, enhancing risks to exposed communities, particularly those that have limited adaptive capacity because of historic disinvestment. Such compound climate events may involve extremes of temperature, air and water pollution, increased frequency and intensification of storms, and wildfire, for example, along with associated power outages, transportation disruptions, population displacement, and ecosystem damage. In addition to understanding these risks, EPA needs to be able to predict impacts related to climate change. Further, there is a need for a process for conducting horizon scanning in order to identify threats before they become stressors. Research is needed to develop and evaluate methods for assessing the risks and uncertainties associated with compound climate events and to integrate these methods into a cumulative impacts framework. As part of EPA's approach to considering cumulative health impacts, ORD can assist in the development and evaluation of methodologies that incorporate compound climate stressors with other chemical and non-chemical stressors for a holistic approach to determining health impacts to climate hazards.
- Environmental justice: ORD's focus on environmental justice is a clear strength; however, there exist a few opportunities where EPA could further take advantage of its expertise. For example, although social equity and justice are important considerations when evaluating potential trade-offs between GHG mitigation, climate adaptation, and urban development, the Fifth National Climate Assessment has noted that approaches to evaluate the social impacts of climate actions remain lacking. For example, floodplain restoration can reduce property damage and promote development in adjacent areas, but it can also shift flood risks from one location to another. Capitalizing on the expertise of social scientists at ICSD, regional assessments could evaluate these trade-offs and ensure that they reflect the multifaceted (health, economic, and social

well-being) nature of inequities. Further, the concept of a *just transition* (transformative actions that address the root causes of climate vulnerability while ensuring equitable access to jobs; affordable, low-carbon energy; environmental benefits such as reduced air pollution; and quality of life for all) should be incorporated into any evaluation of climate action trade-offs. The ICSD could consider how the concept of a *just transition* can be incorporated into its strategic planning. For example, what are the potential unintended consequences on equity and costs-of-living of a higher cost of carbon? ICAP could consider how these issues of equity can be reflected in the calculation of the Social Cost of Carbon.

- **Mixed methods:** In some cases, simple quantitative metrics to assess environmental and social vulnerabilities fail to holistically capture the systemic injustices rooted in racism and classism that affect community well-being and population health. For example, a quantitative measure of land cover may point to a neighborhood that is lacking in tree canopy. Investments in street tree plantings or other green infrastructure may provide a variety of ecosystem services, such as shade, flood protection, and health co-benefits. However, a deeper assessment with community residents may find that some fear that this type of neighborhood change will trigger gentrification. Qualitative methods can be a source of rich context to supplement quantitative measures. As discussed in CQ1, environmental social science is incredibly diverse. Therefore, it is critical to carefully consider the types of research questions that are relevant and the social science methods that may apply. For example, sociologists and historians may provide crucial historical context on the community, researchers with expertise in community-engaged methods may conduct interviews or focus groups with residents, and implementation scientists could provide insight on how best to implement an intervention. ICSD could develop a framework to incorporate the use of both quantitative and qualitative data, across different types and scales, in climate assessments, with an emphasis on the validity and importance of community-driven data and perspective (e.g., integrating lived experience into data synthesis).²
- **Co-benefits/harms:** EPA is funding new studies that examine health and equity benefits/harms of the energy transition. We encourage EPA to continue to build the evidence base for health co-benefits/harms of carbon mitigation and climate adaptation strategies through both intramural and extramural research. In doing so it will be important to account for potential spatial shifts in emissions between urban vs. rural areas taking into account EJ concerns. For example, EPA could assess co-benefits associated with water quality enhancement strategies, e.g., riparian and wetland restoration to mitigate flooding and enhance water quality. With increasing storm frequency and intensity and increased drought these practices contribute to human and environmental health. While potentially a strong motivator for local action, the co-benefits argument has to-date played a limited role in policy discussions around climate solutions. This is a domain in which EPA could play a key catalyzing role.
- **Risk guidance in the aftermath of disasters:** Extreme climate-related events are an increasing concern for many communities. Examples include deadly wildfires, extreme heat events, and devastating coastal storms and flooding events. Unfortunately, in most cases there is no strategy in place for dealing with the community aftermath. We encourage EPA to consider what role it could play in providing expert guidance to affected communities in the immediate

² Beames JR, Kikas K, O'Grady-Lee M, Gale N, Werner-Seidler A, Boydell KM, Hudson JL. A new normal: integrating lived experience into scientific data syntheses. *Frontiers in Psychiatry*. 2021 Oct 29;12:763005.

González R. 2019. The Spectrum of Community Engagement to Ownership. <https://movementstrategy.org/b/wp-content/uploads/2019/09/Spectrum-2-11.pdf>

aftermath of such events, alongside the important role of FEMA in working with communities to recover from disasters. For example, ICSD scientists could offer expertise to FEMA and collaborate to develop and communicate guidance at the regional level to improve public communications about risks. Also, EPA has extensive modeling capabilities which could be turned to developing predictive risk models to augment future damage assessments.

- **Capacity enhancement:** With its increased focus on climate change, we suggest that EPA provide opportunities for new and existing staff to build capacity in this field. Individuals who come from disciplines outside of climate science may lack the knowledge to identify how their expertise connects to climate change adaptation, mitigation, and related interventions. ICSD could assist in identifying external educational resources and networking opportunities to connect staff with others working in this emerging research area. An increasing number of free online course materials are becoming available, curated by several academic institutions. ORD also can encourage bi-directional knowledge sharing and the development of actionable goals alongside individuals at other federal agencies (NIEHS, NASA, NOAA, NSF, NIH, DOE), federally funded organizations like NCAR and leading university centers, professional society organizations (e.g., American Geophysical Union, American Meteorological Society), the private sector (e.g., Google, Meta, OpenAI), and organizations with an environmental justice focus (e.g., Trust for the Public Land, Environmental Defense Fund, Robert Wood Johnson Foundation). An informal network could include recurring meetings and be designed for local, regional, and national scales. In addition, ORD can set aside funds for staff to attend conferences that cover climate and health, such as meetings of the American Geophysical Union, International Congress of Biometeorology, American Public Health Association, International Society of Exposure Science, International Society for Environmental Epidemiology, International Conference on Urban Climate, and the American Meteorological Society.
- **Outreach to business community:** The Subcommittee commends the job that EPA has done on outreach to a variety of external partners. One critical partner in the pursuit of climate resilience is the business community. The Subcommittee suggests bolstering outreach to the private sector as a means of facilitating dialogue with another set of end users of scientific data generated by EPA and to gain insights on recommendations for novel climate adaptation solutions.

Q.2. What suggestion(s) or recommendation(s) does the Subcommittee offer to improve the effectiveness of ORD's approaches to integrate climate sciences across its broader research portfolio?

- **Links to regulatory missions:** The Biden-Harris Administration's Global Methane Pledge of a 30% emission reduction by 2030 is facilitated by non-federal private-public sector efforts to identify and mitigate high-emission sources (e.g., CarbonMapper, GHGSat, MethaneSat). While there is some work by ORD on improved process-based methane emission factors for several source types,³ the Subcommittee suggests that ORD could conduct research to understand the causes and solutions for high-emitter behavior for a wider range of methane sources⁴ and conduct

³ Next Generation Emission Measurement (NGEM) Research for Fugitive Air Pollution, <https://www.epa.gov/air-research/next-generation-emission-measurement-ngem-research-fugitive-air-pollution>.

⁴ Duren, Riley M., Andrew K. Thorpe, Kelsey T. Foster, Talha Rafiq, Francesca M. Hopkins, Vineet Yadav, Brian D. Bue, David R. Thompson, Stephen Conley, Nadia K. Colombi, Christian Frankenberg, Ian B. McCubbin, Michael L. Eastwood, Matthias Falk, Jorn D. Herner, Bart E. Croes, Robert O. Green, Charles E. Miller (2019) California's Methane Super-Emitters, *Nature*, **575**: 180-184. [doi: 10.1038/s41586-019-1720-3](https://doi.org/10.1038/s41586-019-1720-3).

work on other GHG (HFC, SF₆, N₂O) that exhibit high-emitter behavior,⁵ but are not covered by existing efforts.

- Air quality links to climate change: ORD has conducted and funded seminal research on the role of climate change as a contributing factor to air quality degradation, through impacts on wildfires, desertification, and anthropogenic PM_{2.5} and ozone pollution.⁶ Recent research has identified impacts of air pollution on climate change as well, e.g., how reduced aerosol levels due to air quality regulations have “unmasked” global temperature increases. Other work focuses on the air quality co-benefits of GHG mitigation. Meanwhile, a tremendous amount of climate modeling work is being conducted by and sponsored by other federal agencies (DOE, NASA, NOAA, NSF) that could be relevant to these air quality questions. The Subcommittee suggests that ORD encourage other agencies to include, where appropriate, these air pollution-related issues in their climate modeling efforts or use EPA expertise to improve the scientific understanding of how air quality changes in the U.S. will impact local/regional/global climate and vice versa.
- Links to the indoor environment: ORD’s indoor air quality program has a long history of advancing knowledge on time-activity patterns and microenvironmental exposures to all age groups, indoor pollutant sources and emissions, radon exposure, wildfire smoke impacts, exposure reduction strategies, etc. As ICSD’s programs develop over the long term, the Subcommittee suggests that the indoor environment receive consideration with future work on the built environment, energy systems, environmental justice, and climate hazards, like extreme heat. For example, how ventilation and filtration standards are set for building energy efficiency measures has implications for indoor pollutant exposures and thermal comfort during normal operation as well as after a severe weather event (e.g., exposure to indoor mold after a flood). Further, fully electric homes have both decarbonization and indoor air quality benefits. Quantification of these health co-benefits (or potential harms) are important considerations for electrification adoption.
- Stressors: Climate change imposes multi-faceted stresses on both natural systems and societies. Measuring these stresses and impacts through a combination of environmental, social, and biological indicators is crucial for developing effective strategies to mitigate and adapt to the challenges posed by climate change. Environmental stresses (e.g., temperatures changes, sea level rise, extreme weather events), social stresses (e.g., economic disruption, community displacement, health risks), biological stresses (e.g., allostatic load, biodiversity) require interdisciplinary approaches to collaboratively develop comprehensive measurement frameworks. The Subcommittee suggests that ORD work to develop or enhance composite indices that combine environmental, social, and biological indicators; conduct longitudinal studies to capture the dynamic nature of these stressors and cumulative impacts; and engage communities in the measurement and assessment process to ensure inclusion of a broad range

⁵ Buckland *et al.* (2017) Tracking and quantification of gaseous chemical plumes from anthropogenic emission sources within the Los Angeles Basin, *Remote Sensing of Environment*, **201**: 275-296 (<http://dx.doi.org/10.1016/j.rse.2017.09.012>).

Tratt *et al.* (2021) Identification and source attribution of halocarbon emitters with longwave-infrared spectral imaging, *Remote Sensing of Environment*, **258**: 112398 (<https://doi.org/10.1016/j.rse.2021.112398>)

⁶ Jacob, Daniel J., and Darrell A. Winner (2009) Effect of climate change on air quality, *Atmospheric Environment*, **43(1)**: 51-63. <https://www.sciencedirect.com/science/article/abs/pii/S1352231008008571>.

of perspectives and culturally sensitive adaptation strategies. In some cases, this will mean supplementing measures and indicators that are currently being used with additional measures/indicators that are responsive to intense, episodic events. For example, EPA has expanded air monitoring capabilities through its Wildfire Smoke Air Monitoring Response Technology (WSMART) pilot program to provide on the ground support to (in some cases, rural) communities who may not have existing stationary air quality ground monitors. Additional social, biological, and environmental indicators could be considered for collection during intense episodic events.

- Model downscaling of climate impacts: Downscaled climate model outputs can help to understand and anticipate place-based impacts, including on ecosystems, human health, water resources, agriculture, and other sectors, and provide valuable information for development of adaptation and mitigation strategies at local and regional levels, as exemplified in the context of the National Climate Assessment. To meet these needs, it is important for partner organizations, including other federal agencies, to value EPA's mission and incorporate EPA needs when planning and carrying out climate modeling simulations at policy-relevant spatial scales. EPA could have a seat at the table to help in coordinating this strategic development so that national environmental health and equity priorities are best supported across the federal government.
- Emerging technologies for direct GHG removal: As a complement to GHG emission reduction efforts, federal agencies are researching effective strategies and potential disbenefits for carbon dioxide removal (CDR) and negative emission technologies (NET). NOAA just [announced](#) \$24.3M of funding for 17 projects aimed at bringing together academic researchers, federal scientists, and industry to advance research in marine carbon dioxide removal and has an annual \$9M Congressional earmark for [solar engineering research](#). Several major NGOs and corporate interests are funding direct carbon capture and solar engineering projects. Some of these technological approaches could have potential impacts on population health through air pollution impacts from high energy demand, need for carbon dioxide sequestration, unintended stratospheric ozone depletion, aquatic effects, etc. that would fall under EPA's mandate. The Subcommittee suggests that ICSD track and weigh in on the multi-media and environmental justice impacts of these emerging efforts in order to assist and provide guidance to EPA regulatory programs, EPA regional offices, state regulatory programs, and communities that may have to deal with some of these projects.

Q.3. What suggestion(s) or recommendation(s) does the Subcommittee offer to support the three core initiatives of the new Division, namely: regional support, climate assessments, and evaluation?

- Enhancing capacity: EPA could institute a program of sharing expertise from other U.S. government research agencies with expertise in climate science. For example, a secondment program could be useful where EPA can 'borrow' expertise from scientists with specific expertise on a limited time basis for specific climate science studies. This could be an inducement for early- and mid-career employees from other agencies to work on interdisciplinary projects at the EPA.
- Assessment and evaluation: To increase the efficacy of its climate and environmental justice program, we suggest that the ORD develop strategies to understand how its projects are succeeding and falling short. What is working? What is not working? What can be improved? In order to understand these questions, the EPA could establish evaluative approaches for

assessing project successes and shortcomings. Evaluation strategies can consider a mix of quantitative and qualitative measures and draw insights from a broad array of project participants (e.g., non-profits, civil society, business, EPA staff) to elicit a wide range of relevant experiences. These evaluations will enable projects to better achieve their objectives and minimize potential negative or harmful outcomes.

- Enhanced RCAN process: To ensure the effectiveness and accessibility of RCAN, it is important to establish a well-defined, transparent, and efficient process for requesting technical assistance along with implementation. The Subcommittee suggests that ICSD:
 - Clearly delineate the scope and objectives of RCAN, ensuring it aligns with the EPA's mission and community needs around environmental justice.
 - Establish eligibility criteria and a standardized application for technical assistance to regional partners and the general public.
 - Develop a comprehensive communication strategy to raise awareness about RCAN.
 - Design workflows that track projects and allow for feedback during and after technical assistance is provided, both for partners and the general public.
 - Create a public-facing dashboard or other information repository detailing the projects, the impact of RCAN, and case studies of projects.
- Integrating mitigation, adaptation, and resilience: Of these strategies, ORD may have an especially important role to play on adaptation/resilience. Still, it's important to note that climate mitigation, adaptation, and resilience can often be approached as an integrated system, as noted in the recent IPCC WG2 Report (Chapter 18) on climate resilient development pathways. Thus, for example, when pursuing mitigation efforts, one may also engage with adaptation/resilience, and vice versa. One place to consider further integration might be the Organon [project](#) that is currently resilience-focused; could there be opportunities to build mitigation co-benefits into the design process (e.g., in steps 3 and 4 to identify options that have mitigation benefits). Similarly, while building the priorities for RCAN, discussions with partners and other stakeholders could focus on ideas of 'transformative adaptation' and how this might be achieved. As a new Division, ICSD can perhaps 'push the envelope' on new concepts like transformative adaptation to be more innovative than other approaches (e.g., to treat adaptation needs as an opportunity to also overcome societal challenges like inequity or economic distress, rather than merely focusing on vulnerability assessments and plan development).

Recommendations

EPA plays a critical role in protecting our Nation's environment and public health. Unlike other federal agencies that are charged with addressing the climate change challenge, at its core, EPA is a transdisciplinary institution that takes a holistic approach to addressing environmental problems across social, ecological, and technological systems. This ability to work across systems, media, and disciplines makes EPA uniquely suited to tackling the complex dilemmas associated with adapting to

and mitigating climate change. To further advance science and protect public health, the Subcommittee offers the following recommendations:

- **Recommendation 2.1: The Subcommittee recommends that ORD continue to emphasize climate change as a cross-cutting research priority across all of its research centers and programs.** As outlined above, there are many challenges associated with adapting to and mitigating climate change, including understanding the population health impacts of carbon dioxide removal, considering compound climate events in the context of cumulative impacts, evaluating how the Social Cost of Carbon can promote a *just transition*, and integrating climate mitigation and adaptation efforts, among others. **The Subcommittee recommends that ICSD undergo a process to prioritize three or four key transdisciplinary goals the Division will focus on achieving over the next 2-3 years, drawing on its unique strengths. ICSD should also develop concrete and transparent processes for achieving those goals, and for evaluating progress.**
- **Recommendation 2.2:** To ensure that the work of the ICSD addresses EPA’s focus on equity in providing climate solutions, the Division approaches its work through an environmental justice lens. In terms of how to best develop and implement equity-informed climate solutions, several methodological challenges remain. **The Subcommittee recommends that ORD develop guidance on how to integrate different types of data (e.g., quantitative and qualitative, lived experience and scientific, community-sourced and agency-sourced, etc.) for use in climate assessments.** In addition, **ORD should develop a process for extracting and translating lessons learned in place-based case studies to inform guidance that can be more broadly applied in climate-impacted communities.** Specific ideas to move forward for this recommendation are outlined in CQ3.

Charge Question 3

CHARGE QUESTIONS AND CONTEXT

To address critical environmental challenges such as climate change, environmental justice issues, and cumulative impacts, ORD is expanding the use of community-engaged research methods such as co-production, which require place-based investments in research. Due to logistical and resource constraints, it will not be possible to conduct these place-based studies in large numbers of locations. For long-term program sustainability, it is critical that research results from these place-based studies be structured to inform regional and national policies.

Q.1. What suggestion(s) or recommendation(s) does the Subcommittee offer on how to design and implement place-based research so that it can be scaled to generate generalizable insights that are (a) useful for informing state, regional, or national level decision-making; and (b) useful and accessible to our local research partners and other communities?

Q.2. What suggestion(s) or recommendation(s) does the Subcommittee offer on the role of place-based research in developing the science of climate adaptation and mitigation?

Q.3. What suggestions does the BOSC have for additional positional, recognition, or ethical factors particular to community-engaged research, and for best practices to building trust with local partners?

Narrative

The Board of Scientific Counselors (BOSC) Joint Subcommittee on Climate Change and Social and Community Sciences appreciates the opportunity to comment on the efforts of the U.S. Environmental Protection Agency's (EPA) Office of Research Division (ORD) to ground its research in multiple fields and sources of knowledge, including that of local communities. Place-based research can play a large role in developing the science of climate adaptation and mitigation; however, the place-based effort must be rooted in ethics and cultural humility and equity-centered community design to avoid tokenism, misinterpretation of the data, or introducing or compounding harm. ORD has already taken important steps to develop meaningful partnerships with communities and now seeks ways to scale these scientific inquiries, apply it to climate change, and ensure that community-engaged research is done ethically.

As is common in place-based studies, each community and the conditions in its environment will differ from those investigated in the past and those that will be studied in the future. Although lessons, best practices, and approaches can be replicated across communities, each study will require a design that responds to place-specific social, governance, political, cultural, economic, and ecological conditions. As such, we have put together a toolbox (see Appendix 1) with more details on our suggestions. The toolbox offers a suite of best practices and defines some key concepts that social and natural science researchers can use to facilitate a place-based study in partnership with local stakeholders. Before working with any place-based community, researchers and community will benefit from agreeing on which tools might be most appropriate for their partnership. The suggestions in each subquestion summarize these tools.

We recognize that some of the suggestions for Charge Question 3 overlap with those for Questions 1 and 2 (particularly Question 2 in terms of collaboration and connections). This reflects the complementary nature of advice from a broad range of professions. We also recognize that ORD has

limits in what it can implement—for example, it may not be able to change the structure of grant-making at EPA or force collaborations across agencies. Further, ORD would not have near the amount of resources needed to implement all the advice we have provided. Resources allocated to ORD are small compared to those of larger divisions and agencies. Thus, we encourage other entities to recognize the value of ORD’s work and support it through collaboration.

Strengths

The Subcommittee outlines the following strengths of ORD’s efforts:

- Range of methods:
 - Willingness to consider various ways to “co-produce knowledge” (or partner) with communities, beyond just working through universities
 - Variety of approaches that integrate various methodologies to help local communities meet their goals
 - Integrating different types of data and evidence to include more qualitative and experiential data (lived experiences, storytelling, thick description, comparative cases)
- Ethics: Recognition of ethical considerations in data sharing (e.g., following Tribal protocols regarding research)
- Partner-driven research:
 - Centering “co-production” (research in partnership with communities) in a wide range of social science research
 - Collaboration with EPA’s Environmental Justice Division
 - Openness to answering research questions brought to ORD by Tribes, non-profits, and communities, meeting them where they are at
 - Openness to unclear timelines and working on community timelines, using an adaptive approach and avoiding a pre-determined and linear process
 - Ensuring community “buy-in” and support for research
 - Using the languages that communities use around aspects of climate change
 - Understanding the importance of face-to-face meetings
 - Willingness to focus not only on flooding solutions for communities like Crisfield, Chesapeake Bay, but also other important and overlapping community goals (e.g., cultural preservation)
 - Working with the community to identify issues and then staying with the community to resolve those issues
 - Repositioning the EPA as a facilitator and supporter of knowledge creation in collaboration with community
- Compiling case studies: EPA is working to compile lessons learned from climate adaptation in [Searchable Case Studies for Climate Change Adaptation](#) and [Transferability and Utility of Practical Strategies for Community Decision Making: Results from a Coordinated Case Study Assessment](#)

Suggestions

The Subcommittee offers suggestions for each of the three parts of Charge Question 3.

Q.1. What suggestion(s) or recommendation(s) does the Subcommittee offer on how to design and implement place-based research so that it can be scaled to generate generalizable insights that are (a) useful for informing state, regional, or national level decision-making; and (b) useful and accessible to our local research partners and other communities?

In place-based research, the social, governance, political, cultural, economic, and ecological context will vary, requiring background research, local knowledge, and resident collaboration to design the appropriate study in that context. Controlling for the unique conditions in a context can lead the study's conclusions to exacerbate negative impacts or overlook potential solutions to environmental and climate challenges.

We advise that ORD consider when it is appropriate for insights from place-based research to be scaled to inform generalizable insights, and where effective place-based processes can be replicated (but not necessarily scaled). Where data cannot be scaled, it may still be possible to replicate frameworks and methods. In some cases, different knowledge systems (e.g., Indigenous knowledge) should not be merged together, but rather should stand on equal pillars to inform science. The appendix can help teams select the appropriate tools. However, specific concepts and issues that should be considered in place-based studies under the ORD's charge include:

- Cultural competency: Understand the particular circumstances that have contributed to the current challenges a place-based community may face.
- Cross-disciplinary competence: Understand that different disciplines and researchers have different philosophies, skill sets, theories, and contributions to make. In addition to needing a critical mass of social scientists (as suggested in Charge Question 1), non-social scientists should have an understanding of the distinct scientific approaches, language and methods used by the social scientists in place-based research.
- Data standardization: In some instances, ORD may be able to create templates or standardized approaches to facilitate interoperability among datasets. ORD can also help communities learn the collection techniques that research agencies use to standardize data.
- Identifying non-transferability: Since standardized approaches from place-based investigations or particular projects are not always possible, identify what makes each place unique and limits transferability of data.
- Replicating methods: Where place-based data cannot be scaled, it may still be possible to replicate place-based strategies, designs, methods, and approaches.
- Cross-cutting themes: Despite the difficulties of scaling data, ORD may be able to identify cross-cutting themes that merit further research (e.g., gentrification related to climate adaptation).
- Different knowledges: In addition to quantitative and categorical qualitative data, non-categorical qualitative and experiential data are essential to inform policy and be accessible to

non-governmental audiences. Facilitate “bridging” or “braiding” different knowledges into research, with the help of knowledge mediators.

- Knowledge mediation: Identify knowledge mediators that can broker information between community members and outside researchers.
- Indigenous populations: Indigenous communities, which may be federally recognized Tribes (sovereign nations) or other populations, may present specific considerations for research, such as direct ties to the environment, higher exposure levels, poor health indicator statistics, and different worldviews.
- Implications of different methods: Consider combining different methods and forms of knowledge creation (e.g., inductive, deductive, individual, deliberative, participatory) to provide pluralistic insights.
- Database: Consider creating an accessible, searchable repository of findings from community-engaged research.

Q.2. What suggestion(s) or recommendation(s) does the Subcommittee offer on the role of place-based research in developing the science of climate adaptation and mitigation?

In this subsection, we offer a range of resources for climate data. Tools for adaptation and mitigation should be co-created with communities, with a holistic view of their needs in mind, and assurance the communities will be able to access and benefit from the tools. Specific approaches to help align place-based research with the scientific needs for place-specific climate adaptation and mitigation include:

- Understanding the socioeconomic context and history: As noted in 3-1 in regard to cultural competency, understand the historical, social, and economic contexts that may limit a community’s adaptive capacity (e.g., systemic disinvestments in infrastructure).
- Place-based influence and identity-based limitations: It is also important to understand the contexts that can increase vulnerability and limit individual adaptive capacity (e.g., sexuality, disability status, and class).
- Community needs and access to information: Apply an environmental justice lens to determine which adaptation strategies are effective, acceptable, and accessible in a particular community, given the context.
- Holistic approach to climate resilience: When seen through an EJ lens, climate change adaptation and mitigation should consider a larger range of threats and factors beyond climate change such as housing, health, education, and the criminal justice system.
- Co-creation of community tools: Understand what tools may be useful for community health/adaptation, and work with communities to co-design models and tools that can outlast a particular research project.
- Sensors and community knowledge: Regulatory monitoring is incomplete to address adaptation and mitigation needs at the neighborhood and community scale. Consider how community members can work with low-cost sensors to measure localized weather and air quality. Also

consider how community knowledge (in terms of quantitative monitoring as well as qualitative and experiential data) can be used to fill in gaps in understanding complex climate adaptation and mitigation needs.

- Interdisciplinary and interagency data collaboration: Look to environmental datasets on air quality and land use used by other agencies (see the Appendix for key examples).
- Co-benefits and tradeoffs: Consider strategies that have co-benefits, which may involve both mitigation and adaptation goals, and consider the trade-offs in these strategies. Each intervention should be place-specific and ensure that basic services are provided and human rights are assured.

Q.3. What suggestions does the BOSC have for additional positional, recognition, or ethical factors particular to community-engaged research, and for best practices to building trust with local partners?

Below we outline strategies to ensure that the research is ethically carried out with communities at the level of partnership they are comfortable with. Social scientists on the Subcommittee draw from their own experience and cite several publications that may be useful in approaching community partnerships. We offer suggestions for building relationships with communities, emphasizing that researchers must invest their time to build relationships. A financial investment is also important: community partners should be paid for their expertise. Meaningful community consent, involvement, and power sharing from the start and throughout is important. It also must be clear how data derived from the research will be used, and proper credit and ownership rights must be ensured. Finally, research results should be shared in ways that are accessible to community members. Specific approaches and issues that should be included while planning for and implementing community-engaged research include:

- General principles: Various sources provide general guidance for working with communities in ways that are consistent with environmental justice (see the Appendix for key examples).
- Relationship and trust-building: Take the time to build relationships with communities and understand the power disparities and challenges that will affect place-based research. It may take one grant cycle just to build the necessary trust and relationships.
- Focus on social learning: Understand the existing relationships in a community and what is needed for different groups of stakeholders to participate, learn, and pass on their learning.
- Training: The appendix lists key training programs for working with communities in a participatory manner.
- Defining the community: Determine who is the “community” and who are the stakeholders in each study, and recognize that there may be conflict between different parts of the community (including between community leaders and key stakeholders).
- Modality of interaction: Determine how stakeholders prefer to interact (e.g., face to face or on social media platforms).
- Building partnerships: Build advisory boards consisting of place-based organizations with knowledge of local issues.
- Diversifying who participates: Avoid research fatigue among frequently researched communities by reaching out to other communities.

- Networks as partners: Consider partnering with networks of environmental justice groups, universities, and/or researchers that can bring their members together for peer-to-peer learning (see Appendix for examples).
- Interagency place-based research collaboration: Encourage other agencies and parts of EPA working on place-based research to collaborate with EPA ORD, particularly EPA's Environmental Justice Thriving Communities Technical Assistance Centers, which can help communities with grant applications (see Appendix for examples).
- Consent: Recognize the importance of free, prior, and informed consent when bringing research projects to communities, such as with carbon capture research and placement of experimental projects. Honor Tribal Institutional Review Boards (IRBs) (for Tribes that have IRBs, or other processes that Tribes may have for research approval) and policies for research and consultation.
- Design: Community members should be included from the beginning and throughout the process. Work with them to design projects. Understand how they want to participate (if at all) and help them take on the roles they desire. This can help contribute to structural changes that community members may want to see in their environments.
- Manage expectations: Be transparent with communities from the beginning about what ORD's research can or will do and how it can be used. Use Memorandums of Understanding (MOUs) when working with communities to clarify data ownership, research use, and community contributions.
- Terminology: Use terms that are meaningful to the particular community you are working with and avoid terms that are obtuse or offensive (e.g. use "partnership" instead of "co-production").
- Benefits for community participation: Find ways to meaningfully and directly compensate each community member that participates in research.
- Dissemination of research results: To ensure that research results are returned to those who participated in the study, consider using a multidimensional dissemination approach that is co-developed by the communities who are receiving the information. This means using a range of different media that is translated into the appropriate local languages as well as into lay terms.
- Rights to data and sharing: At the beginning of the project, agree with the community on authorship, who will own data, and how it will be shared.
- Sustainability: Consider how to provide for the sustainability of a solution once it is implemented, both in terms of the intervention and the partnerships formed.

Recommendations

We end with two overarching recommendations. First, include the community in the entire research process, from conceptualizing the research to having an ownership stake in the results. This recommendation summarizes the suggestions for community involvement. Second, leverage existing place-based research by cooperating on research approaches and sharing databases with other divisions of EPA, other federal agencies, states, localities, tribes, and those outside of government. Specifically:

- **Recommendation 3.1: Community-Led and Community-Driven Research**: EPA ORD can take steps to include the community in the entire research process, from conceptualizing the research

to having an ownership stake in the results and next steps. EPA ORD can work with its researchers and encourage other research institutions to leverage their power and privilege to help communities create the changes they want to see in their environmental health. Specifically, in its own research, EPA ORD can adopt a community-based participatory research approach that

- Uses a holistic approach that acknowledges community limitations and vulnerabilities as well as power and policy structures, and avoids unrealistic strategies to address environmental risks;
 - Identifies feasible structural change goals;
 - Uses a community-driven approach to ensure that community benefits result from the project;
 - Relies on community-based knowledge mediators to ensure community involvement and information translation;
 - Acknowledges multiple ways of knowing and sources of knowledge;
 - Translates findings into multiple formats and through multiple channels; and
 - Ensures co-production credit and rights for the community in authorship and other forms of intellectual property.
- **Recommendation 3.2: Collaboration across and within Agencies:** EPA ORD can leverage existing place-based research by encouraging cooperation on research approaches and sharing databases with:
 - other divisions of EPA (particularly those involved in environmental justice, including Environmental Justice Thriving Communities Technical Assistance Centers and Children’s Health Protection Advisory Committee);
 - other federal agencies (e.g., Department of Health and Human Services);
 - states, localities, and tribes; and
 - those outside of government—particularly community-based organizations and nonprofit networks. Examples include [I See Change](#) (residents upload qualitative observations and photos regarding environmental data in their neighborhood), [Local Environmental Observer](#) (Alaska subsistence harvesters report observations and share photos), [Rising Voices](#) (network of Indigenous knowledge holders and university/agency researchers), [Thriving Earth Exchange](#) (partnerships of volunteer academic scientists and communities seeking to address an environmental issue), and [USCAN Environmental Justice Network](#)).

Beyond cooperating on methods and sharing data, ORD should utilize partnerships to refer communities in need of assistance to partners in a position to help (e.g., referring a community-based organization to a TCTAC).

Appendix 1: Toolkit with Details on Suggestions for Question 3

This appendix serves as a toolkit that expands on the suggestions for Question 3 and provides references.

Q.1. What suggestion(s) or recommendation(s) does the Subcommittee offer on how to design and implement place-based research so that it can be scaled to generate generalizable insights that are (a) useful for informing state, regional, or national level decision-making; and (b) useful and accessible to our local research partners and other communities?

- **Cultural competency:** Understanding the culture, history, and politics of a community is important for successful place-based research. Each place-based research initiative should be grounded in historical context, not just focused on present and future scenarios. It takes time to understand the history of a place and use that historical and social context to translate meanings and findings to other scales. For example, it would be important to understand place-based cultural trauma that a given community or region may have experienced. We encourage ORD researchers to build time to review relevant historical and social context into their research plans. This step in the research process can be done in ways that do not burden communities with the responsibility of educating ORD researchers. For example, ORD researchers can consult local newspapers or digital media, sign up for the newsletters of community organizations, attend community events, or other passive means of understanding the past, present, and future issues facing communities of interest.
- **Cross-disciplinary competence:** Different disciplines and researchers have different philosophies, skill sets, theories, and contributions to make. In addition to needing a critical mass of social scientists (as suggested in Charge Question 1), it is also important that their non-social science colleagues have an understanding of the distinct scientific paradigms/approaches, frameworks, language, and methods used by the social scientists, particularly in place-based research. It will likely take a commitment to long-term relationship building and an exploration of complexity sciences before interdisciplinary teams can work at maximum effectiveness--- thus, selecting scientists with prior multidisciplinary team experience can be a staffing priority. Also, training existing research staff about social science methods and practices will enhance chances for success.
- **Data standardization:** The lack of data standardization for place-based community research means that data collected for different projects usually cannot be merged and used more broadly. For communities that want to contribute their data to larger scientific endeavors, it can seem unethical to work on a project for many years and then not have a federal agency use these data. ORD can take a leadership role in creating templates or standardized approaches in data collection and reporting to ensure interoperability among datasets. This should not add pressure on the community to follow only one protocol, but should ensure the data collected can be used. See Ramírez-Andreotta et al. (2021) for an example of a method to integrate community science data with existing governmental environmental monitoring and social

attribute data (vulnerability and resilience variables).⁷ This issue receives further consideration in [subquestion 3 regarding CARE principles \(defined therein\)](#). ORD can also help communities learn the common practices of other agencies such that community data and local knowledge may be used as an addition (those data that can be standardized and extrapolated) or as a complement to data collected from other sources by those agencies and ORD.

- **Ontologies:** A key challenge in integrating different datasets is the lack of widely adopted ontologies for vulnerability and resiliency factors. Ramírez-Andreotta et al. (2021) addresses this through an application ontology known as the Superfund Research Project Data Interface Ontology (SRPDIO).
- **Identifying non-transferability:** At the same time, researchers should consider that standardized approaches from place-based investigations or particular projects are not always possible. Each place has characteristics and conditions that result from a confluence of complex, interdependent phenomena. It is important to contextualize what makes each place unique and limits its transferability. For example, most air quality data do not get adjusted for temperature and humidity, so it is difficult to aggregate. Further, what is most useful to a particular community may be very specific, and this may be less useful to other communities. One approach is to address which characteristics and conditions are community-specific and consider how they might or might not apply in other contexts. Also, consider including in reports a section with findings specific to the community and a section that other communities can use.
- **Replicating methods:** Where place-based data cannot be scaled, it may still be possible to replicate place-based strategies, designs, methods, and approaches.
- **Cross-cutting themes:** Despite the difficulties of scaling data, ORD may be able to identify cross-cutting themes that merit further research. For example, one theme arising in connection with climate adaptation is gentrification, as less physically vulnerable sites become more valuable.
- **Implications of different methods:** It is important to understand that different methods provide different insights and how they can be integrated in the evaluation of complex social-ecological systems. We encourage ORD researchers to explore and implement pluralistic forms of knowledge creation (inductive, deductive, individual, deliberative, participatory) and consider mixed methods approaches.⁸
- **Different knowledges:** In addition to quantitative and categorical qualitative data, non-categorical qualitative and experiential (or experience-based⁹) data are essential to inform policy and be accessible to non-governmental audiences. Non-institutional forms of knowledge,

⁷ Ramírez-Andreotta MD, Walls R, Youens-Clark K, Blumberg K, Isaacs KE, Kaufmann D, Maier RM. 2021. "Alleviating Environmental Health Disparities through Community Science and Data Integration." *Frontiers in Sustainable Food Systems*. 5, 182. 2021. <https://www.frontiersin.org/article/10.3389/fsufs.2021.620470>, <https://pubmed.ncbi.nlm.nih.gov/35664667/>

⁸ See West, S., Schill, C. Negotiating the ethical-political dimensions of research methods: a key competency in mixed methods, inter- and transdisciplinary, and co-production research. *Humanit Soc Sci Commun* 9, 294 (2022). <https://doi.org/10.1057/s41599-022-01297-z>

⁹ Ervik, Hilde, and Alex Strømme. 2023. "Bridging the Gap Between Experience-Based Knowledge and the Scientific Knowledge." *International Educational Research* 6 (2): p1–p1. <https://doi.org/10.30560/ier.v6n2p1>.

including Indigenous, traditional, and local knowledge¹⁰ from systematic investigation, storytelling, ethnography, and other methods, may be specific to a particular time, place, and political, social, economic, cultural, and geographic context.¹¹ Rather than assuming that this information is difficult to integrate with quantitative or "Western" data, ORD should facilitate "bridging" or "braiding" this knowledge into policymaking processes, with the permission and consent of the knowledge holders, so that it is held in equal regard and importance to quantitative and experiment-derived data. Those trained in social observation, intercultural communication, or mediation can be helpful in bridging the knowledge gap between institutional and non-institutional sources of knowledge.

- **Knowledge mediation:** Finding a way to translate knowledge from communities to external researchers is important in Indigenous and historically underserved communities that may be reluctant to share. It can be important to have a knowledge mediator or "cultural knowledge broker" (sometimes known as a promotor(a)) from the community. This person serves as the broker, interpreter, and/or translator of information between individuals in the partnering population and the persons and organizations outside of the community.¹² Because they are from the community, they can effectively reach, teach and/or share information with their peers. May et al. (2003)¹³ identified five general domains of practice of promotoras: information and referral, education, emotional support, community and capacity building, and advocacy. Knowledge mediators can bridge communities in two ways: horizontally, by facilitating social networks within the community, and vertically, by connecting residents with researchers or critical services from outside the community (May et al., 2003). These "bridging acts" are critical for community-driven science because they connect ethnically diverse community groups with environmental health information to then make informed choices.
- **Indigenous populations:** Indigenous communities, which may be federally recognized Tribes (sovereign nations) or other populations, may present specific considerations for research, such

¹⁰ Additional data types include narratives, storytelling, autoethnographies, discourse, artifacts, and other dialectical sources of data. For examples, see Adade Williams, Portia, Likho Sikutshwa, and Sheona Shackleton. 2020. "Acknowledging Indigenous and Local Knowledge to Facilitate Collaboration in Landscape Approaches—Lessons from a Systematic Review." *Land* 9 (9): 331. <https://doi.org/10.3390/land9090331>. Also see Cottrell, Clifton. 2022. "Avoiding a New Era in Biopiracy: Including Indigenous and Local Knowledge in Nature-Based Solutions to Climate Change." *Environmental Science & Policy* 135 (September): 162–68. <https://doi.org/10.1016/j.envsci.2022.05.003>.

¹¹ Gandarillas, Miguel Ángel, this link will open in a new tab Link to external site, and Michael K. McCall. 2023. "Ecocultural Networks as Grounds for Spatial Planning. A Psychosocial Approach Applied to Coastal Development." *Journal of Cultural Heritage Management and Sustainable Development* 13 (1): 108–22. <https://doi.org/10.1108/JCHMSD-01-2021-0008>.

¹² Ramírez-Andreotta MD, Buxner S, Sandhaus S. "Co-created environmental health science: Identifying community question and co-generating knowledge to support science learning." 2023. *Journal of Research Science in Teaching*. <https://doi.org/10.1002/tea.21882>.

¹³ May ML, Bowman GJ, Ramos KS, Rincones L, Rebollar MG, Rosa ML, Saldana J, Sanchez AP, Serna T, Viega N, Villegas GS, Zamorano MG, Ramos IN, et al. "Embracing the local: enriching scientific research, education, and outreach on the Texas–Mexico border through a participatory action research partnership." *Environmental Health Perspectives* 2003;111(13): 1571–6.

as direct ties to the environment, higher exposure levels, poor health indicator statistics, and different worldviews.

- Database: Consider creating a repository of findings from community-engaged research—this could be a devoted webpage/searchable database or as far as developing an open-access, practice-based journal. It could be structured with metadata that allows for easier access to critical information about the study designs and parameters.

Q.2. What suggestion(s) or recommendation(s) does the Subcommittee offer on the role of place-based research in developing the science of climate adaptation and mitigation?

- Understanding the socioeconomic context and history: Researchers should invest time in understanding the historical, social, and economic contexts that have led to disproportionate environmental burdens or limited adaptive capacity. For example, systemic disinvestments in infrastructure have led to many communities with substandard water infrastructure that is more prone to flooding. These communities may have a low tax base, making it harder to raise funds to build and maintain more resilient infrastructure. Understanding these limitations in adaptive capacity can help avoid adaptation strategies that are unrealistic. Researchers should consider ways to understand this historical context without burdening communities with the responsibility to educate researchers. Local newspapers, community newsletters, websites, and other print and digital media can provide a useful introduction to the historical and social setting of a place. We acknowledge that collaborative on-the-ground, place-based engagement can also reveal important insights into key contextual factors. The key is to balance doing upfront homework about a place that does not burden community members with strategic place-based engagements that reveal novel insights into complex social and environmental challenges. Regardless of methods, historical context provides essential detail to any community science initiative and demonstrates a commitment on behalf of researchers to invest in learning about a place before they begin a research effort.
- Place-based influence and identity-based limitations: Consider how the intersectional identities of individuals influence their level of vulnerability to climate change such as physiological and developmental differences, race, ethnicity, sexuality, gender, disability status, language, and class, among others.¹⁴ Studies show that people with intersecting marginalized identities have access to fewer resources to adapt to climate threats and risks.¹⁵ There is a role for improving access to climate mitigation and adaptation knowledge and resources through action research to help such communities address place-based threats. Collective adaptation provides a framework to consider for devising participatory place-based research for adaptation and mitigation.¹⁶

¹⁴ Barnett, Jon, Sonia Graham, Tara Quinn, W. Neil Adger, and Catherine Butler. 2021. "Three Ways Social Identity Shapes Climate Change Adaptation." *Environmental Research Letters: ERL [Web Site]* 16 (12): 124029. <https://doi.org/10.1088/1748-9326/ac36f7>.

¹⁵ Marks, Danny, Mucahid Mustafa Bayrak, Jahangir Selim, David Henig, Ajay Bailey, and this link will open in a new tab Link to external site. 2022. "Towards a Cultural Lens for Adaptation Pathways to Climate Change." *Regional Environmental Change* 22 (1). <https://doi.org/10.1007/s10113-022-01884-5>.

¹⁶ Wannewitz, Mia, and Matthias Garschagen. 2023. "Collective Adaptation to Climate Change." *Current Opinion in Environmental Sustainability* 61 (April): 101248. <https://doi.org/10.1016/j.cosust.2022.101248>.

- Community needs and access to information: It is important to examine impacts of climate change through the lens of environmental justice. This can involve determining what adaptation strategies can be effective and acceptable in the communities that need them the most. For instance, [Urban Integrated Field Laboratories](#) assists with impact assessment and adaptation in four regions that include several metropolitan areas (Chicago, Baltimore, Phoenix, Tucson, Flagstaff, Beaumont/Port Arthur). It is also important to make sure communities can access tools and information. For examples of work done to enhance open-source software for modeling, analysis, and visualization, see the work of [Southwest Urban Corridor Integrated Field Laboratory](#) and the [Jefferson Project at Lake George](#). The latter is a public-private partnership for a water quality observing program with predictive models. The latter two examples are methods for working with private and nonprofit groups, recognizing that although government agencies are drivers of funding, this funding can only go so far.
- Holistic approach to climate resilience: When seen through an EJ lens, climate change adaptation and mitigation should consider a larger range of threats and factors beyond climate change such as housing, health, education, and the criminal justice system. Beyond just focusing on how to physically adapt to climate change, research should consider connections between environmental and social/economic issues and how to direct participants to the help they may need.
- Co-creation of community tools: Ideally a community can work together with researchers to create a tool that contributes to environmental health/adaptation, and the tool can be continually improved in response to how community members use the tool. One method for building relationships to work on climate change projects is to have relevant parties talk about past events for which they were unprepared or used erroneous forecasts that led to poor decisions. This can be a segue for introducing predictive models, and using them with past data to show what the models would have predicted. Such models can be tailored and tuned to local needs for future predictions. There is also a role for visualizations tailored toward the specific needs of a community, co-designed with their input to enable the use of relevant environmental data with confidence.
- Sensors: Both regulatory and community sensors (in addition to other sources of community information) can be helpful in monitoring environmental exposures related to climate change. There is potential for collaborative deployment of both low-cost sensors as well as research-grade instrumentation for measuring weather and air quality. Data from the latter could be used to help calibrate a larger number of cheaper sensors to provide more localized assessments. The same notion could also apply to measurements of water quality and soil conditions. While sensor data will not provide all the information needed for adaptation and mitigation, it can help establish a baseline for evaluating on-going adaptation strategies through continuous monitoring. The data can also be used to develop and verify predictive models. Some of those models could include representations of adaptation strategies. For short-term models, the observations could be assimilated to reduce errors in the initial conditions. More generally, they could be used to bias-correct numerical models or be used to train machine-learned models. It is essential to establish tools to help community and local monitors calibrate data to ensure accurate results and comparisons across jurisdictions. Some measuring instruments may have limited accuracy and precision, hence, multiple sources are important. There may also be

challenges related to lack of landowner permission to put a sensor on a site, and the question of who owns the data from the sensors.

- **Importance of community knowledge:** Regulatory monitoring is incomplete to address adaptation and mitigation needs at the neighborhood and community scale. Community knowledge—through community monitoring, qualitative, and experiential data—is essential to filling gaps in understanding complex climate adaptation and mitigation needs. Researchers should recognize the importance of community science given the historical information that communities may have that would inform a particular approach to adaptation and mitigation. As discussed in more detail in 1.6, communities have particular knowledges about their environment that have often been ignored and deserve consideration. Some of this knowledge may be held by local institutions such as churches. Likewise, some neighborhoods may be aware of pollution sources that are not apparent by regulatory monitoring. Not all pollution sources can be detected using current monitoring equipment, and community residents can supplement instrumentation data with experiential data, which can be triangulated using qualitative research best practices.¹⁷ Consider the approaches of [Breathe Providence](#) and the broader [Breathe Cities](#) initiatives. Piggyback on existing networks that “crowd-source” information from place-based communities related to climate change observations, including [I See Change](#) (a for-profit company that facilitates residents uploading qualitative observations and photos regarding environmental data in their neighborhood) and [Local Environmental Observer](#) (Alaska subsistence harvesters report observations and share photos). Community-based monitoring and qualitative and experiential data are essential to understanding the complexity of pollution sources and impact and the committee recommends facilitating the collection, analysis, and dissemination of community knowledge.
- **Interdisciplinary and interagency data collaboration:** Other agencies beyond EPA maintain valuable datasets, for example, NASA’s datasets on air quality and land use. There may also be a role for commercial providers that can fill in the gaps from open sources. NASA has been purchasing such data, which it then makes available to federally funded researchers. They include land use/land cover, atmospheric dynamics and chemistry, water resources, and more. High-level access is available at [Earth Information Systems](#), and all data are available at <https://www.earthdata.nasa.gov/>. Consider using the following NASA datasets: [ARSET - Satellite Data for Air Quality Environmental Justice and Equity Applications](#), [TEMPO air quality data](#), [ARSET - Satellite Data for Air Quality Environmental Justice and Equity Applications](#), as well as commercial data such as [GHGSat](#). [NASA’s Atmosphere Observing System](#) is developing new instrumentation to create datasets for improving monitoring and prediction of weather, air quality, and climate change. There are also open datasets available from the EU (e.g., [Copernicus Atmospheric Monitoring System](#)). In the private sector, there is Microsoft’s [Project Eclipse](#) that provides hyperlocal environmental sensing and Google’s [Environmental Insights Explorer](#) that provide high-resolution [urban tree canopy data](#), among other data.
- **Co-benefits and tradeoffs:** Consider strategies that have co-benefits, which may involve both mitigation and adaptation goals. Examples include nature-based solutions such as planting shade trees in yards (which can lower air-conditioning bills), and vegetation that sequesters carbon and mitigates flooding. Vegetation may also have the benefit of beautifying a community. However, street trees also require maintenance and can have high rates of

¹⁷ Marshall, Catherine, and Gretchen B. Rossman. 2011. *Designing Qualitative Research*. 5th ed. Los Angeles: Sage.

mortality or disease that place burdens on communities. It is important to recognize that climate adaptation or mitigation strategies may have tradeoffs or unintended consequences. For instance, vegetative strategies to moderate the urban heat island effect can potentially affect allergies or take down power lines during storms. Each intervention should be place-specific and ensure that basic services are provided and human rights are assured.

Q.3. What suggestions does the BOSC have for additional positional, recognition, or ethical factors particular to community-engaged research, and for best practices to building trust with local partners?

The following suggestions represent best practices for working with communities that ORD may want to strive to implement within ORD and promote among collaborators.

- **General principles:** Various sources provide general guidance for working with communities in ways that are consistent with environmental justice. Examples include [17 Principles for Environmental Justice](#), [Interagency Working Group on Environmental Justice](#), [Principles of Anti-Oppressive Community Engagement for University Educators and Researchers](#), and [A Participatory Action Research Field Guide from the Healthy Neighborhoods Study](#). An additional resource is the EPA's Children's Health Protection Advisory Committee's [August 2023 letter](#) to Administrator Regan, which provides recommendations for EPA action on climate impacts on children's environmental health. In particular, Question 4 within the letter provides recommendations for addressing EJ issues through a child- and community-centric approach. Further, EPA as a whole is developing a [Meaningful Involvement Policy](#) that may be informative.
- **Relationship and trust-building:**
 - Meet research participants where they are instead of having preconceived expectations. Build bidirectional pathways whereby communities can approach researchers and vice versa.
 - Time for relationship-building and understanding community-identified problems should be built into the study design. The design also needs to recognize ways to support participants and make the best use of their limited time and attend to any technology limitations.¹⁸ For communities that have large power disparities with governing entities or have endured abusive research in the past, it will take much longer to build relationships. Researchers must move at the speed of trust, bring resources to the table, and understand and acknowledge historical social context.
 - The time needed to build relationships and complete projects may be longer than a single funding cycle or administration. We recognize that ORD EPA may have no control over grant-making but may be able to socialize or encourage a culture of grant-making that better corresponds to the needs and limitations of communities. For example, agencies providing grant funding could offer tiered funding opportunities, with initial planning grants to get community buy-in/input. For example, the National Fish and Wildlife Foundation [National Coastal Resilience Fund](#) provides grants for planning, followed by grants for design and then implementation. Similarly, the National Science Foundation [Civic Innovation Challenge](#) provides grants to undertake planning and team development activities, followed

¹⁸ Davis LF, [Ramírez-Andreotta MD](#), Buxner S. 2020. Engaging Diverse Citizen Scientists for Environmental Health: Recommendations from Participants and Promotoras. *Citizen Science: Theory and Practice*, 5(1): 7, pp. 1–27. DOI: <https://doi.org/10.5334/cstp.253>.

by a second grant to execute and evaluate their research-centered pilot projects. That said, some communities may already know what they need and may be ready for implementation, in which case imposing a preliminary planning grant phase could be burdensome.

- In some situations, trust in government has been lost due to unfulfilled promises and even corruption and fear of retaliation. It is important for agencies and researchers to acknowledge past wrongs and take the time to heal with the community.
- **Focus on social learning:** Community engagement can mean different things to different stakeholders. Some see engagement as contributory, where community provides input at some point during the research cycle. Others consider engagement to occur only when a certain degree of power and control is ceded to non-institutional partners and community members.¹⁹ However, climate change adaptation and mitigation depend on social learning.²⁰ ORD's research and planning activities require careful consideration of who is engaged, their interrelationships, and ways to support ongoing experimentation and novel approaches in the research and planning processes.
- **Training:** There are a number of training programs specific to working with communities in a participatory manner. Examples include [Online Course on CBPR: A Partnership Approach for Public Health](#), [CitiProgram's Community-Engaged and Community-Based Participatory Research Training](#), [CitiProgram's Research with Native American Communities: Important Considerations When Applying Federal Regulations](#), [University of Pittsburgh's Community PARTners Core](#), and [CBPR Institute](#). Associations such as the [Action Research Network of the Americas](#) and [Association for Advancing Participatory Sciences](#) also provide training resources in community-based participatory research as well as participatory action research and action research for members.
- **Defining the community:** Caution is needed to define the particular "community" or "communities" in each study. "One size" does not fit all when interacting with communities. Definitions differ by place. Some may be geographically broader than others while some may be more diverse than others. Elected officials and local governments may not always represent a community. In some Indigenous communities all communication must flow through the elders; Spending time in communities to understand power dynamics and to hear different voices is important. It is also important to acknowledge that a researcher may never be able to get a fully representative view of the community; limitations and biases must be acknowledged, and it may take time to get relevant stakeholders involved in discussions. In each study, ORD should take the time needed to determine who constitutes the diverse stakeholders that may comprise the community, including individuals as well as local businesses and other entities. Further, ORD should understand the norms of the community. **Modality of interaction:** Recognize that some traditional communities or people (particularly those with limited internet or cell phone access or limited time to read) may prefer meetings where information is exchanged face-to-face.

¹⁹ For more information on the impact of communities having an ownership stake in information, see Binet, A, Y Nidam, R Houston-Read, CG Lopez, GZ Del Rio, D Abreu, C Baty, et al. 2022. "Ownership of Change: Participatory Development of a Novel Latent Construct for Neighborhoods and Health Equity Research." *Social Science & Medicine* 309 (September). <https://doi.org/10.1016/j.socscimed.2022.115234>

²⁰ Collins, Kevin, and Ray Ison. 2009. "Jumping off Arnstein's Ladder: Social Learning as a New Policy Paradigm for Climate Change Adaptation." *Environmental Policy and Governance* 19 (6): 358–73. <https://doi.org/10.1002/eet.523>.

Others may prefer to participate on an online platform rather than taking the time to attend a meeting.

- Building partnerships: Building advisory boards consisting of place-based organizations can help align research efforts with existing community-identified needs and assets/strengths. Community knowledge of local assets and benefits can be useful in cost-benefit and other analyses.
- Diversifying who participates: There can be a sense that the same communities are researched over and over again (e.g., the climate change-induced relocation of Newtok, AK, or Isle de Jean Charles, LA) while other communities with similar issues are ignored (e.g., those in Interior Alaska struggling with riverine erosion). It is important to avoid research fatigue among frequently researched communities and reach out to other communities. Also, adequate compensation and alignment with community needs may help reduce communities' sense of being over-studied.
- Networks as partners: Consider partnering with networks of environmental justice groups, universities, and/or researchers that can bring their members together for peer-to-peer learning (e.g., [Rising Voices](#)--network of Indigenous knowledge holders and university/agency researchers; [Thriving Earth Exchange](#)—partnerships of volunteer academic scientists and communities seeking to address an environmental issue; and [USCAN Environmental Justice Network](#)).
- Interagency place-based research collaboration: Encourage other agencies working on place-based research to collaborate with EPA ORD. For example, the Department of Health and Human Services has programs aimed at advancing participant engagement through lived experiences and narratives and guidance for working effectively with tribal communities to integrate narratives into policy evaluation. See [Advancing Contextual Analysis and Methods of Participant Engagement](#) and [Changing the Narrative on Research, Evaluation, and Data with Native Communities](#).
- TCTACs as partners: In 2023, EPA selected 16 Environmental Justice Thriving Communities Technical Assistance Centers ([EJ TCTACs](#)) in partnership with the U.S. Department of Energy that will receive \$177 million to help underserved and overburdened communities across the country. We recommend that ORD researchers encourage communities to connect with regional and national TCTACs who can support future grant applications to state or federal funding sources for energy or environmental goals. We recognize that while ORD researchers can refer communities to TCTACs, researchers are not authorized to assist with grant applications. We also see a role for ORD researchers in helping to collect baseline social and environmental data that can support future community applications for funding while simultaneously building the capacity of communities to engage in collaborative research and community-centered science.
- Consent: Recognize the importance of free, prior, and informed consent when bringing research projects to communities, such as with carbon capture research and placement of experimental projects. Obtaining consent is particularly important when working with those who have less power (e.g., those with disabilities, youth, elders, low-income communities).
- IRBs: Honor Tribal Institutional Review Boards (IRBs) (for Tribes that have IRBs, or other processes that Tribes may have for research approval) and policies for research and consultation. Federal agencies are required to adhere to federal laws mandating consultation with federally recognized Tribes, such as [Executive Order 13,175](#) and National Historic Preservation Act Section 106 (54 U.S.C. 302706 (b)). Tribes that are not federally recognized also

merit consultation and appropriate processes. ORD may want to host a workshop with key Tribal, non-profits, local businesses, schools, and community leaders to implement a document for ethical community-engaged research projects ([Climigration Network](#) has been working on this).

- Design:
 - Conventional health intervention and health promotion strategies have largely failed to mitigate the sources of environmental health risk for EJ communities because the strategies often address health at the individual behavior level rather than interacting with relevant social, cultural, and political contexts. Using an equity-centered community design and participatory approach can help build trust.
 - Work with communities to design projects. Extending the “right to know” ethic to the “right to design” can engage community members with diverse social backgrounds in data sharing processes and in the end, co-create final design solutions and experiences that build the end-users’ environmental health, data, and visual literacy.²¹
 - Community members should be included from the beginning and throughout the process. Invite their thoughts and suggestions on design rather than sharing a pre-developed project, which may focus on an area they are not even focused on.
 - Community members may want to do more than just be participants in studies by external researchers. Some may want to serve in research roles themselves and receive the appropriate training to take on this role. Help community members take on the roles they desire.
 - Understand the difference between different types of research that involve communities, from community-engaged research to community-driven research.²²
 - One way to determine what is important to particular communities is to conduct [Information Collection Requests](#).
 - Research should be useful for community members as well as government policymakers. The input from community organizations could involve recommendations around policy and engaging with other stakeholders such as local and state governments.
 - Using an equity-centered and culturally-appropriate approach can help incorporate local and cultural knowledge and practices so data will be understandable and applied.²³
 - Ideally, place-based research should promote the structural changes that communities want to see in their environments. Structural change is more likely when the research question is informed by local knowledge; there is long-term commitment to the effort; community members are formally leading; decision-makers are engaged in the research process; and different types of knowledge are valued (Davis and Ramírez-Andreottam, 2021).

²¹ See [Ramírez-Andreotta MD](#), Buxner S, Sandhaus S. “Co-created environmental health science: Identifying community question and co-generating knowledge to support science learning.” 2023. *Journal of Research Science in Teaching*. <https://doi.org/10.1002/tea.21882>.

²² See Davis LF, Ramírez-Andreotta MD. 2021. “Participatory Research for Environmental Justice: A Critical Interpretive Synthesis.” *Environmental Health Perspectives*, 129(2). DOI: <https://doi.org/10.1289/EHP6274>.

²³ Ramírez-Andreotta MD. Facilitating equity in return of individual results. National Institute of Health’s ECHO Return of Individual Research Results to Participants Workshop. March 2023. Available at: <https://videocast.nih.gov/watch=49334>

- Consider utilizing existing models ([Community-Based Participatory Research model](#) and [Design Thinking](#)) to formalize the process for designing and implementing place-based research.
- Consider creating a solicitation for case studies and additional types of outputs on community-engaged research—see [here](#) for a solicitation from NIH Fogarty center.
- **Manage expectations:** Be transparent with communities from the beginning about what ORD’s research can or will do and how it can be used. Use Memorandums of Understanding (MOUs) when working with communities to clarify data ownership, research use, and community contributions.
- **Terminology:** Consider using different terminology than “co-production”, which is not as powerful or meaningful to communities as “partnership”, “community-led”, “co-creation” or “community driven”. “Co-production” is a science-based term that has little-to-no meaning to communities. Likewise, some communities are engaged in “mitigation” and “nature-based solutions” but they may not be using these terms. Using academic terms can generate misunderstanding and distrust. Take the time to understand the language used in the community and use that language in all processes and outputs.
- **Benefits for community participation:**
 - There is a need for mutual benefits, so that both the participating community and the researchers directly benefit, everyone is clear and transparent on the expected and actual benefits of the partnership, and the research does not come across as extractive or exploitative. For example, while communities might indirectly benefit from climate change mitigation, they may not be getting specific and timely direct benefits. Take the time to identify and discuss the benefits of all participants, and pay close attention to the immediate needs and capacity limits of participants.
 - While there are often federal government limits on compensation, failure to compensate the participant (while the agency-funded researcher is getting compensation) is unfair to the participant and marginalizes their expertise. It is now becoming standard practice to pay individual community members and community-based organizations just as any expert would be paid for their participation. Consider allocating the budget to pay people the rate that other experts would get (e.g., not just gift cards, not \$10/hour) to avoid tokenizing them.
- **Dissemination of research results:**
 - It is essential to return the research results to those who participated in the study, not only because it is ethical, but also because it can build environmental health, science literacy, and participants’ relationships with science and support action. But the typical format of publishing results from place-based research (e.g., peer-reviewed journals) may not be accessible (and therefore useful) to the local communities.
 - Titles of some publications can seem inaccessible to local communities (e.g., “Transferability and Utility of Practical Strategies for Community Decision-making: Results from a Coordinated Case Study Assessment”).
 - Consider using a multidimensional dissemination approach that is co-developed by the communities who are receiving the information. This means that

- Findings are available in different forms of media, including videos and printed articles and factsheets.
- Particularly for communities with limited access, there is a central location where hard copies are located. It may also be appropriate to have gatherings among local communities to share what they have learned.
- The research is translated into the appropriate local languages as well as into lay terms.
- Communications can be evaluated by metrics in the NIH Partnerships for Environmental Public Health (PEPH) Evaluation Metrics Manual.²⁴
 - Environmental Research Translation²⁵ is a proposed framework for environmental scientists to promote interaction and communication among involved parties in a way that builds community capacity and scientific literacy. This holistic approach is rooted in public participation approaches to science, which includes a transdisciplinary team, effective collaboration, information transfer, public participation in environmental projects, and a cultural model of risk communication. Although there are challenges associated with the implementation of this framework, it is anticipated that application of this proposed translational science method could promote more robust community participation.
- Rights to data and sharing: While it is often assumed that communities are comfortable with research freely being shared, some may not be, especially when Indigenous knowledges are involved. This is a challenge, as publicly funded research is generally considered open to all. At the beginning of the project, there should be a discussion about how data will be shared and permission for sharing. It should also be clarified who owns the data (e.g., intellectual property rights) and who is listed as an author. Participants who had a meaningful role in the research should be listed as co-authors. It is important to understand the collective nature of certain knowledges and avoid individual attribution when there should be collective attribution. One way to build trust is to be transparent and come to agreement upfront through a [data sharing, ownership, and publishing agreement](#). There are particular concerns around data governance for information generated by Indigenous peoples, given past abuses. Consider following the [CARE Principles for Indigenous Data Governance](#), where CARE stands for Collective benefit, Authority to control, Responsibility, and Ethics. Guidance for implementing CARE principles appears in the footnote.²⁶

²⁴ National Institute of Environmental Health Science, Evaluation Metrics, Partnerships for Environmental Public Health (PEPH), 2012. <https://www.niehs.nih.gov/research/supported/translational/peph/metrics/index.cfm>

²⁵ [Ramírez-Andreotta](#) MD, Brusseau, ML, Artiola, JF, Maier, RM, Gandolfi, AJ. 2014. "Environmental Research Translation: Enhancing Interactions with Communities at Contaminated Sites," *Science of the Total Environment*, 497-498:651–664, PMID: 25173762.

²⁶ Carroll, S. R., Garba, I., Plevel, R., Small-Rodriguez, D., Hiratsuka, V. Y., Hudson, M., & Garrison, N. A. (2022). "Using Indigenous Standards to Implement the CARE Principles: Setting Expectations through Tribal Research Codes." *Frontiers in genetics*, 13, 823309; Carroll, S. R., Plevel, R., Jennings, L. L., Garba, I., Sterling, R., Cordova-Marks, F. M., Hiratsuka, V., Hudson, M., & Garrison, N. A. (2022). "Extending the CARE Principles from tribal research policies to benefit sharing in genomic research." *Frontiers in genetics*, 13, 1052620.

- Sustainability: As recognized in a 2024 ORD publication,²⁷ ORD researchers cannot continue to work with a community forever, and should clearly define the end of a project. But they should also consider the sustainability of a solution once it is implemented, both in terms of the intervention and the partnerships formed. Rather than focusing on one stakeholder in isolation, a community of stakeholders that can carry the project forward once it is done. For example, if the intervention involves tree planting, there needs to be human resources and infrastructure available to water and maintain the trees.

²⁷ Canfield KN, Hubbell B, Rivers L, Rodan B, Hassett-Sipple B, Rea A, Gleason T, Holder A, Berg C, Chatelain CD, Coefield S, Schmidt B, McCaughey B. Lessons learned and recommendations in conducting solutions-driven environmental and public health research. *J Environ Manage.* 2024 Feb 19;354:120270. doi: 10.1016/j.jenvman.2024.120270. Epub ahead of print. PMID: 38377748.