Research Area Descriptions:

RA 9: Benefits from Remediation, Restoration, and Revitalization

RA 10: Community-Driven Solutions

Table of Contents

LIST OF ACRONYMS

A-E	Air and Energy Research Program
AOC	Area of Concern
BMP	Best Management Plan
CBPO	Chesapeake Bay Program Office
CRSI	Climate Resilience Screening Index
CSO	Combined Sewer Overflow
CSS	Chemical Safety for Sustainability
DASEES	Decision Analysis for a Sustainable Environment, Economy and Society
DISC	Decision Integration for Strong Communities
DSS	Decision Support System
EGS	Ecosystem Goods & Services
EPA	United States Environmental Protection Agency
EPIC-N	Educational Partnerships for Innovation in Communities - Network
ERAF	Ecological Risk Assessment Forum
ES	Ecosystem Services
ESML	EcoService Model Library
ExpoBox	EPA's Exposure Toolbox
FEGS	Final Ecosystem Goods and Services
FY	Fiscal Year
GIS	Geographic Information System
GLNPO	Great Lakes National Program Office
GOMPO	Gulf of Mexico Program Office
HIA	Health Impact Assessment
HSRP	Homeland Security Research Program
HWBI	Human Well-being Index
I-WASTE	Incident Waste Assessment and Tonnage Estimator
ICLUS	Integrated Climate and Land Use Scenarios
N-PHAM	National Public Health Assessment Module
NEP	National Estuary Program
NEPA	National Environmental Policy Act
OAR	EPA's Office of Air and Radiation
OBLR	OLEM's Office of Brownfields and Land Revitalization
OCR	EPA's Office of Community Revitalization
OEJ	EPA's Office of Environmental Justice
OLEM	EPA's Office Land and Emergency Management
ORCR	EPA's Office of Resource Conservation and Recovery
ORD	EPA's Office of Research and Development
OSRTI	OLEM's Office of Superfund Remediation and Technology Innovation
OW	EPA's Office of Water
PIP	Pathfinder Innovation Project
R2R2R	Remediation to Restoration to Revitalization
RA	Research Area
RARE	Regional Applied Research Effort

RCRA	Resource Conservation and Recovery Act
RESES	Regional Sustainability and Environmental Sciences Research Program
SDM	Structured Decision Making
SHC	The Sustainable & Healthy Communities Research Program
SHEDS	EPA's Stochastic Human Exposure and Dose Simulation
SPIRAL	Sustainability Partners Incorporating Research into Academia and Localities
SSWR	Safe and Sustainable Water Resources Research Program
STL	Superfund and Technology Liaison
StRAP	Strategic Research Action Plan
SV	Sun Valley
VELMA	Visualizing Ecosystem Land Management Assessment tool

MAP OF EPA REGIONS
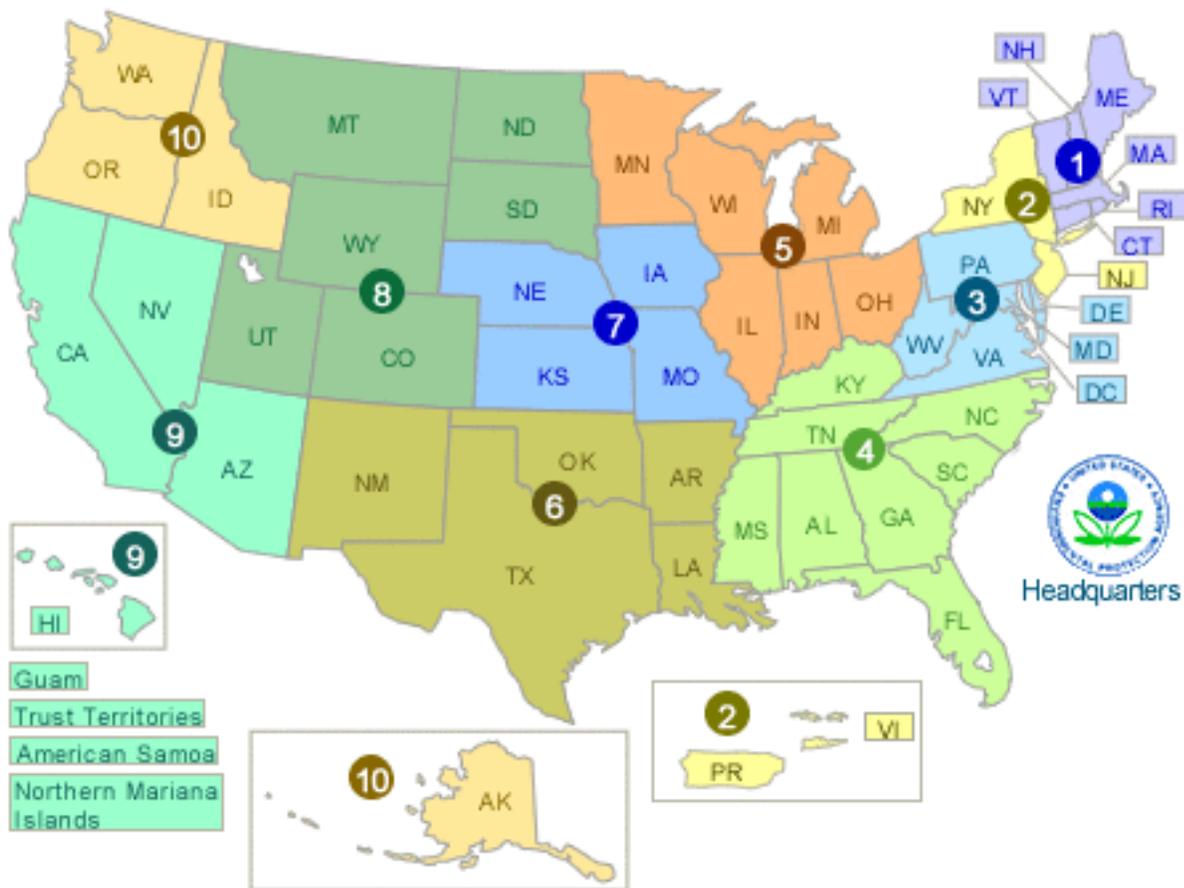
SHC Research Area 9 Description

National Research Program: *SHC*
Topic: *Topic 3: Healthy and Resilient Communities*
Research Area: *RA 9 Community Benefits from Remediation, Restoration, and Revitalization*
Research Area Coordinator (MI): Marc Russell*, Center for Computational Toxicology & Exposure (CCTE)*
Research Area Start Date: *09-2019*
Research Area End Date: *09-2022*

Overview
Research Area 9 develops methods and metrics to characterize and forecast the potential benefits from remediation and restoration that improve ecological and human health and well-being. Research Area 9 builds on the research in Topic 1 by using the Remediation to Restoration to Revitalization (R2R2R) framework developed by GLNPO to link site-specific environmental improvements to community revitalization after natural disasters and contaminant cleanup and restoration efforts. Research will be focused on: 1) understanding the causal links between ecosystem goods and services and their effects on human health and well-being; 2) developing weight of evidence approaches to evaluate environmental restoration and the contribution of ecosystem services to community revitalization and health promotion; 3) and provide EPA, states, and communities with metrics to evaluate environmental conditions and environmental public health and well-being.

Program/Regional/State Needs

1) Evaluation of Restoration Effectiveness
Problem Statement: EPA, states, and the private sector invest heavily in restoration activities relevant to contaminated sites, such as within the Great Lakes Areas of Concern (AOCs). Approaches for assessing the effectiveness of restoration efforts have only recently been developed. Temporal and spatial variability in existing restoration metrics are poorly characterized and difficult to implement for short-term and longer-term assessments of ecological recovery and associated beneficial uses. The resilience of the socio-ecological systems to environmental changes, such as extreme weather events, is also poorly characterized. As a result, managers lack data and methods to project future restoration effectiveness or assess the effectiveness of previous restoration actions.

2) Linking Remediation and Restoration to Revitalization
Problem Statement: Programs such as GLNPO want to know how site remediation and restoration activities contribute to community health and revitalization. EPA and partner agencies are going beyond evaluating the effectiveness of remediation and restoration activities – they are now assessing how these activities contribute to revitalization of adjacent communities, yet more work is needed. Project managers need evidence linking the environmental condition of restored sites to measures of human health and well-being. State and federal programs need to understand how investments to clean up contaminated sites will benefit their communities, and they need to communicate this to the public. Approaches are needed to more fully integrate community priorities, redevelopment goals, and human health and well-being impacts into remediation and restoration decisions, such that outcomes are more beneficial for community revitalization efforts. Decision makers need metrics and methods to

demonstrate linkages between remediation/restoration and redevelopment/revitalization that span spatial and temporal scales. Cleanup actions, for example, occur at a site-specific scale over the course of a few years or more. The available metrics are not commonly compatible with the larger spatial extents and longer time periods needed to assess the impacts of long-term ecological restoration or to measure the cumulative benefits of multiple remediation and restoration projects.

3) Translating ORD Tools for Brownfield Communities
Problem Statement: Brownfield grantees develop area-wide plans and other actions designed to revitalize real estate and communities. Those grantees sometimes lack technical expertise or manpower to maximize the public benefits from site cleanup, redevelopment, and revitalization efforts. SHC's science-based tools can potentially support improved redevelopment decisions but need to be more widely available and tested in real-world situations to ensure usability.

Output 9.1: Methods and Measures for Characterizing Restoration Effectiveness

Output Description:
Existing and innovative methods and measures will be evaluated to identify relevant spatial and temporal scales for meeting partners' needs. SHC will evaluate both short-term and long-term effectiveness of linked remediation and ecological restoration actions, including potential threats from extreme weather events. SHC will work with GLNPO and other partners to refine existing or develop new approaches that can be used to assess restoration effectiveness and to measure the change in ecological condition and associated beneficial uses. This research will use physical, chemical, genomic, biological, ecological, health promotion, and or socio-economic lines of evidence to address stakeholder-driven requirements and regulatory mandates at these sites.

Output Format: The output will be metrics, models, technical information, and demonstrations which will be delivered as briefings and associated synthesis document and briefing materials.
Output Lead: Susan Yee (CEMM)

EPA Program/Regional or State/Tribal Partner(s): Region 3 Chesapeake Bay Program Office (CBPO), Region 10 Puget Sound Team, Region 4 Gulf of Mexico Program Office (GOMPO), Region 5 Great Lakes National Program Office (GLNPO), Office of Water (OW) National Estuaries Program (NEP) and related geographically-based entities, (e.g., Tillamook Estuaries Partnership), Other External Partners: City of Daphne, Alabama; County of Yakima Washington

Partner Engagement Plan: ORD will work closely with partners to ensure assessments of restoration reflect common beneficial uses, address partner needs, and integrate with existing partner efforts. ORD will work with partners to summarize technical information in ways that are visual and intuitive, synthesize lessons learned and recommended approaches that are broadly transferable to other R2R2R applications.

Interdependencies: This output will contribute information to efforts to synthesize practical strategies for ecosystem services assessment in the restoration component of R2R2R under RA9 Output 2. This

output will develop methods for assessing restoration effectiveness that will be applied in Safe and Sustainable Water Resources (SSWR) Research Area 1 to communicate socio-economic benefits of restored water quality and biological condition.

Start Date: *09/2019*   Delivery Date: 09*/2022*

Product 9.1.1: Approaches to evaluate restoration effectiveness and to quantify levels of restored ecological condition needed to ensure production and resilience of beneficial uses and other ecosystem services

Brief Description and Research Use: This product will refine, develop, and give guidance on methods, metrics, and models to assess the effectiveness of restoration outcomes, and potential benefits of remediation in conjunction with future use assessments. Reviews of US and international environmental literature and reports will be used to identify best-practices for measuring restoration effectiveness (particularly regarding production and adaptive management of ecosystem services), provide examples of the application of those practices, assess knowledge gaps, and assess what methods from the broad restoration literature could be applied, modified, or developed for contaminated site clean-ups. Methods will quantify what levels of habitat restoration or ecological condition ensure restoration of critical ecosystem functions and services, including their resilience to future extreme events. Ecosystem services assessments span the goals of R2R2R by linking restored biophysical condition to social and economic benefits. This product will identify, develop, and test methods, metrics, and measures by which analysts and decision-makers can measure ecosystem function and services, quantify how restoration of ecological condition may impact ecosystem services through development and application of ecosystem service production functions, and assess potential benefits of restoration to stakeholders. Methods will provide objective criteria for characterizing what levels of condition are sufficient to achieve desired uses, evaluating effectiveness of restoration projects, assessing a restored site's resiliency to disturbance, and communicating benefits to stakeholders in the context of the R2R2R paradigm across multiple scales and ecosystems. The final product will be a report summarizing and synthesizing the research results into a proposed methodology to evaluate the effectiveness of site restoration with respect to ecological function and production of ecosystem services.

Product Form: EPA Technical Report, summarizing technical information, methods, and associated journal articles, and communicated through web-based information, conferences, and webinars

Interdependencies:
SHC RA9 Output 2 – Methods will inform efforts to synthesize practical strategies for ecosystem services assessment in the restoration component of R2R2R
SSWR RA1 - this work has related work specific to estuaries, applications of National Aquatic Resource Survey, National Coastal Condition Assessment (NARS-NCCA) data, and communicating socio-economic benefits of restored water quality and biological condition

Region 1; Region 3 CBPO; Region 4 GoMPO; Region 5 GLNPO; Region 10; OW NEP and related external and geographically based organizations (e.g., Tillamook Estuaries Partnership). Additional external partners: City of Daphne, Alabama.

Start Date: 09/2019   Delivery Date: 06/2022

Example milestones:
- Identification, prioritization, & development of Final Ecosystem Goods and Services metrics for restoration of green infrastructure
- Review and demonstrations of ecosystem services production functions to forecast changing ecosystem services under varying levels of remediation and restoration
- Development of ways to summarize technical information (e.g., visualization approaches, lookup tables) to simplify communication of ecosystem services assessments to partners and stakeholders to quickly assess levels of condition needed to achieve a desired beneficial use
- Conceptual framework for ecological suitability indices to measure ecological characteristics needed to maintain critical habitat functions
- Approaches for extrapolating data in an ecological suitability quantification framework
- Develop and provide guidance (tech transfer) on new methods, which can be applied to evaluation of restoration effectiveness
- Assessment of genomic methods as an innovative approach to measure the success of restoration on medium- to long-term ecological health
- Methods and sampling designs to assess restoration effectiveness and/ or restored site's resiliency to disturbance and on- and offsite improvements from prospective and retrospective case studies

Product 9.1.2 Demonstrations and lessons learned from place-based studies evaluating the effectiveness of restoration to produce beneficial uses and other ecosystem services

Brief Description and Research Use:
This product will apply and assess approaches to assess effectiveness of restoration outcomes and the potential benefits of remediation actions in case study applications. These case study applications are necessary to evaluate and validate the methods and metrics that are the main deliverable of the Output. The case studies will include restoration of contaminated sites, restoration of wetlands and river floodplains to provide revitalization opportunities post-remediation, remediation and restoration of Great Lakes Areas of Concern to address Beneficial Use Impairments, and evaluation of reference locations to validate approaches and evaluate restoration potential. Large legacies of land use exist that can complicate restoration activities including remediation of contaminated sites and changes to infrastructure; place-based studies will apply and evaluate restoration effectiveness assessment methods and metrics that can help with the identification of a broader set of ecosystem and environmental benefits to help inform remediation, restoration, permitting, and funding decisions. Methods will be tailored to reflect stakeholder goals for beneficial uses and other ecosystem services at each study site. Coordination across several case study applications will allow lessons learned to be

extracted and recommendations made about best practices for measuring and quantifying restoration effectiveness which are useful locally but broadly transferable. The final product will synthesize the results of the case studies to provide demonstrations of restoration effectiveness assessment methods across multiple restoration contexts, and to discuss the transferability of these methods to other locations and contaminated site restoration applications.

Product Form: Briefing materials that summarize lessons learned from the journal articles and presentations generated by this research. These briefing materials will be communicated through web-based information, conferences, and webinars.

Interdependencies:
SHC RA9 Outputs 2 – Case studies will inform efforts to synthesize practical strategies for ecosystem services assessment in the restoration component of R2R2R
SSWR RA1 Output 3 – Case studies will contribute to work communicating socio-economic benefits of restored water quality and biological condition in estuaries and on coasts

Partners: Region 1, Region 3 CBPO, Region 5 GLNPO, Region 10; OW NEPs and associated geographically-based organizations (e.g., Tillamook Estuaries Partnership). Additional external partners: City of Daphne, Alabama, County of Yakima, Washington.

Start Date: 09/2019   Delivery Date: 09/2022

Example Milestones:
- Applications to assess levels of habitat restoration needed to achieve desired levels of ecosystem services in systems containing one or more contaminated areas in various stages of remediation, including relevant reference sites (e.g., Pennsylvania RESES, Great Lakes, Tillamook Bay, Puget Sound, Mobile Bay, MassBays, South Florida, Chesapeake Bay RESES)
- Applications to assess benefits of restoration in remediated sites (e.g., Pennsylvania RESES, Great Lakes AOC)
- Assessment of ecosystem services of restored floodplain habitat that includes contaminated sites and has undergone remediation for those involved in river restoration decision making (e.g., Yakima, Washington)
- Methods and sampling designs to assess restoration effectiveness and restored sites' resiliency to disturbance and on- and offsite improvements will be discussed from prospective and retrospective case studies (e.g. Great Lakes AOC)

Output 9.2: Ecosystem Services Tools and Approaches to Support Remediation to Restoration to Revitalization

Output Description:
SHC will report on applications of ecosystem services tools and approaches in support of community-based Remediation to Restoration to Revitalization (R2R2R) related decision making. This will include:

1) collaborative case study assessments of the utility of existing methods for quantifying and mapping ecosystem services in different decision contexts; 2) specifically evaluating the potential for application of these methods to support decision making in remediation, restoration, or revitalization contexts; and 3) translation of existing methods and development of new or improved methods, knowledge, and data sets (including publicly-accessible tools for classifying final ecosystem services and their beneficiaries) to better facilitate the application of ecosystem services and their benefits as decision-support in remediation, restoration, or revitalization contexts.

Output Format:
The deliverables in this Output will be developed with a focus on translational and strategic science communication.[1] They include a suite of reports and peer-reviewed journal articles (with lead authors for EPA reports being encouraged to identify journal articles that can be developed from their report). Additional communication vehicles will be explored, including digital products (may include Story Maps, ArcMap application, information portal, wizard, EnviroAtlas Use Cases). Other types of deliverables may include Concept maps, datasets, and guideline documents.
Output Lead: Matthew Harwell (CEMM)

Partners:
NEPs (Mobile Bay, Tillamook Bay), Regional Superfund Remedial Project Managers, Regional Risk Assessors, and additional on-the-ground collaborators

Partner Engagement Plan:
We will work directly with ORD Partners and communities to disseminate and promote an Ecosystem Goods & Services (EGS) approach to decision making. Stakeholders will be engaged throughout, including workshops (SHC 9.2.3), targeted conversations on translational communications with a focus on lessons learned, transferability of approaches, and on-the-ground usability. Stakeholders have been engaged in SHC's 2016-2019 StRAP Coordinated Case Study Task from the beginning and all findings (SHC 9.2.1) will be developed in close cooperation with these partners. They will be able to directly assess how to choose and implement select EGS tools and principles of Structured Decision Making. SHC 9.2.2 will directly engage partners, the Ecological Risk Assessment Forum, and other key ORD scientists, in a manner similar to the Regional Sustainability and Environmental Sciences (RESES) effort, "Understanding and Evaluating Ecosystem Goods & Services at Site Remediation Projects and Applying Their Benefits to Sustainability and Livability for Surrounding Communities".

Interdependencies:
All three Products are interrelated and speak to larger efforts to translate ORD's ecosystem services research into useful tools and approaches for application at contaminated sites, including Great Lakes AOCs, Brownfields, and Superfund sites. 9.2.1 and 9.2.2 inform 9.2.3. The work in 9.2.2 follows on

---

[1] Harwell, M., C. Jackson, J. Molleda, and L. Sharpe. 2017. SHC Project 2.61 Community-Based Final Ecosystem Goods and Services Strategic Communication Plan. U.S. Environmental Protection Agency, Washington, DC, EPA/600/X-17/365.

nicely to the approach for examining ecosystem services outlined in Ecosystem Services at Contaminated Sites.[2] (Additionally, 9.2 work supports:

- SHC RA9 Output 3 Products on R2R2R effectiveness.
- SHC RA9 Output 4 Case Studies to Apply and Analyze Use of Tools at Brownfield Sites
- SHC RA10 Output 4 Pathways to Revitalization and Resilience that Build Community Capacity with a focus on capacity and specific tools
- SSWR Watersheds 1 Output 5 Product 1– specification of CEMs

Start Date: 10/2019 Delivery Date: 09/2022

Product 9.2.1: Comparison of a Framework for Incorporating Ecosystem Services into Decision Making across Five US Case Studies: Governance, Engagement, Tools, Assessment, and Benefits

Brief Description and Research Use:

Communities need information for how and when to use available tools for decision support. The SHC 2.61.5 Coordinated Case Studies Task has been working with five local communities to understand transferability of select tools between communities and across issues of interest (e.g., greenspace vs. forestry management). Comparison of a similar approach across five community case studies allows for evaluation of the transferability and utility of the different Practical Strategy components[3] across sites and between different issues of interest (e.g., water quality vs. greenspace). Key points of comparison are governance, engagement, ecosystem service interdependencies, assessment tools, and targeted human benefits. The synthesis report will translate the findings of the Coordinated Case Studies and provide a framework for decision support based on preservation of ecosystem goods and services (EGS) and human well-being. This synthesis will be used by community stakeholders to choose tools for assessment and understand when and how they should be used at the local level. The outcome will be a nationally relevant roadmap for application of Practical Strategies and incorporation of ecosystem services to community level decision support. The focal point of this research has been transferability of assessment methods between sites and between local issues of concern. This synthesis will also explore the translation of the decision framework and the EGS concept for working in impaired sites such as Brownfields and Superfund sites. This research is important because terms like "outcomes," "success," and stakeholder participation can be context dependent and look different in different types of projects. This Product will help EPA to better understand the range of stakeholders in communities and which ORD tools best match local needs.

---

[2] Harwell, M.C., Grissom, G., Jackson, C., Kravitz, M., Lipps, J., Lynch, K., Mahoney, M., Neale, A., Pachon, C., Scheuermann, K. 2019. Ecosystem Services at Contaminated Sites. U.S. Environmental Protection Agency, Washington, DC, EPA/600/X-19/018.

[3] Yee, S., J. Bousquin, R. Bruins, T.J. Canfield, T.H. DeWitt, R. de Jesús-Crespo, B. Dyson, R. Fulford, M. Harwell, J. Hoffman, C.J. Littles, J.M. Johnston, R.B. McKane, L. Green, M. Russell, L. Sharpe, N. Seeteram, A. Tashie, and K. Williams. 2017. Practical Strategies for Integrating Final Ecosystem Goods and Services into Community Decision-Making. U.S. Environmental Protection Agency, Gulf Breeze, FL, EPA/600/R-17/266.

Product Form:
EPA report and case study data for EnviroAtlas. Additional communication vehicles will be explored, including the use of Concept maps and Story Maps.

Interdependencies:
This Product informs the other two Products in Output 2. Additionally, this work supports SHC RA9 Output 3 Products on R2R2R effectiveness.

Partners:
NEPs - Mobile Bay National Estuary Program, Tillamook Bay National Estuary Program, Region 2, Region 5 GLNPO

Stakeholders and community leaders have been engaged in the SHC 2.61 Coordinated Case Study Task from its beginnings and all findings, including this synthesis report, will be developed in close cooperation with these partners. They will be able to use the report to directly assess how to choose and implement select ORD tools including the Visualizing Ecosystem Land Management Assessments (VELMA) model, Decision Analysis for a Sustainable Environment, Economy, & Society (DASEES) tool, Health Impact Assessment (HIA), the Final Ecosystem Goods and Services (FEGS) scoping tool, and Structured Decision Making. Support for use of these tools will be continued into the future by integrating this synthesis report into new research under in SHC RA9. We will continue to work directly with communities and EPA Regional partners to disseminate and promote an EGS approach to decision making.

Start Date: 09/2019 Delivery Date: 10/2021

Product 9.2.2: Consideration of Ecosystem Services at Cleanup Sites – A Retrospective Analysis and Synthesis of Existing ORD Research

Brief Description and Research Use:
The purpose of this research is to provide contaminated site project managers a basic understanding of ES and provide guidelines for consideration of ES at cleanup sites, including to improve ES for potential site reuse. This research includes several components: (1) translating ORD work-to-date on location-specific consideration of ecosystem services at clean-up sites; and (2) advancing new analyses on consideration of ES at clean-up sites. The first component explores EPA ORD's work-to-date on how to approach ES consideration in contaminated site cleanup processes. This work will be a peer-reviewed journal article that provides background information about ES and presents a four-step framework: (1) identify site-specific ES; (2) quantify relevant ES; (3) examine how cleanup activities affect ES; and (4) identify and implement best management practices (BMPs) through the application of two case studies to illustrate the hypothetical evaluation process. The second component will involve a retrospective analysis of several cleanup sites where remediation/restoration actions have occurred. Here, the effort will focus on: 1) presenting a retrospective analysis of ES and the remedial BMPs employed; 2) drawing conclusions about the changes in ES (as a result of remediation), and the potential for improving ES for site reuse; and 3) describing the lessons learned from this exercise as it applies to providing

generalizable guidelines for consideration of ES at contaminated sites. Examining sites that have already been cleaned up will help us understand practices that have worked, and those that need to be improved or changed. Cleanup sites selected for the retrospective analysis will be selected based on the ability to obtain data and its suitability, and type of site-cleanup or restoration decision context (e.g., may include Brownfield, Superfund, and/or Great Lakes AOC sites). Overall, these efforts will outline a practical approach that may help site cleanup project managers understand ES present at their site, understand how the remedial action(s) may impact them, and effectively communicate ES concepts and involve the public in site decisions.

Product Form: EPA report and peer-reviewed publications

Interdependencies:
This Product informs the larger research in SHC RA9 Output 2, including efforts to translate ORD's ecosystem services research into useful tools and approaches for application at contaminated sites, including Great Lakes AOCs and Brownfield and Superfund sites. It has connections to SHC RA9 Output 2, Product 3, Translating ORD's Ecosystem Services Tools and Approaches to Support Contaminated Site Clean-up Activities.

This work follows on nicely to the approach for examining ES outlined in Ecosystem Services at Contaminated Sites[4] developed under SHC's FY2016-2019 StRAP. As the tools used in this project employ the FEGS classification system, the work would benefit the testing of methods for transferring metrics and indicators of FEGS among places and ecosystems.

Partners: OLEM, Regional Superfund Remedial Project Managers, Regional risk assessors, ORD STLs

To best inform the delivery of results, this effort will include direct engagement of Partners, the Ecological Risk Assessment Forum (ERAF), and other key ORD scientists throughout the effort, in a manner similar to the previous RESES project, "Understanding and Evaluating Ecosystem Goods & Services at Site Remediation Projects and Applying Their Benefits to Sustainability and Livability for Surrounding Communities.[5]"

Start Date: 10/2019 Delivery Date: 09/2022

Product 9.2.3: Translating ORD's Ecosystem Services Tools & Approaches to Support Contaminated Site Cleanup Activities

Brief Description and Research Use:

---

[4] Harwell, M.C., Grissom, G., Jackson, C., Kravitz, M., Lipps, J., Lynch, K., Mahoney, M., Neale, A., Pachon, C., Scheuermann, K. 2019. Ecosystem Services at Contaminated Sites. U.S. Environmental Protection Agency, Washington, DC, EPA/600/X-19/018.

[5] Harwell, M.C., Grissom, G., Jackson, C., Kravitz, M., Lipps, J., Lynch, K., Mahoney, M., Neale, A., Pachon, C., Scheuermann, K. 2019. Ecosystem Services at Contaminated Sites. U.S. Environmental Protection Agency, Washington, DC, EPA/600/X-19/018.

This Product examines intermediate & final Ecosystem Goods and Services (EGS) tools for use in remediation, restoration, and revitalization decisions. The overall goal is to expand upon previous efforts to translate EGS research to give contaminated site managers access to practical, comprehensive information, tools, and experiences.

In recognizing that Remedial Project Managers and other contaminated site project managers are busier than they have ever been, this effort will look to work within existing cleanup processes, rather than looking to add/insert new processes. This effort will also bring in – and learn from – previous efforts to develop and Green & Sustainable Remediation (GSR) concepts for contaminated sites.

In a co-developed effort between ORD and Partners, a pair of virtual "mini-workshops" are envisioned in the first year to explore the value-added application of ecosystem services for contaminated cleanups with an ultimate end goal of connecting existing ES tools with how they feed into the existing cleanup process and identify opportunities for additional research. These workshops will focus on "targeted learning" as initial, incremental-learning steps before looking to develop new tools. This effort will aid ORD in continuing to learn about contaminated sites and Partners will learn about ES concepts to inform their potential relevance. Overall, all will learn about the value of translational science.

The first Virtual Workshop will focus on "Facilitated Learning" of: (1) suite of existing processes for cleanups (Superfund, Brownfields, RCRA, etc.); and (2) the value-added contribution that ecosystem services assessments may be able to provide existing processes. The second Virtual Workshop will: (1) consider potential ES elements that may be helpful with cleanup processes; and (2) identify where crosswalks between ES tools and frameworks and a suite of contaminated site cleanup processes might be developed in future. Future research in this Product will develop based on the outcomes of these workshops.

Product Form:
Reports (e.g., a "guidelines" report for informing specific R2R2R decision contexts); Manuscripts; Digital Products (may include Story Maps, information portal, wizard, EnviroAtlas Use Cases).
Interdependencies:
This Product has connections to Products SHC 9.2.1, Comparison of a Framework for Incorporating Ecosystem Services into Decision Making across Five US Case Studies: Governance, Engagement, Tools, Assessment, and Benefits, and SHC 9.2.2, Consideration of Ecosystem Services at Cleanup Sites – A Retrospective Analysis and Synthesis of Existing ORD Research.

Additionally, this work is potentially related to:
- SHC RA9 Output 4 Case Studies to Apply and Analyze Use of Tools at Brownfield Sites
- SHC RA9 Output 3 Product 3, Case studies demonstrating how we implement R2R2R
- SHC RA10 Output 3 Pathways to Revitalization and Resilience that Build Community Capacity with a focus on capacity and specific tools
- SSWR Watersheds 1 Output 5 Product 1– specification of CEMs

Partners: OLEM, Region 5 GLNPO, Regional Superfund Remedial Project Managers, Regional Risk Assessors, ORD STLs, and additional on-the-ground collaborators

Start Date: 10/2019 Delivery Date: 09/2022

Output 9.3: Contribution of Site Remediation and Restoration to Revitalizing Communities and Improving Well-being

Output Description: The goal of this output is to identify new approaches and metrics to better promote community revitalization through site remediation and ecological restoration. Collectively, these studies address the contribution that changes in environmental and ecological condition make to changes in human well-being and community revitalization. The first product focuses on the connection to human well-being. This research will evaluate causal connections between ecosystem condition and human health and well-being in the context of communities located near sites undergoing remediation and restoration and for which both chemical and non-chemical stressors are present. The research will assess the impact of social and biophysical co-factors that may modify the impact of ecosystem-health relationships on revitalization. Similarly, these studies will evaluate if and how these relationships hold across multiple spatial and temporal scales relevant for R2R2R decisions. The second product will focus on developing, validating, and demonstrating methods and metrics to assess longer-term ecological and health benefits of remediation and restoration. These studies will evaluate if and how these benefits help revitalize communities, examining data across multiple spatial and temporal scales. Objectives of the research includes synthesis and centralization of published methods and metrics useful for linking remediation and restoration to revitalization, developing innovative economic and sociocultural methods to improve benefit valuation, and evaluating risks and resilience of contaminated sites from natural hazards. The third product will focus on case studies to demonstrate how we integrate community priorities, redevelopment goals, and community benefits into remediation and restoration decisions. Case studies will occur across the United States, including Puerto Rico, Puget Sound, Great Lakes, and Sun Valley. These studies will address Legacy Act, Superfund, and Brownfield sites.

Output Form: The report-summary will summarize and highlight partner interactions and impact across the work produced in Output 3, highlighting evidence of revitalization at remediated and restored sites
Output Lead: Joel Hoffman (CCTE)

Partners: OW, AO, Region 2, Region 3, Region 4, Region 5, Region 10

Partner/Customer Engagement Plan: See Products

Start Date: 10/01/2019   Delivery Date: 09/30/2022

Product 9.3.1: Assessing ecosystem services and human well-being indicators for Great Lakes Areas of Concern, Superfund cleanup, Brownfields remediation, and waterfront revitalization

Brief Description and Research Use: The research for this product will demonstrate and elaborate on how environmental, social, and economic indicators of human well-being can be linked to community revitalization goals and outcomes at multiple spatial and temporal scales around the Great Lakes. Revitalization may be associated with site remediation and habitat restoration associated with Area of Concern use impairment removal, Superfund cleanup, Brownfield reuse, and waterfront revitalization. Two focus areas will be revitalization indicators of social equity, environmental justice, and public health, and translation of biophysical indicators of ecosystem services into socioeconomic benefits using the National Ecosystem Services Classification (NESCS Plus). Case studies based in Great Lakes communities will leverage empirical data collection, literature review, and extraction of existing data from EPA and non-EPA databases. Case studies will be situated in both urban and non-urban communities at different points in their revitalization trajectory. The Remediation, Restoration, and Revitalization framework (R2R2R) was developed by the ORD and the Great Lakes National Program Office to help fulfill Great Lakes Water Quality Agreement commitments "to restore and maintain the chemical, physical, and biological integrity of the Waters of the Great Lakes" R2R2R could also be a useful paradigm for fulfilling Section 303 Water Quality Standard objectives of the Clean Water Act (CWA) "to restore and maintain the chemical, physical and biological integrity of the Nation's waters" and CERCLA and RCRA objectives "to protect human health and the environment." This research will use ecosystem services classification frameworks to translate and link ecosystem services to enhance program activities related to beneficial use delisting of Areas of Concern, restoration and maintenance of designated uses under the CWA, and remediation under CERCLA and RCRA.

Product Form: The product will be a report (supported by peer-reviewed publications) addressing the availability, sensitivity, and application of revitalization indicators in the Great Lakes context.

Partners: OW, Region 5

Start Date: 10/2019   Delivery Date: 09/2022

Product 9.3.2: Risks of Extreme Events to Superfund, Community Waste Management and Remediation Activities and Verification of the Climate Resilience Screening Index

Brief Description and Research Use: An assessment of natural hazards risk profiles will describe the underlying additional risks to the counties of the United States and their existing Superfund, RCRA, R2R2R and Brownfield sites from five of the 12 major hazard events (hurricanes, coastal and riverine flooding, tornadoes and wildfires) included in the Climate Resilience Screening Index (CRSI). To assess and quantify the impact on revitalization in a community from the clean-up of Superfund, RCRA, R2R2R AOCs and Brownfield sites, the overall underlying risks associated with nation and these sites must be understood. The overlay of these variables will quantify the additional risk of these sites to natural hazards and in turn assess the risk to adjacent communities. This information is important in assessing the magnitude of revitalization of these communities after site restoration. Similarly, this research will

examine the ability of CRSI to assess the level of resilience in counties impacted by major hurricanes, wildfires, tornadoes in 2017 and 2018. This verification will assess the ability of CRSI to gauge the ability of counties/communities to be prepared for and recover from natural hazard events and thus, make the index applicable to restoration communities like the Superfund, RCRA, Brownfields and R2R2R AOCs in the Great Lakes, as well as other revitalization sites like Sun Valley, Proctor Creek, San Juan and Puget Sound. The verification is an internal assessment. External assessments of the utility of CRSI will be gathered via a beta testing survey of an application that includes CRSI as one of its elements.

For these products, the plan is to complete the coverages nationally through direct interactions with Regional and OLEM partners, with the Regional and OLEM communities through routine presentations and workshops (knowledge sharing), and through periodic R2R2R workshops at their headquarters (culture development through program evolution).

Product form: Deliverables include datasets of natural hazard risk histories and intersection of natural hazard risks and Superfund, RCRA and Brownfield sites, CRSI verification test, and associated guidance.

Interdependencies: As noted above, this output represents a cross-cutting research focus that is relevant to Outputs 1, 2 and 4 in RA 9 and all Outputs in RA 10. Is essential to/supports:
- Puget Sound data and outputs to/from: SSWR RA2 Output 15, Trajectories of aquatic ecosystem responses to & recovery from nutrient pollution (McKane Puget Sound project)
- San Juan outputs from SSWR RA1, Watersheds, Outputs 3 and 4
- Great Lakes outputs from SHC RA2 Output 1, SHC RA9 Output 1

Partners: Region 5 OEJ & GLNPO, Region 8, Region 10 NEP, OW. Additional external partners: Minnesota Department of Natural Resources, Corporación del Proyecto ENLACE del Caño Martín Peña, University of Washington Puget Sound Institute, Washington Department of Ecology, City of Seattle, Denver Housing Authority, University of Colorado at Denver, Colorado State University

Start Date: 10/2019   Delivery Date: 09/2022

Product 9.3.3: Assessing how human health and wellbeing is affected by site remediation and restoration

Brief Description and Research Use: This product will examine the public health benefits of the R2R2R process, specifically the relationships between contaminated sites, changes in ecosystem goods and services (EGS) as a result of the R2R2R process at contaminated sites, and health outcomes at the individual, community, and broader public health levels. This product will result in tools and databases that can be used to quantify and predict the public health benefits of improving contaminated sites, while also providing links to health biomarkers and biological mechanisms. The approaches used in the product include systematic reviews, epidemiologic studies, natural experiments, and novel electronic health cohorts. Eco-health relationships will be delivered to the EnviroAtlas Eco-Health Relationship Browser team. The project has three main components. In the first component, we will conduct a workshop in Spring 2020 with ORD collaborators and select partners to optimize alignment between

place-based research at contaminated sites and health outcomes research in this product. In the second component, we will quantify community- and individual-level responses to the revitalization of contaminated sites and accompanying changes in local EGS. In the third component, we will evaluate the broader public health benefits of EGS and the R2R2R process. Overall, this product will provide insights into the community health metrics impacted by contaminated site revitalization/R2R2R. This product allows partners to communicate the benefits of R2R2R and associated improved EGS, as well as provide the tools and knowledge to maximize public health benefits of the R2R2R process at contaminated sites. There are several partners for this product including Region 4, OLEM, GLNPO, and MAHEC to name a few, who will be engaged throughout the product particularly in the workshop to align health outcomes assessment with contaminated site-based work occurring in SHC RA9 Outputs 1, 3, and 4.

Milestones associated with this product include:

- Use existing tools to characterize the distribution of ecosystem goods and services and link these to electronic health databases, thereby quantifying the impact of ecosystem goods and services on lifespan and healthspan
- Treat the R2R2R process as a natural experiment, comparing health metrics before the R2R2R process was initiated with those after final revitalization is completed
- Concurrent assessment of long-term, local (ZIP code) exposures to multiple, individual environmental stressors as determinants of local variation in health in the elderly. This milestone will identify specific, modifiable aspects of the urban environment that are associated with health improvements among the elderly
- In conjunction with observational approaches currently being employed, assess the benefits of restoration/revitalization and other environmental rejuvenation strategies. This milestone will provide details on key biological decrements that result from depleted living conditions with a focus on identifying specific biomarkers of health and disease

Interdependencies: This is a broad and cross-cutting product that will have multiple impacts on products and outputs in SHC including all outputs in RA 9 and in RA 10.

Partners: Office of Environmental Justice (OEJ), Region 3, Region 5 GLNPO, Region 10, Other external partners: Denver Housing Authority, North Carolina Division of Public Health, NC Department of Environmental Quality

Start Date: 10/2019   Delivery Date: 09/2022

Product 9.3.4: Economic evaluation of contaminated site and brownfields remediation using non-market and market valuation methods

Brief Description and Research Use: EPA, States, and communities are interested in measuring the economic impacts of contaminated sites remediation, restoration and revitalization efforts on the communities surrounding remediation/restoration sites. The goal of this research is to estimate the

benefits and economic impacts of site-remediation/cleanup and revitalization efforts using various economic valuation methods and econometric approaches. In order to demonstrate the methods, R2R2R type sites will be chosen for data collection; Potential sites are Proctor Creek Watershed in Atlanta GA and Great Lakes AOC sites. The number of sites will be based on resource availability and partner priorities. The Proctor Creek watershed is faced with several environmental challenges such as combined sewer overflows (CSOs), Poor water quality, flooding as well as brownfields that remediation/ restoration/revitalization efforts have been trying to address in the past several years, in addition to economic issues. Data will be collected on individual property sales, census tract median home prices, repeat sales information, local/neighborhood employment, wages, personal income, poverty, taxes collected, and spatially explicit data on brownfields/contaminated sites, and the status of remediation/restoration from communities surrounding the sites. Property sales data will be collected from Zillow and/or the County/local Governments. Spatially explicit information will be linked using GIS analysis. Estimation will involve modified hedonic models, capitalization metric based on repeat sales, and economic impact analysis. The output from this research product will assist partners/communities in evaluating the economic impacts of remediation, restoration and revitalization efforts of contaminated sites. The product will be communicated to partners through presentations and technical summaries, in addition to peer reviewed manuscripts.

Product Form: A report describing the approach, results and impact, supported by manuscripts on the economic impacts of brownfields and their revitalization (2-3 manuscripts expected)

Partners: Region 4

Start Date: 10/2019   Delivery Date: 09/2021

Product 9.3.5: Where to work? Development of remediation and restoration strategies to revitalize community health and well-being in contrasting urban-estuarine ecosystems

Brief Description and Research Use: This product will use contrasting urban-estuarine ecosystems to broadly demonstrate watershed-scale strategies for determining where and how to implement contaminated site remediation and restoration practices to revitalize community land-water assets and human health and well-being. Demonstration sites will include contaminant and health-impacted communities across three estuaries of national concern – San Juan Bay, Puget Sound, and Great Lakes. Products from this research will include transfer of user-friendly tools and practical restoration guidance to community, Region (2, 5, 8 and 10) and Estuary Program partners. Guidance will include practical steps to (1) implement best practices for restoring contaminated land-water community assets; and (2) assess R2R2R benefits to human health and well-being. Health and well-being metrics will include projected reductions in exposures to contaminants in episodic flood waters, drinking water, fish and shellfish, and usability of waters and other community assets for fishing, swimming, boating, etc. The San Juan, Puget Sound, and Great Lakes demonstration sites represent the most mature work within Research Area 9 regarding the application of R2R2R and the development of practical strategies for partners. They all have established, multi-year working relationships with partners. Each has already conducted data-supported problem formulation and is proposing to address specific high-value

partner needs. And all three demonstrations are considering one or more of social, economic, or health benefits in the approach. These three demonstrations are also likely candidates for developing additional eco-health research in association with Product 9.3.3.

Product form: Practical restoration guidance (EPA report) and transfer of user-friendly tools – supported by a synthesis of R2R2R demonstration site products

Partners: Region 5 GLNPO, Region 10, OW

Start Date: 10/2019   Delivery Date: 09/2022

Product 9.3.6: Documenting and baselining the benefits of community revitalization at Sun Valley Colorado

Brief Description and Research Use: This research, which compliments the Sun Valley FY18 RESES effort, will collect primary data on the health of the Sun Valley population prior to neighborhood revitalization, thereby enabling assessment of the eco-health impacts of redevelopment. The study location is Sun Valley (SV), Colorado, a public housing neighborhood located in Denver that is undergoing a comprehensive revitalization effort. For the FY18 RESES project, Ecosystem service (ESS) improvements reflected in the SV revitalization plans will be captured in relevant metrics and linked to secondary health and well-being metrics using empirical models already established by ORD. This product extends those efforts through collection of complementary health and bio-marker data from Sun Valley residents. Initial efforts will focus on collection of saliva samples (FY20) but could be expanded to blood and urine in FY21 and FY22, dependent on funding and viability of recruitment. The data collected will support the RESES modelling effort and will also serve as a standalone product to baseline key health biomarkers such as allostatic load in the Sun Valley population prior to revitalization. Where appropriate, the report will also incorporate findings from aligned efforts to collect and analyze well-being data for the SV population and to further characterize the scope and potential benefits of the ESS improvements linked to revitalization.

Product Form: A written, non-technical "roadmap" guidance document (EPA Report) detailing metrics and connections between them for evaluating the ESS, health, and well-being impacts of revitalization.

Partners: Region 8, Office of Community Revitalization (OCR)

Start Date: 10/2019   Delivery Date: 09/2022

Output 9.4: Case Studies to Apply and Analyze Use of Tools at Brownfield Sites
Output Description:
SHC will work with OLEM's Office of Brownfields and Land Revitalization (OBLR) EPA regions, and communities receiving Brownfield grants to select relevant tools and assess their applicability across different project types, timeframes, and community scales. The objective is to evaluate and improve

the applicability and usability of these tools. This work will identify refinements needed to support their wider use. SHC will develop products that describe the tool functions, experience level needed, data and system requirements, and criteria for tool selection, in the context of Brownfield-related activities. The pilot testing will include tools from among those listed in Appendix 4 selected in consultation with OLEM and other relevant partners. This output will also include outreach to make users more aware of existing tools.

Output Format: Multiple – See Products
Output Contact: Britta Bierwagen (CPHEA)

EPA Program/Regional or State/Tribal Partner(s): OLEM, Region 1, Region 4, Region 5, Region 6, Region 9. Additional external partners: Local community planners, Potential brownfields grant applicants, , and states.

Partner Engagement Plan: Multiple – See Products

Start Date: 09/2019 Delivery Date: 09/2022

Product 9.4.1: Applying EnviroAtlas to Brownfields assessments and redevelopment

Brief Description and Research Use for RAPID: This product focuses on applying EnviroAtlas tools and data to the brownfields process, from grant application to revitalization efforts. EnviroAtlas provides interactive tools and a wealth of data that could be applied to brownfields grant applications, assessments, redevelopment, and revitalization. The aim is to work with OLEM/OBLR and other brownfields stakeholders to identify the most effective ways to apply these tools and resources to Brownfields assessment and redevelopment in order to develop guidance for their use and make strategic improvements to the tools such that the Brownfields stakeholder community can readily interact with relevant EnviroAtlas resources and apply currently available EnviroAtlas data through a straight forward, easy-to-use format. Central to this product is understanding stakeholder needs in order to make enhancements to EnviroAtlas for Brownfields use and collaboratively developing Brownfields-focused user guides/case studies.

Product Form: Additional reporting function added to EnviroAtlas, User guide, Case Studies / Use Cases, workshop

Interdependencies: Requires/Supported by SHC 10.1.13 – Mapping Assets and Vulnerabilities, Enhanced Functionality and new tools in EnviroAtlas

Partners: OLEM, EPA Regional Brownfields. Additional external partners: Local community planners, Potential brownfields grant applicants

Start Date: 10/2019   Delivery Date: 6/2022

<u>Full Description:</u>
This work focuses on applying EnviroAtlas tools and data to the brownfields process, from grant application to revitalization efforts. EnviroAtlas provides interactive tools, including a geospatial mapping application and a relational browser on eco-health relationships, along with a wealth of data that could be applied to brownfields grant applications, assessments, redevelopment, and revitalization. The aim is to work with OLEM/OBLR to identify the most effective ways to improve the tools such that the Brownfields stakeholder community can readily interact with relevant EnviroAtlas resources and apply currently available EnviroAtlas data through a straight forward, easy-to-use format.

Feedback will be gathered from the Brownfields community through multiple avenues, including through early input through a listening session at the Annual Brownfields Conference (Dec 2019) and workshops, webinars, and/or training sessions with communities as defined by OLEM/OBLR and/or Regional partners to pilot and demonstrate available data, and to gather feedback on the most useful added functionality for user needs. OLEM will act as liaison with Brownfields grantees and help identify potentially receptive Brownfields sites (up to 3) to apply existing EnviroAtlas data and gather feedback on data needs (FY 20 and 21). EPA Regional Brownfields partners will work with ORD to determine tools and datasets that may be useful to Brownfields grant applicants. To increase success for these collaborations, it will be important to have funds in for an individual who can help with ongoing community engagement and workshop facilitation.

This work may also include identifying and engaging communities where SHC is already working to apply EnviroAtlas to revitalization efforts post remediation of sites – including Brownfields, Superfund, and other areas of concern. Existing projects where this may be possible include the *Beneficial Use of Dredged Materials: Opportunities, Community Benefits, and Applied Guidance* (R5) RESES project in Region 5 and ongoing work in Chesapeake Bay and Puerto Rico (FY 20 – FY 22, ongoing).

In addition to web capabilities, a user guide will be developed for applying the data, tools, and added functionality in Brownfields processes. The guide would include success stories/case studies in a format to be determined from stakeholder feedback. One interactive option would be a Story Map showing redevelopment that has worked well, best practices, and application of EPA data and tools to different Brownfields scenarios. Feedback from engaging with the stakeholder community may identify data layer gaps in EnviroAtlas. If so, this information will be fed back into Research Area 10, Output 1 where it may be possible to generate those map layers.

Product Milestone: EnviroAtlas brownfields map dashboard screening tool
Central to this product is the creation of a simple, intuitive, pan-and-zoom EnviroAtlas map interface for public stakeholders to visualize brownfields possibilities. This added EnviroAtlas function addresses the need for a simple GIS mapping tool to help community stakeholders (e.g., citizens, mayor's office, planners, economic development council) visualize information reported by brownfield grantees in their neighborhood-scale spatial context with GIS layers showing population, floodplain, greenspace, topography, high resolution imagery and other EnviroAtlas layers. This GIS visualization tool will help citizens and community partners answer questions such as, "Is this brownfield site in a floodplain? What is the population? What are the fine-scale, neighborhood-level environment, infrastructure,

economics and socio-demographics of my area of interest?". This dashboard tool emphasizes at-a-glance insights and integrates the visual language of maps with dynamically linked charts, graphs and tables. Added functionality to EnviroAtlas will allow users to export maps and variables to help apply for Brownfields grants, and help city planners evaluate, document, and revitalize Brownfield sites. Information gathered from EnviroAtlas workshops and feedback-gathering opportunities will be used to iteratively develop the proposed Dashboard/widget plug-in and additional reporting functionality (FY 22) while assisting OLEM/OBLR, Grantees, and other stakeholders until that work is complete.

Product 9.4.2: Demonstration of Effectiveness of Revitalization of a Prevalent Type of Brownfields Site

Brief Description and Research Use:

This product will assess and test conditions that make abandoned gas station sites good candidates for revitalization. There are about 225,000 abandoned gas stations, making them common brownfield sites. These are prime development areas located along commercial corridors and rural backroads. Despite being eligible for brownfield grants, many remain vacant due to fear of liability at contaminated sites. This research proposal highlights the abandoned gas station as an identifiable brownfield property type and seeks to better equip communities in understanding potential contaminants from station operations and structures and planning for opportunities to use green and gray infrastructure investment along commercial corridor areas. As frequent gateway sites, revitalizing abandoned gas stations and providing community-responsive information may help communities create environmentally sound and aesthetically pleasing commercial reuses and resources that may have national scale value. With OBLR and Regions 1, 4, 6, and 9 we will identify state and local partners and specific communities to assess the characteristics of successful revitalization. We will examine (1) site characteristics (physical and biological), (2) contaminant trends in the surface, subsurface, and groundwater, (3) remediation methods (e.g., bioremediation and phytoremediation) and (4) restoration and revitalization strategies. Data on past and present gas station remediation and revitalization will come from OBLR (e.g., Cleanups in My Community, grants database) and states. Based on this review and assessment we will produce a checklist of criteria for selecting good candidate abandoned gas station sites for revitalization and will test the checklist with partner communities. This checklist provides communities with a quick assessment method to identify sites, remediation methods, and revitalization strategies that have the greatest potential to produce impactful and tangible community benefits.

Product Form: Site selection checklist; documentation of successful remediation and revitalization methods; use case results of checklist application in communities for partners; journal article describing methods and results; incorporation into existing tools/dashboards if appropriate (e.g., EnviroAtlas Brownfields Dashboard)

Partners: OLEM, Regions 1, 4, 6, and 9, states (e.g., New Hampshire)

Start Date: 10/2019 Delivery Date: 9/2022

Product 9.4.3: Health Impact Assessment (HIA) Applications to Brownfields Reuse and Redevelopment to Support Community Resiliency and Revitalization

Brief Description and Research Use:

This Product provides a twofold approach to apply health impact assessments (HIAs) to Brownfields processes. First, it will conduct an HIA at a Brownfields site to assess HIA utility. Second, it will provide a retrospective evaluation of ORD HIAs to determine how community capacity and context influence HIA success. The HIA-Brownfields application is a direct collaboration between ORD, OBLR, and the respective Region. The goal is to conduct a rapid HIA for a recent Brownfields grantee to evaluate HIA value to OBLR and the Brownfields community. HIAs are potentially more abstract than is useful for a place-based or defined project area so this provides a testbed for OBLR projects. This research seeks to introduce new considerations to Brownfields practice and practitioner exposure to potential or quantified environmental and public health impacts of projects, providing recommendations to support community resiliency and revitalization.

The second part of this research will be a retrospective evaluation of ORD-led HIAs to determine how community capacity and context influence the ability to benefit from ORD tools and information, and how these lessons can be applied to Brownfields. Although HIAs are conducted in a standardized way, their timing, implementation and the context and capacity of communities varies greatly. For example, prior ORD HIAs include different contexts, such as brownfields remediation, flooding resilience through green infrastructure, habitat restoration, and indoor air quality. This review evaluates how HIAs affected community capacity, metrics for HIA success and which were most influential for decisions, actual decision and implementation recommendations, and how lack of capacity or other factors hindered the ability to achieve desired outcomes.

Product Form:
1. EPA report on HIA application to Brownfield site
2. Peer reviewed publication related to recommendations of how rapid HIAs can contribute to Brownfields reuse and redevelopment
3. EPA report on evaluation of ORD HIAs examining community context and capacity to HIA success
4. Peer reviewed publication of how variability in community context and capacity influences HIAs and potential applications to Brownfields

Interdependencies: Supported by SHC 9.4.4: *Tools Awareness, Identification Selection and Use in Brownfields Cases*.

Partners: OLEM

Start Date: 09/2019   Delivery Date: 09/2022

SHC Research Area 10 Description

National Research Program: *Sustainable and Healthy Communities*
Topic: *Healthy and Resilient Communities*
Research Area: *Research Area 10 Community-Driven Solutions*
Research Area Coordinator (MI): *Susan Julius, Center for Public Health and Environmental Assessment (CPHEA)*
Research Area Start Date: *10-2019*
Research Area End Date: *10-2022*

Overview
Research Area 10 addresses community resilience, with a focus on vulnerable groups, and examines potential impacts of hazards with the objective of speeding community recovery and sustaining public benefits. Communities are complex environments where the interrelationships among geography, people, land use, policies, and the built, natural, and social environments help determine a community's health and well-being. Adverse impacts from natural hazards such as extreme climate events are magnified when a community's or individual's resilience is low, meaning they lack access to fundamental resources such as healthy food, health care, and robust infrastructure. Vulnerable groups, such as children, the elderly, people with low-income, and minorities, warrant special consideration because these groups often face greater adverse impacts due to disproportionate exposures, more susceptible physiology, or other social or built environment factors.

Many communities responding to, or preparing for, natural hazards struggle with understanding the best way to make their community more resilient to chronic and acute stressors. To become resilient, programs and communities need information on the intended and unintended consequences that often result from environmental changes. EPA's mission includes consideration of vulnerable groups in its actions, in addition to ensuring that its regulations do not have a differential impact on communities or cause an increase in health disparities. Taking actions that minimize adverse impacts and disparities while maximizing benefits requires understanding the linkages between changes in the biophysical environment and the resulting consequences on health, economy, and well-being.

Program/Regional/State Needs (or logically grouped set of needs) (no more than ½ page)
This research area supports Regional, State and Local decisions that affect community public health, wellbeing and resiliency by providing actionable, science-based information on the following objectives and priorities:
- EPA Strategic Plan Obj 2.2 and Office of Policy Memo on EPA's Environmental Justice and Community Revitalization Priorities: Supporting the goal of cooperative federalism and community-driven solutions to catalyze real results.
- EPA Strategic Plan Objective 3.3: Supporting assessment of the impact of pollution on vulnerable populations and lifestages, such as children, tribes, and low-income or minority communities.

- ORD Strategic Plan Goals 1 (Advancing Environmental Science and Technology) and 2 (Cooperative Federalism: Informing and Supporting Federal, State, Tribal and Local Decision-making)
- Goal 4 of the Superfund Task Force: Promoting redevelopment of Superfund sites for community revitalization.
- EPA/FEMA Memorandum of Agreement: Supporting long-term disaster recovery and hazard mitigation.
- Homeland Security Research Program: Improving situational awareness for disaster response.

Specific Partner needs by Problem Statement include:

Characterizing Place: Identifying Community Assets and Vulnerabilities: Characterizing natural and built community assets and vulnerabilities that affect public health, post-remediation community revitalization or disaster resilience.
- **OCR** needs asset mapping to inform effective Superfund-related community redevelopment and revitalization decisions.
- **OLEM, OW/OWOW** and many regions want to better understand hazards, especially for flooding and contaminated sites, and ecosystem assets that can mitigate hazards like flooding and heat, so they can implement practices that are most effective, cost-efficient and have multiple benefits.

Relationships between Exposures and Vulnerabilities and Associated Health Outcomes from Multiple and Cumulative Stressors: Characterizing the cumulative and interactive influences of stressors in the built, natural, chemical and social environments on public health and well-being, especially for vulnerable groups like children and the elderly, as well as communities of Environmental Justice (EJ) concern, like low income, tribal and minority populations.
- **OEJ** and **regions** want to better understand determinants of health and vulnerabilities, especially those that can disproportionately affect susceptible and EJ populations to effectively target interventions and resources, to assess and solve long-term health issues.
- **Regions** need to characterize potential health impacts to gauge effectiveness and benefits of management options.

Integrating Decision Support Tools and Processes to Support Community-Driven Problem Solving: Creating EPA tools that are more usable and useful for decision makers and that support evidence-based and place-oriented decisions that avoid impacts and maximize cobenefits.
- **Regions** want usable tools, metrics and methods that fit into communities' practices and help evaluate and rate vulnerabilities, provide relevant information for resiliency/recovery planning and the comparison of scenarios and decision options.
- **OEJ** needs usable tools to empower overburdened communities to better characterize their own environmental health problems and create solutions that equitably distribute benefits.

Decision Making to Improve Resiliency: Characterizing expected impacts to communities due changing conditions and natural hazards, the resulting consequences on health, economy, and well-being, and effective actions that will increase community resilience to hazards, enable speedy community recovery, and provide other public benefits.
- Numerous **regions** and **OEJ** have expressed needs for:

- Ways to forecast extreme weather and the implications for facilities planning and resource management, so they can adequately prepare for disasters and appropriately plan for community resiliency;
- Information and approaches for assessing how practices/changes to the built infrastructure and natural assets (e.g., green infrastructure) can increase both community well-being and resilience, to take actions that maximize benefits;
- Ways to identify stressors and impacts, including disparities, due to climatic changes, to enable decisions that equitably distribute the benefits of actions.

Assumptions and Constraints: An important assumption is that the Partners who have participated thus far will have the support of their management to remain committed and engaged throughout the development of the proposed products.

Output 10.1: Data and Approaches for Identifying and Mapping Assets and Vulnerabilities

Output Description: SHC will provide methods derived from available data to help partners and stakeholders understand their current and changing socio-ecological and physical conditions (i.e., assets and vulnerabilities that are critical to making redevelopment, revitalization, and resilience planning decisions). Partners will help identify parameters (e.g., related to the physical environment, ecosystem services, socio-economics, infrastructure) that are of greatest relevance and utility for common decisions around the potential for site restoration and redevelopment and for general decisions about community resilience. This research will identify and focus on how existing federal, state, and local datasets and metrics can quantify, map, and evaluate natural, social, and economic assets and vulnerabilities at the local level. This includes exploring ways to apply and expand existing EPA tools (e.g., EnviroAtlas) and metrics (e.g., Human Well-Being Index, HWBI) for targeted decision-making. For example, new sources of data, new data layers for targeted decision making, trends over time, and community-driven alternative scenario tools can be added to the EnviroAtlas. Because of the complexity and unique site-specific nature of identifying and mapping assets, this output will also provide data, guidance, and tools to states and communities to compile their own maps.

Output Format: Presentation/technical fact sheet that summarizes publications, datasets and tools accessible through EnviroAtlas, educational materials
Output Lead: Anne Neale (CPHEA)

EPA Program/Regional or State/Tribal Partner(s): Listed within each product description

Partner Engagement Plan: Partners will be kept abreast of current activities through the RACT, as well as through other existing workgroups, as appropriate. Presentations will also be given through the SHC webinar series to provide updates and opportunities for feedback.

Interdependencies: SHC, RA9 and other outputs in RA10.

Start Date: *10/2019*   Delivery Date: 09*/2022*

Product 10.1.1: Quantifying ecosystem services and identifying beneficiaries for parks, public / protected lands and community greenspaces.

Brief Description and Research Use: We will deliver park/ protected area usage data for the nation and a use case highlighting application of the data. These data will help communities understand usage patterns and where to invest in protected lands/parks or marketing of existing parks. For each park/protected area, I data will include total visitation, origins of visitors (e.g., local versus destination travel), and visit duration. To accomplish the research, we will use commercially-available, aggregated and anonymized human mobility datasets. This work is in response to the Office of Community Revitalization's (OCR) newly launched grant program promoting outdoor recreation as a pathway to revitalization (https://www.epa.gov/smartgrowth/recreation-economy-rural-communities). We will work with OCR and Regions 1 and 3 to pilot the methodology and produce data sets for the communities where OCR has awarded the first eight grants and several others. Once the methodology has been vetted, published, and proven useful to our partners, we plan to then create the data for the entire nation.

Access to outdoor recreational resources is tied to a community's well-being. Participation in outdoor recreation can lead to better health, community social cohesion and sense of place. Outdoor recreation amenities can help a community become a more desirable place to live and can help support and enhance the local economy. Outdoor recreation can be a significant source of income and jobs for communities. These data not only support OCR's Grants program, but also the Regions, and other Program Offices as they engage in community planning/revitalization. These data may also be of value to OLEM, as one possible use for remediated contaminated sites is outdoor recreation. These data will be useful to eco-health research efforts investigating the relationships between access to parks / outdoor recreation and human health outcomes. Additionally, the data will be useful for evaluating equity of park access and usage.

Product Type: Scientific Data/dataset

Product Form: Park usage data published in EnviroAtlas for the nation including a use case highlighting usage of the data. Will be communicated in periodic newsletters, presentations, and trainings.

Interdependencies: SSWR-RA1-Output 5 (Economics and WQ modeling)- proposing use of similar data for coastal and lake resources and WQ impacts. SSWR-RA3-Output 1 (Translational Pilot on Cape Cod)- proposing use of similar data for assessing coastal use and recreation in TMDL impaired estuaries

Partners: OCR, OW, OP, EPA Region 1 and Region 3, and other EPA Regions. Additional external partners: Cape Cod Commission (MA), EPA Southern New England Program (SNEP)

Start Date: 10/2019   Delivery Date: 09/2022

Product 10.1.2: Assessment of Multidimensional Community Vulnerability and Resilience

Brief Description and Research Use:
This product takes the form of a multidimensional community vulnerability and resilience assessment which when delivered will contain values for every census block group. The attributes incorporated into the assessment will include: (1) exposures and losses related to natural and technological hazards; (2) health and social connections to the surrounding environments; and (3) disparities within the larger community that influence access and isolation. These data will provide valuable information to help identify community assets and vulnerabilities, they will help identify areas of concern and develop strategies for engaging the community and targeting pressing issues.

Identification of assets and exposures/liabilities influencing vulnerability to both natural and technological hazards will encompass 11 natural hazard types (hurricanes, tornados, coastal flood, inland flood, landslides, earthquakes, fire, drought, wind, hail, and temperature extremes (high and low), 3 loss categories (natural, developed, and dual-benefit lands), and 4 technological hazard types (nuclear, Superfund, TRI, and RCRA sites). Special attention will be paid to the interaction of natural and technological hazards, i.e. flood water carrying contamination from contaminated sites. Social attributes and well-being will be connected to surroundings, both natural and built. Measures of access will be estimated through a combination of ethnic/racial segregation indices and an Index of Relative Rurality (IRR).

We will first develop and test the data in multiple communities including high regional priority areas, Proctor Creek in Region 4 and Sun Valley in Region 8. We will interact with the Regions and communities to ensure the data are useful. Once the method is fully developed and vetted, metrics will be calculated for the entire US and published in EnviroAtlas. We will leverage and coordinate/collaborate with completed and ongoing SHC indicator work (e.g., EQI, HWBI, DISC) as appropriate.

Product Type: Scientific Data\dataset
Product Form: The final product will be a suite of EnviroAtlas data layers, to include web services, downloadable data, metadata, fact sheets, and inclusion in the EnviroAtlas Interactive Map. Intermediate products will include suites of data layers for Proctor Creek and Sun Valley. Methods, pilot studies, and use cases will be published in peer-reviewed manuscripts.

Interdependencies: Builds upon existing work in RA 9.3 (Sun Valley, CO project), RA 10.4 (Potential Impacts from changing conditions). Also relates to the Environmental Quality Index (EQI) – development of census tract, community, rural, Tribal and examine cumulative health impacts for vulnerable groups.

Partners: OEJ, OCR, Region 4. Additional external partners: Emory University

Start Date: 09/2019   Delivery Date: 08/2021

Product 10.1.3: Building an Approach and Tool to Estimate Human Health-Related Outcomes from Community Built and Natural Features.

Brief Description and Research Use: We will deliver Version 2 of the National Public Health Assessment Module (N-PHAM) tool. We will: 1) add additional health outcomes (e.g., diabetes, cardiovascular disease, hypertension), 2) improve the statistical models, 3) complete the plugin widget for EnviroAtlas and other applications, 4) evaluate the use of the tool for Brownfields and other community revitalization work, and 5) conduct testing and validation in additional communities and use these efforts to develop guidance and use cases (e.g., Honolulu, HI; San Joaquin Council of Gov'ts, CA; Houston, TX). The already-completed Version 1 of N-PHAM generates population estimates for obesity, moderate mental health and poor general health at the census block group level.

We will use assembled data on the built, natural, and social environment from N-PHAM, Version 1 and health outcomes from the California Household Travel Survey and the California Health Interview Survey. We will statistically model relationships between health outcomes and environmental features across a range of age and income groups, controlling for socio-demographic factors. These data and the derived relationship algorithms will then be compiled into a tool allowing the user to estimate health outcomes associated with multiple development scenarios. While the health outcomes are derived from California-specific surveys, the derived relationships have been tested successfully in Wisconsin and New York for NPHAM Version 1 and will continue to be tested and validated for Version 2.

This product can be used by OLEM, OCR, OEJ, Regions and communities to estimate health outcomes at the census block-group level from changes to community built and natural features. This tool can empower communities to choose investments that affect health, quality of life, health care costs, and environmental justice related disparities. It can help communities improve resilience and increase their infrastructure assets while reducing their vulnerabilities.

Product Type: Software/Software Application

Product Form: N-PHAM Version 2 software application with plugin widget for EnviroAtlas, communicated in periodic newsletters, presentations, and trainings.

Interdependencies: A product has been proposed in RA10 Output 3 (10.3.1) to study the effectiveness of plugging into community processes as opposed to delivering new stand-alone tools. Eco-health research developed in RA 10.2 will contribute modeled relationships between urban greenery and physical-activity related health outcomes and indicators.

Partners: OCR, OBLR, OAR, Regions

Start Date: Q1/FY2020   Delivery Date: Q4/FY2022

Product 10.1.4: Enhanced EnviroAtlas Functionality and New Tools for Asset and Vulnerability Mapping

Brief Description and Research Use: In the context of partner-requested needs, we will add functionality to EnviroAtlas to expand its capability to a broader array of decision contexts. There are 5 areas targeted for improvement, all of which respond to partner requests and will enhance the ability to map community assets and vulnerabilities. The technology has only recently become available to allow these improvements. The proposed functionality will be represented in milestones and includes:

- Open source scripts and GIS toolboxes of the processes we develop and use to produce the community extent metrics for EnviroAtlas.
- EnviroAtlas code to facilitate serving national extent and featuring community extent grid-cell based data layers allowing users to calculate metrics for their own areas and geographical units of interest.
- EnviroAtlas code to allow EnviroAtlas users to create decision-relevant indices by statistically combining multiple EnviroAtlas data layers into a single number.
- Code update to the dasymetric population mapping tool to calculate residential population density estimates for every 30-meter square pixel in the U.S.
- Added functionality to allow incorporation of projections (e.g., land use, population) and scenarios.
- Other

We will engage with OLEM, OCR, OTAQ, OEJ, and the Regions to implement these new capabilities. We will share access to our behind-the-firewall development server with our partners so they can be involved throughout the development process. The engagement will focus on both the functionality and the user-experience.

These new capabilities will be useful to Program Offices and Regions and the wider EnviroAtlas user community. All code is made available on GitHub making it available to other developers inside and outside of the Agency. Detailed help guides, use cases, videos, and walkthroughs will be developed as necessary to accompany the new functionality. All new functionality will be communicated in newsletters and in presentations.

Product Type: Software/Software Application

Product Form: A full suite of functionality and tools published in EnviroAtlas including documentation and use cases. Will be communicated in periodic newsletters, presentations, and trainings.

Partners : OCR, OLEM, OW, OTAQ, Regions

Start Date: 10/2019   Delivery Date: 09/2022

Milestone 1: **Open source scripts and GIS toolboxes of the processes we develop and use to produce the community extent metrics for EnviroAtlas.**

This product will allow users to more readily create and/or modify data layers for themselves. Region 3 would like to partner in this effort. An example of a use would be a community (e.g., Chesapeake Bay Watershed) who already has developed high resolution land cover data and who wants to calculate EnviroAtlas community metrics for themselves. With this enhanced functionality, the community could calculate the metrics for themselves and could calculate them for whatever geography they wished (e.g., city blocks or neighborhoods instead of Census block groups). This functionality relates to Product 10.1.6, developing new processes to build community data more efficiently. EnviroAtlas already shares their code openly but it requires advanced GIS skills and is challenging for others to use without support. This enhancement will make it easier for the code /toolboxes to be used by others independently of the EnviroAtlas Team. Delivery by end of 2nd quarter FY 2021.

Milestone 2: **EnviroAtlas code to facilitate serving national extent and featured community extent grid-cell based data layers which will allow users to calculate metrics for their own geographies of interest.**

This product will allow users to summarize and visualize EnviroAtlas data for their own geographies (e.g., contaminated sites, congressional districts, National Environmental Policy Act (NEPA) sites, small drainage basins) rather than being limited to current EnviroAtlas geographies (e.g., census block groups, 12-digit HUCs).An example of this would be allowing a user to select a contaminated site, create a buffer around that site, and calculate a suite of metrics. This work is a continuation of work started in FY 19. This functionality has been requested since EnviroAtlas first went public, but the technology has only recently evolved to facilitate it. It also requires that we operate in the cloud which is finally becoming a reality. Region 3 is interested in partnering in this new methodology and has an existing use for it. This functionality would make EnviroAtlas more useful in the NEPA process and for other specific site assessments. Delivery by end of 4th quarter FY 2021.

Milestone 3: **EnviroAtlas code to allow EnviroAtlas users to create decision-relevant indices by statistically combining multiple EnviroAtlas data layers into a single number.**

I number of geospatial indicators can be overwhelming and it can be challenging for users to mentally combine multiple maps to understand how to proceed for a given decision context. This enhancement will proceed with the development of a list of decision-relevant contexts with our Program Office and Regional stakeholders. An example of this could be combining multiple data layers into one single layer to show areas to avoid for a particular use (e.g., debris landfill, development). We will use a robust statistical approach to combine multiple metrics into a single index, the approach will apply an objective, data-driven, weighting scheme. This work is a continuation of work started in FY19. This technology will be developed for featured community extent and national extent data. Delivery by end of 4th quarter FY 2022.

Milestone 4: **Code update to the dasymetric population mapping tool to calculate residential population density estimates for every 30-meter square pixel in the U.S.**

The dasymetric population mapping tool allows user to disaggregate census block population and map it to a 30-meter square pixel, so that we have an estimation of residential population for every 30 square meters on the ground. These data are useful for emergency response, for estimating populating living near roads, airports, ports, railroads, and contaminated facilities, and for other decision contexts.

This tool has been very popular and has been used widely in the US and in other nations (e.g., Nepal, Italy). In addition to the tool, we will refine our methods for identifying uninhabited areas to improve our density estimates. Once developed, we will use the new tool to provide new dasymetric population data for the nation including Alaska and Hawaii and will use these data for products delivered to OTAQ. This work is a continuation of work started in FY19. The tool will be downloadable as a plugin for commercial GIS software (ESRI ArcMap PRO) and code for open source GIS software to reach a wider audience. The data resulting from this functionality will be used by OCR, OEJ, and the Regions as well as OTAQ. Delivery by end of 4th quarter FY 2020.

Milestone 5: Added functionality to allow incorporation of projections (e.g., land use, population) and scenarios.
Adding functionality to allow for new sources of projection data (e.g., land use, population) and when applicable visualizing and measuring projected change and outcomes over time. Understanding what may happen in the future helps communities understand their vulnerabilities. Part of this will also involve developing code to allow users to evaluate scenarios, a functionality which has been requested frequently. Part of this work is tied to the NPHAM tool, Product 10.1.3. Delivery by end of 4th quarter FY 2022.

Milestone 6: Other functionality as identified, placeholder for high priority Regional/Program Office Needs
This last milestone serves as a placeholder for any unidentified high priority EPA needs for EnviroAtlas functionality that may arise during this strategic research period. This work could supersede one of the other milestones if agreed to upon by the Program Offices/Regions/ORD

Product 10.1.5: New EnviroAtlas National Geospatial Data Layers for Mapping Assets and Vulnerabilities

Brief Description and Research Use: We will produce at least 15 new national data layers for EnviroAtlas. We will work with our EPA partners to identify, prioritize, research, and develop these data layers. The process for development of each data layer follows a sequence of steps including needs assessment, researching existing source data, methods development, internal review, iterative versioning, peer review, data documentation (metadata and fact sheets), and finally data publication in EnviroAtlas.

EnviroAtlas already contains hundreds of geospatial data layers that can be viewed in the Interactive Map, downloaded or used as web services. These data layers are being used in many different decision contexts and in research efforts. New geospatial products and technology are rapidly evolving (e.g., Sentinel 2 which provides 10-meter imagery globally every 5 days, Google Earth Engine, WorldView, cloud computing, artificial intelligence and machine learning, human mobility data). These new products and technology create opportunities to develop new data products for EnviroAtlas that have been requested by one or more Program Office or Region.

We will engage with OLEM, OCR, OTAQ, OEJ, OW, OAR, and the Regions to develop these new data layers as appropriate. We will share access to our behind-the-firewall development server with our partners so they can be involved throughout the development process. The suites of data layers will be represented in milestones and include:

- Abandoned mines and mine attributes
- Population living in X proximity to contaminated sites, busy roads, walkable roads, railroads, railyards, airports, ports, etc.
- Erosion-related metrics (30 m product), including soil retained on the landscape due to current land cover/land management practices.
- Concentrated animal feeding operations (CAFO's)
- 10-meter flow direction/flow accumulation grids and river/stream confluences for the nation.
- Outdoor recreational resources
- Social Vulnerability Index.
- Other.

Product Type: Scientific Data\dataset

Product Form: Geospatial data layers for EnviroAtlas including downloadable data and web services, metadata, fact sheets, Peer-reviewed publications, Use cases, code in Github repository. Will be communicated in periodic newsletters, presentations, and trainings.

Partners: OCR, OLEM, OTAQ, OW, Regions

Start Date: 10/2019   Delivery Date: 09/2022

Milestone 1: Abandoned mines and mine attributes
Abandoned mine data have been requested by multiple EPA Regions including Region 9 and Region 3 and are of interest to multiple Tribes. These data would also likely be of interest to OW, OLEM, and OEJ. We will use existing sources of data and will work with stakeholders to determine which mine attributes are of the most interest.

Milestone 2: Population living in X proximity to contaminated sites, busy roads, walkable roads, railroads, railyards, airports, ports, etc.
Population living in X proximity to contaminated sites, busy roads, walkable roads, railroads, railyards, airports, ports, etc. We will use our dasymetric population data to estimate numbers of people living in X buffer distance to contaminated sites, busy roads, walkable roads, railroads, railyards, airports, ports, etc. These data have implications for exposure to various contaminant sources, emergency response, community revitalization, grant applications, environmental justice, etc. These data will be relevant to Regions, OTAQ, OEJ, OLEM, and other Program Offices.

Milestone 3: Erosion-related metrics (30 m product)
This erosion-related product will include as estimate of soil retained on the landscape due to current land cover/land management practices (i.e., ecosystem service). Erosion and the retention of soil on

the landscape is a critical factor relating to contaminant transport and food and water security. Once the method is fully developed, it could be applied to future projections. This work will be the continuation of work funded in FY 2019. We will investigate the use of Sentinel 2 imagery to calculate antecedent moisture and residue indices which are important inputs to erosion modeling. These data will be used for multiple flood-related products. We expect these data will be of interest to OLEM, OW, and EPA Regions and will be important for disaster preparedness and response.

Milestone 4: Concentrated animal feeding operations (CAFO's)
We will develop geospatial data layers related to CAFO's as well as an EnviroAtlas dashboard and featured collection for use by OW, OAR, OECA, Tribes, States and Regions (e.g., exposure assessment, emissions accounting, enforcement, contaminant modeling both from and to CAFO's). Over the last decade, ORD and OECA have explored remote sensing pattern recognition techniques to extract CAFOs from aerial imagery. Now for the first time, new GIS data, Sentinel satellite imagery and cloud GIS computing allow us to tackle this problem directly and comprehensively. In Phase 1, we would develop the methodology to identify swine and poultry CAFOs and in Phase 2, we would do the same for cattle feedlots and dairies. At no time will any PII about individual farms or farmers be collected. Any resulting data from this effort will be aggregated up prior to release, meeting EPA policies regarding releasing data related to farm locations. Despite being hotspots of nutrients, pathogens, pharmaceuticals, and heavy metals, there is no existing national map of aggregated CAFOs.

Milestone 5: 30 and 10-meter flow direction/flow accumulation grids and river/stream confluences for the nation.
We will publish web services of 30-meter flow direction and accumulation and river/stream confluences for the nation. Once nationwide NHDPlus High Resolution is available for the entire nation (now ~80-90% complete), we will use the same methods to update to a 10-meter version. These data will be of interest to OLEM, OW, and the Regions, they will be relevant to contaminant transport, flooding, erosion modeling, etc.

Milestone 6: Outdoor recreational resources
Identification of all lands used for outdoor recreation including Federal, state, and local lands and parks. These data will be used with RA 10, Output 1, Product 1 and will be important to OCR, OLEM, OEJ, and the Regions. Outdoor recreation can be a pathway to community revitalization and can provide important community benefits. This analysis will also highlight where outdoor recreation resources are lacking.

Milestone 7: Social Vulnerability Index.
OEJ and OW and Region 10 have expressed interest in including indicators and an index of social vulnerability in EnviroAtlas. Other products in SHC are generating vulnerability indices. While other parts of the SHC program are developing these indices, we will investigate adding CDC's Social Vulnerability Index (SOVI) to EnviroAtlas as an initial step to meet the immediate needs of the Program Offices.

Milestone 8: Placeholder for high priority Regional/Program Office Needs

This last milestone serves as a placeholder for any unidentified high priority EPA needs for geospatial data layers that may arise during this strategic research period. This work could supersede one of the other milestones if agreed to upon by the Program Offices/Regions/ORD.

Product 10.1.6: Developing novel, collaborative methods to create EnviroAtlas Featured Community Data

Brief Description and Research Use: This product will add high-resolution (one square meter) land cover data and derived metrics for additional communities to EnviroAtlas. We will use a new, collaborative approach to develop data for our featured communities and will focus our efforts on two communities only. We will work directly with EPA Region 4 and Region 8 (or other) and with community organizations and universities to refine our methods and develop the data. We will also work with partners and stakeholders to apply the data to specific, yet-to-be-determined decision contexts. The use of the data in decision contexts will be documented in use cases for each of the examples and will be published in EnviroAtlas.

Region 4 requested that Atlanta become an "EnviroAtlas community" and the Denver Council of Governments (DRCOG) requested that Denver be added to EnviroAtlas. For Atlanta, our partners/stakeholders will include Region 4, the Atlanta Regional Commission (ARC), River Keepers, University of Georgia, University of Northern Georgia, Georgia Tech, and others. For Denver, our partners/stakeholders will include Region 8, DRCOG, the University of Denver, and others. We will work with the above-mentioned stakeholders to produce the high-resolution Land Cover and metrics for each of the communities. Resulting from this process will be guidance and sharable scripts and toolboxes which can be shared with other communities through the EnviroAtlas web site. The collaborative process will be documented in a "lessons learned" internal report. The EnviroAtlas already contains high resolution and approximately 100 derived metrics for 30 communities encompassing over 1,200 municipalities (epa.gov/enviroatlas). These data layers are being used in many different decision contexts and in research efforts and are illustrative of community assets and vulnerabilities.

Product Type: Scientific Data\dataset

Product Form: Geospatial data layers for EnviroAtlas including downloadable data and web services, metadata, fact sheets, Peer-reviewed publications, Use cases, code in Github repository, report on collaborative process. Will be communicated in periodic newsletters, presentations, and trainings.

Partners: Region 3, Region 4, Region 8

Start Date: 10/2019   Delivery Date: 09/2022

Product 10.1.7: Decision Integration for Strong Communities (DISC)

Brief Description and Research Use: DISC is a suite of tools that can be readily enhanced and adapted to provide resilience guidance. DISC provides information covering a variety of topics including economy, ecology, housing, transportation, education and health using science-based indicators selected for their usefulness in answering the question, "What are the biggest opportunities to advance environmental sustainability, health and well-being in my community?". It also allows communities to evaluate how relationships between economic, social and natural environment features shift over time and with different policy interventions.

DISC is directed toward smaller communities that do not have resources to evaluate and assess their sustainability footprint. DISC provides a simple way for communities to assess the current status, evaluate the impacts of potential action and find resources to help. Region 10 continues to be actively engaged in the development of DISC and we intend to reach out to other regions and regional organizations once DISC becomes public.

DISC incorporates the HWBI and a small portion of the CRSI to create a new index. An enhanced DISC will include additional data from CRSI and be coordinated with PIs from HWBI and CRSI to ensure updates of those tools will be incorporated into DISC. Possible future enhancements include incorporation of information from other indices, supporting multiple data sets for comparisons over time, and providing finer grained data below the county level.

The current version of DISC is in beta testing phase where communities can test the tool and give feedback on value and usability. The final version of DISC will be made available for use by communities, and any feedback will be used for an improved application to increase the environmental, social and economic resilience of communities.

Product Type: Software application

Product Form: DISC is a downloadable software application that can be used either as a stand-alone application or using supporting web services to enhance aspects of the tool.

Interdependencies : DISC is linked to several product and research areas concerned with creating indicators and indices. Among these are the HWBI and the CRSI.

Partners: OCR, Region 10

Start Date: 10/2019   Delivery Date: 09/2022

Output 10.2: Characterize Select Interrelationships Between Environmental Stressors to Address Cumulative Impacts on Community Health

Output Description: SHC will collaborate with EPA partners to develop and use new and existing information, methods, approaches, and tools within a Total Environment framework[6] to address cumulative health impacts for vulnerable groups, such as children. This includes: 1) understanding the myriad chemical and non-chemical stressors found in the total environment (built, natural, social); 2) identifying linkages between built and natural environmental conditions, social determinants of health, and adverse impacts on health and well-being; 3) identifying environmental disparities to enable EPA, states, tribes, and communities to incorporate considerations of disproportionately-impacted groups into risk assessments and epidemiological investigations; and 4) developing and applying these methods and approaches for assessing cumulative health impacts by incorporating a health endpoint, measure or marker. Work in this output will inform and be informed by other outputs in RAs 9 and 10.

Output Format: Presentations and Technical Summaries/Technical Fact Sheet
Output Lead: Nicolle Tulve (CPHEA)

EPA Program/Regional or State/Tribal Partner(s): Listed within each product description

Partner Engagement Plan: Partners will be kept abreast of current activities through the RACT, as well as through other existing workgroups, as appropriate. Presentations will also be given through the SHC webinar series to provide updates and opportunities for feedback.

Interdependencies: SHC RA9 and other outputs in RA10.

Start Date: 10/2019   Delivery Date: 09/2022

Product 10.2.1: The Role of Environmental and Public Health Factors in Children's Long-term Health and Social Development

Brief Description and Research Use: Three papers will explain observed variability in the publicly available Opportunity Atlas between census-tract-level estimates of children's earnings distributions, incarceration rates, and other outcomes such as teenage birth rates by race, gender and parental income for the entire United States. Previous studies established that the neighborhood where a child grows up can have substantial effects on their upward income mobility. These estimates allow researchers to trace the roots of mobility outcomes back to the childhood neighborhoods. However, only half of the tract-level variance in children's outcomes was explained by neighborhood disadvantage characteristics. Research is needed to understand the relationship between a child's total environment (environmental, social, and building) and long-lasting health and social impacts. We hypothesize that environmental factors can explain some of remaining variability in the values from the Opportunity Atlas. These factors include air pollution exposures (e.g., industrial sources, traffic), water quality, exposure to contaminated sites, and ecosystems goods and services (e.g., green space). Specific contaminants will also be considered such as lead.

---

[6] Tulve, N.S., et al. Development of a Conceptual Framework Depicting a Child's Total (Built, Natural, Social) Environment in Order to Optimize Health and Well-Being. (2016) J Environ Health Sci 2(2): 1-8.

Descriptions and quantifications of the relationships between environmental factors from this product could be used to add environmental data to future builds of the Opportunity Atlas, potentially be incorporated into tools such as EJScreen, or included as data layers in other mapping or indicator-based tools. In addition, these analyses could be used to inform long-term interventions in specific communities by helping target the most impactful environmental factors. For example, some cities have offered housing vouchers to move families to neighborhoods where their child's social mobility may improve, but the effectiveness of such strategies may be limited if the comparative evaluation of neighborhoods fails to account for relevant environmental factors.
Product Form: This product will be a series of publications.

Key Words: Children's health, environmental exposures, public health, well-being

Interdependencies: This product will use the census-tract level EQI as a potential determinant.

Partners: Region 10; OEJ

Start Date: 10/2019   Delivery Date: 09/2022

Product 10.2.2: Translating the Wealth of Publicly Available Children's Environmental Health Information

Brief Description and Research Use: This product will provide the scientific content for the children's health and healthy homes app. Children are exposed to both chemical and non-chemical stressors at each lifestage throughout their lifecourse. There is a wealth of publicly available information about children's environmental health (e.g., toolkits, apps, publications) that has been generated by ORD, EPA grantees, and other stakeholders and targeted to address needs of parents/caregivers/medical providers/others. In 2017, the regional pediatric environmental health specialty units (PEHSUs) held children's environmental health training sessions and focus group meetings in five local communities where environmental issues that affect children's health were discussed. Based on feedback from these meetings, the need was identified for efficient access and application of this wealth of information by stakeholders to support resilient and healthy environments for children. The goal is to provide home health care workers, parents, and community decision makers a scientifically-based tool to enable assessment, prevention, and intervention to address chemical and non-chemical stressors in children's environments. Curation and synthesis of these resources will enable translation of EPA research in children's environmental health for use by a wide range of stakeholders in the Regions and States. The app will be designed, developed, and tested in conjunction with the awarding of a R3 Regional Applied Research Effort (RARE) project.

Product Form: Scientific data/Database

Partners : Region 3, OCHP, OEJ, Additional external partners: Pediatric Environmental Health Specialty Units

Start Date: 10/2020   Delivery Date: 09/2022

Product 10.2.3: Selected Chemical and Non-Chemical Stressors Measured in Licensed Child Care Centers in Portland Area Indian Country

Brief Description and Research Use: This product will report selected environmental concentrations and non-chemical stressor information for tribal child care centers located in the Pacific Northwest. These results will be compared with the results from the nationally representative child care center study. Children's environmental health issues are present in school and daycare facilities on Tribal lands, and present an ever-increasing set of complex challenges to be addressed. Childhood is a sequence of lifestages where physiology, anatomy, and behavior characterize identifiable periods of development in successive stages for each individual. Children's physiological characteristics may influence their exposures to chemical agents found in their everyday environment either by affecting their rate of contact with various media or altering the exposure-uptake relationship. Children's behaviors and the ways they interact with their environment may also influence their exposures to chemical agents. As a result, children may be more vulnerable to chemical agents than adults due to these differences in behavior and biology. Young children's exposures to lead, allergens, pesticides, PCBs, other chemicals and biological agents may result in adverse health effects and decreases in well-being. Similarly, exposure to non-chemical stressors (e.g., play area, healthy foods) may exacerbate adverse health effects and changes in well-being when considered in combination with chemical stressors. Evaluating the types of non-chemical stressors found in child care centers will help determine how the interrelationships between chemical and non-chemical stressors impact overall environmental health. In collaboration with the Indian Health Service and Region 10, ORD will collect, analyze, and report chemical concentrations and non-chemical stressor information to evaluate environmental hazards in tribal child care centers relative to nationally representative data.

Product Form: Scientific Data/Database, report, fact sheet(s), publication(s))

Partners : Region 10

Start Date: 10/2016   Delivery Date: 09/2021

Product 10.2.4: Evaluating Non-Chemical Stressors for Children's Environmental Health Protection

Brief Description and Research Use: This product will be a workshop report. Children are exposed to both chemical and non-chemical stressors at each lifestage throughout their lifecourse. Exposure to some chemical stressors (e.g., pesticides, metals, perfluorinated compounds) is routinely measured and assessed. Research on non-chemical stressors (e.g., poverty, violence, food insecurity, lack of access to greenways and recreational facilities, inadequate health care) is less routine in the context for

potential combined effects with chemical stressors. Research on the interrelationships between chemical and non-chemical stressors and how these interactions affect health and well-being is still in its infancy. However, animal research has shown that non-chemical stressors do affect the biological response to chemical agents and there is every indication that this premise would be applicable for humans. To better understand the plethora of non-chemical stressors, ORD needs to develop an approach to study non-chemical stressors within a chemical stressor paradigm. Research is needed to identify which non-chemical stressors are likely to be most relevant, how these non-chemical stressors vary throughout the life course, and how non-chemical stressors interact with chemical stressors and with other non-chemical stressors. In this product, we will work with PO/RO partners to conduct a problem formulation workshop to identify and prioritize relevant non-chemical stressor information most strongly linked to chemical agents to develop and evaluate an approach for integrating this information within the total environment framework for more holistic decisions on community health relevant to children.

Product Form: Workshop report

Interdependencies : Identification and engagement of researchers in SHC RA9 and RA10 to participate in the planning and execution of the workshop.

Partners : Region 3

Start Date: 10/2020   Delivery Date: 09/2022

Product 10.2.5: Understanding environmental asthma triggers and ways to manage it in community settings through research, education and outreach

Brief Description and Research Use: This product will be information on tested methods for reducing asthma triggers. Asthma is the most common chronic disease of children in the U.S., costing $56 billion each year. Low-income, minority families have twice the asthma prevalence as others in the U.S. This product will result from two studies. The first is a collaboration with Columbia University, Mailman School of Public Health and a non-profit volunteer group which is providing asthma trigger interventions in low-income NY homes. The Columbia and EPA researchers are evaluating the interventions' effectiveness. The second study is a collaboration with Harvard Medical School. Our team is testing the use of high-efficiency particulate air (HEPA) filtration in inner-city schools in Boston to reduce asthma triggers. EPA is helping evaluate the effectiveness of this intervention. This research will be used by the Regions to educate families and schools on methods to reduce asthma triggers.

Product Type: Presentations and Technical Summaries/Technical Fact Sheet

Product Form: Information and educational outreach through both Columbia and Harvard Universities, which are working directly in these underserved communities, and in collaboration with the U.S. EPA's Regions and the Offices of Children's Health Protection and Environmental Justice.

Interdependencies : SHC RA9

Partners: Region 1, Region 2, Region 6, OCHP, OEJ.

Start Date: 10/2019   Delivery Date: 09/2022

Milestone 1: Relationship between mold levels in a low-income community in New York City and interventions to reduce wheezing/asthma prevalence. This study will scientifically evaluate interventions to improve these conditions. **Delivery Date: 09/2020.**

Milestone 2: The application of HEPA filtration in schools to reduce asthma symptoms. Our goal is to determine the efficacy of HEPA filtration and integrated pest management (IPM) to reduce school-specific pollutants, mold and pest allergens, and to quantify changes in disease morbidity. **Delivery Date: 09/2022.**

Product 10.2.6: Novel and improved biomarker-based health metrics to evaluate cumulative health impacts of contaminated sites and blighted communities

Brief Description and Research Use: This product will characterize biological mechanisms of detrimental health impacts of brownfields, urban blight, and contaminated sites, and produce methodological tools to enable small sample size surveys in disadvantaged communities, such as Sun Valley in Denver, CO. We will develop rapid, integrated composite biomarker-based metrics to measure the cumulative subclinical impacts of living in an overburdened community impacted by adverse environmental factors. This product will also support health impact assessments and inform health-centered policy interventions.

This product will also characterize chronic physiological dysregulation, accelerated biological aging, impaired functions of immune, cardiovascular, and metabolic systems, and overt obesity in relation to contaminated sites and various measures of urban deprivation. Health outcome measures will be based on more than 100 serological, salivary, and urine biomarkers of immune, neuroendocrine, cardiovascular, and metabolic systems, as well as physical fitness, microbiome composition, and DNA methylation data from ongoing and new studies. Exposure data will include contaminated sites, traffic, and landcover data. Sociodemographic and behavioral factors, as well as chronic infections that disproportionally affect disadvantaged individuals, will be accounted for in data analysis. Statistical models will be developed to group biomarkers in composite indices, and to quantify effects of exposure. This product will also characterize an association between chronic physiological dysregulation and increased susceptibility to acute environmental stressors in prospective settings using data from an ongoing study. Most important epidemiologic findings will be validated using targeted toxicological experiments to demonstrate cause-effect relationships with exposure.

Product Form: Webinar presentations/presentation

Product Type: Series of presentations on: preliminary results - 09/2020; methodological tool kit – 09/2021; summary of cause-effect relationships based on epidemiological and toxicological results - 05/2022; internal synthesis report – 04/2022; a series of peer-reviewed manuscripts – 09/2022

Interdependencies : Methodological tools from this product will support health assessments in SHC 9.3.3.4.

Partners: Region 2, Region 4, OLEM. Additional external partners: North Carolina Department of Environmental Quality

Start Date: 10/2019   Delivery Date: 09/2022

Product 10.2.7: Bioaccessibility model for organic compounds sorbed to ingested soils and house dusts.

Brief Description and Research Use: This product will produce empirically derived (in vitro) post-ingestion bioaccessibility (percent mobilization) models for organic compounds sorbed to ingested soil or house dust. Upon completion, the models are intended to reside in EPA's Exposure Toolbox (ExpoBox, a publicly available toolbox for assessing exposure). The models will be linked to EPA's Stochastic Human Exposure and Dose Simulation (SHEDS) and other models, as appropriate, and can be used to inform risk assessments as part of the decision process for remediation of contaminated sites. This research is relevant to understanding the relationship between chemical and non-chemical stressors and addresses disproportionate impacts when communities are exposed to sources of semivolatile organic compounds that are, or may become, sorbed to soil and/or house dust.

Background: Soils and house dusts are sorbents that function as sinks and sources for many regulated organic compounds. Since children consume relatively large amounts of soil and dust, ingestion constitutes an important pathway for children's exposure to sorbed chemicals. Understanding the extent to which these chemicals become bioaccessible is critical when estimating the dose resulting from ingestion of contaminated soils and dusts.

Currently, Agency risk assessments assume all ingested organics are 100% bioaccessible. Predictive models will reduce uncertainty in exposure/dose calculations and can assist in formulation of solutions that are more site specific.

Approach: We will use a standardized in vitro 3-compartment test system (simulated digestive tract) and characterized (total organic and black carbon) soils and house dusts. The soils and dusts will be supplied by the American Healthy Homes Study. Total organic and black carbon content will be characterized. We will use a suite of organic compounds with an expanded range of log K_{ow}'s. Bioaccessibility data will be modeled using SAS General Linear Models. Proof of concept of this approach was completed under the previous StRAP.

Product Form: Peer-reviewed journal publications

Interdependencies : Supports SHC RA 5, Output 5 (This research will incorporate selected PFAS forms) and CSS Output REMD 7 (Develop, evaluate and apply next-generation monitoring methods, alongside traditional monitoring methods, to identify critical sources and pathways of human and ecological exposures.)

Partners: OCHP

Start Date: 10/2019   Delivery Date: 09/2022

Product 10.2.8: Advancing Translation of Eco-Health Science through EnviroAtlas and the Eco-Health Relationship Browser

Brief Description and Research Use: This product will synthesize new and recent findings on the relationship of natural infrastructure access, composition, and design to health outcomes related to physical activity and engagement with nature. Everyday opportunities to participate in these behaviors have been found to protect against obesity, depression, and stress. These negative states are widespread, with disproportionate prevalence in vulnerable populations. They contribute significantly to additional adverse health and economic outcomes, decreasing individual and community resilience. This product will support community revitalization efforts by communicating the scientific evidence on how neighborhood natural infrastructure contributes to healthful lifestyles and mitigates key public-health issues.

Research will build on previously-replicated eco-health linkages and address geographically dispersed populations to strengthen weight of evidence and potential for generalizability. To support causal inference, experimental designs will be employed such as pre-and post-intervention analyses and longitudinal studies involving change in residential address. The team will analyze individual-level health data and sociodemographic covariates with ORD-derived landcover metrics such as green streets and window views, and proximity to parks and blue spaces.

The synthesis product will draw on published weight-of-evidence approaches. Eco-health evidence proposed as sufficiently reinforcing to support widespread neighborhood-level mapping and modeling will first undergo external peer review through the journal publication process. Evidence passing this scrutiny will be incorporated into the health plug-in module (10.1.3) and developed into EnviroAtlas map layers (10.1.5 / 10.1.6). Included in this synthesis product is an update to the Eco-Health Relationship Browser which will inform the consideration of non-chemical stressors under 10.2.6 and 10.2.10 and the interpretation of many EnviroAtlas maps.

Product Form: EPA synthesis report on the extent of generalizability of research results to additional community geographies and populations. Update to the Eco-Health Relationship Browser tool on EPA's public website.

Interdependencies: This product will contribute to 10.1.3, 10.1.5, 10.1.6, 10.2.6, 10.2.9, and 10.2.10. It will also use data from 10.2.9.

Partners: OCR; Region 3

Start Date: 10/2019   Delivery Date: 09/2022

Milestones:
12/2020: Manuscript submitted to journal on neighborhood natural environment and mental-health status
09/2021: Interim update to the Eco-Health Relationship Browser through 2018
12/2021: Manuscript submitted to journal on neighborhood natural environment and weight status
03/2022: Webinar for EPA client offices and regions on synthesis findings

Product 10.2.9: Environmental Quality Index (EQI) – development of census tract, community, rural, Tribal and examine cumulative health impacts for vulnerable groups

Brief Description and Research Use: This product will: 1) provide publicly available datasets and web maps for a census tract EQI, 2) develop a report outlining potential ways to include rurality and tribal measures within EJSCREEN, 3) develop a community/stakeholder engagement plan as a guide to developing future community level EQI's, and 4) develop a report outlining the associations between the EQI and the domain specific indices and health outcomes. This research will address two of the five focused research areas under Topic 3 of the SHC's StRAP 2019-2022: (3) address risks and impacts to vulnerable life stages and communities, including characterizing interactions between chemical and non-chemical stressors and (5) provide EPA, states, and communities with metrics to evaluate environmental conditions and environmental public health and well-being. This product encompasses the Total Environment Framework[7] in that the EQI examines the intersection of the natural, chemical, and social components of environment.

Product Form: Publicly available datasets and web maps for a census tract EQI; a report outlining potential ways to include rurality and tribal measures within EJSCREEN; a community/stakeholder engagement plan as a guide to develop future community level EQI's; a report outlining the associations between the EQI and domain specific indices and health outcomes.

Interdependencies : 10.1 Community Vulnerabilities Model – identifying and categorizing rurality is a component of this product; 10.2.8 Eco-Health Research to Support Vulnerable Populations and Cumulative Impact Assessment – EQI will inform work on eco-health relationships and the greenery measures will help inform future development of the EQI; 9.4.3 Health Impact Assessment (HIA) Applications to Brownfields Reuse and Redevelopment to Support Community Resiliency and Revitalization

---

[7] Tulve, N.S., et al. Development of a Conceptual Framework Depicting a Child's Total (Built, Natural, Social) Environment in Order to Optimize Health and Well-Being. (2016) J Environ Health Sci 2(2): 1-8.

<u>Partners</u> : OEJ. Additional external partners: ATSDR, North Carolina Department of Environmental Quality

<u>Start Date</u>: 10/2019   <u>Delivery Date</u>: 09/2022

<u>Milestones for Census tract EQI:</u> Creating the county level was our first step in trying to develop a way to account for multiple exposures across multiple media across the U.S. However, county may not provide enough granularity in geographic scale to account for within county environmental hazards and the associated health outcomes. We currently have a working prototype for the census tract EQI. However, we still have some constructs within the domains that we believe we can find a better measurement to represent that construct and ultimately that domain (e.g., water domain). Thus, further work is needed for the completion of a census tract EQI. Recently, I presented information to the EJSCREEN team about the EQI and received some interest in the census tract version. Developing the census tract version of the EQI will provide a nice groundwork we can use as we venture into developing community level EQIs.
<u>Milestone 1:</u> Beta version of EQI 10/2020
<u>Milestone 2:</u> Final Census tract EQI peer review, OSIM review, publicly available begin reviews 01/2021 end 9/2022

<u>Milestones for report outlining potential ways to include rurality and tribal measures within EJSCREEN:</u> Based on previous work with the county level EQI, we recognized early on that there were stark differences between urban and rural counties regarding overall environmental quality. This led us to incorporate Rural Urban Continuum Codes, developed by USDA, as part of our development of the EQI. We have used the EQI to explore how overall environmental quality (and domain specific indices) impact health outcomes such as preterm birth, infant mortality, overall mortality, asthma, and cancer incidence, among others. In doing this research, we noticed that the rural socio-economic measurements as part of the sociodemographic domain were not characterizing rural poverty as well as the measures characterize urban poverty. Also, rural environmental exposures are not as well characterized as urban exposures.

OEJ has indicated that rural and tribal communities who use EJ Screen seem to have similar problems we encountered in the county level EQI that representation of poverty and cumulative environment are not well represented. OEJ would like to partner with this research endeavor to incorporate within EJ Screen a measure of rurality.

This work will explore ways to better characterize environmental contamination and socioeconomic status in rural and Tribal communities. As part of this work, we especially want to further explore assessing and quantifying rural and tribal environmental quality. This aspect of the research may potentially inform and be applied toward EJSCREEN.
<u>Milestone 1:</u> Establish a working group with OEJ and the EJSCREEN team begin 10/2020
<u>Milestone 2:</u> Develop an internal white paper for EJSCREEN outlining potential ways to incorporate rurality and tribal areas 10/2021

<u>Milestones for developing a community/stakeholder engagement plan as a guide to developing future community level EQI's</u>

To address impacts/benefits of actions taken within a community for such events as brownfield restoration, superfund cleanups, hazardous waste disposal, and other similar actions as well as overall environmental effects from natural disasters, we propose to develop community level EQIs at different time points (e.g., before restoration/cleanup, during restoration and cleanup, and after restoration cleanup) to attempt to examine the impact of these actions over time on a community's overall environmental quality, and domain specific environmental quality (i.e., air, water, land, sociodemographic and built environments). The EQI was developed in such a way that overall environmental quality can be examined and domain specific quality can be examined. Within the EQI, Superfund sites, hazardous waste sites, brownfields, greenspace are captured in the Land domain. So not only can we examine changes in overall environmental quality over time, we can also see changes in the land domain specifically and how that may impact the other domains (e.g., sociodemographic domain).

We have had discussions with ATSDR about the possibility of developing community level. ATSDR indicated several communities they had in mind that would benefit directly. We will work with ATSDR to develop a community/stakeholder engagement plan as a guide to developing future community level EQI's in the communities identified.

Milestone 1: Based on ongoing discussions with ATSDR, collaboratively develop draft engagement plan 10/2020

Milestone 2: Final version of plan entered into clearance 10/2021

Milestone 3: If funding available, begin implementing engagement plan with communities identified 10/2022

Milestones for assessing impact of overall environmental quality and domain specific quality on human health

One of the main purposes of developing the EQI was to explore how multiple stressors, chemical and non-chemical impact human health. This work will explore the impacts of overall environmental quality (including non-chemical stressors) and domain specific (air, water, land, sociodemographic/economic and built environments) on health outcomes such as low birthweight, birth defects, cardiovascular disease, and others using the updated county Environmental Quality Index (EQI) for years 2006-2010. Further, this work will begin exploring the impacts of overall environmental quality on health outcomes at a finer scale (census tract, community level) once the finer scale versions of the EQI are developed.

Milestone 1: Peer reviewed journal publications utilizing the EQI in health outcome research begin 10/2020 end 01/2022.

Milestone 2: Draft report outlining the impact of overall environmental quality on health outcomes using full range and journal publications published (since first published EQI and health manuscript) 3/2022

Milestone 3: Final report into clearance 8/2022

Product 10.2.10: Cumulative health effects of exposure to contaminated sites and non-chemical stressors: causal interactions and biomarkers of effect

<u>Brief Description and Research Use:</u> This product will be a guide to understanding interactions of non-chemical and chemical stressors at sensitive life stages when determining community disease risk and making decisions on risk mitigation strategies. Responses to contaminated sites are influenced by modifiable lifestyle and psychosocial factors that can be negative or positive effectors of response. Health promoting factors like green space, healthy foods and exercise can reduce adverse health impacts. Chemical and non-chemical stressors associated with poor children's health can be identified in public databases, and products submitted to SHC RA 9 and 10 seek to understand relationships between non-chemical and chemical stressors. Integrated with epidemiological/clinical approaches, research to develop this product will provide causal evidence for effects of modifiable factors (psychosocial, dietary, and environmental quality factors at different life stages) on health risks near contaminated sites. Along with providing causal links, this product will elucidate novel translational serum, molecular, cellular and functional biomarkers for assessing allostatic load (a measure of total stress burden). In cells and animals exposed to chemicals (modeled on contaminated sites) and non-chemical stressors under controlled conditions, stress will be assessed by measuring stress hormones and central nervous system mediators and genomic signatures will be identified to support association data derived from clinical/epidemiological studies and aid in identification of vulnerable groups. Adverse health outcomes including allergic asthma, cardiovascular diseases, and metabolic diseases will be evaluated in coordination with clinical/epidemiological studies. The product of these translational studies will support decision making for social and environmental justice, identify community level risk factors, and inform mitigation strategies to improve community resiliency and health sustainability.

<u>Product Type:</u> Report/Manual

<u>Product Form</u>: Guidelines for considering chemical and nonchemical stressor interactions in community health strategies near contaminated sites; underlying peer-reviewed publications and presentations.

<u>Interdependencies </u>: Must be integrated/collaborative with epidemiological/clinical studies under SHC RAs 9 and 10.

<u>Partners </u>: OEJ; OLEM; OCHP; OITA

<u>Start Date</u>: 10/2019   <u>Delivery Date</u>: 09/2022

Output 10.3: Pathways to Revitalization and Resilience that Build Community Capacity

<u>Output Description:</u>
This Output will create actionable information and resources for implementing technical support programs and designing tools for community decision-making based on analysis of social factors, organizational factors, and knowledge-transfer techniques that influence success. Opportunities exist to better support communities in their use of decision tools and other scientific resources for resilience and revitalization planning and implementation. In some cases, a disconnect exists between available information and tools, how those tools are designed and deployed, and the capacity of communities to

use them. This output will bridge that disconnect. It will create knowledge, insights, and resources about the dimensions of community capacity, how capacity grows and changes in response to program and tool use, and what approaches EPA programs and tool designers can implement to maximize their value to communities for decision-making. This includes decisions in specific contexts, like planning for post-disaster clean-up activities. The output will also apply knowledge-transfer approaches (e.g., "train-the-trainer" style workshops leveraging existing partnerships, web-based materials) to build community capacity to use various SHC tools to make decisions to revitalize and become more resilient in the face of environmental stressors and disasters.

Product 1 in this Output will build a framework for tool developers and program practitioners to assess community capacity and organizational factors during the tool/program development and improvement processes. It will do this by conducting an in-depth, multi-year analysis of an EPA program/tool in current use. Milestones within the product will address specific partner-articulated needs within the broader topic, including (1) documenting the role of partnerships in environmental justice community decision-making, (2) overcoming barriers to effective use of tools and information in planning and decision making, and (3) creating resources for tool developers who are interested in "plug-in" functionality of their scientific information to existing, widely-used community decision-making software. Knowledge generated for partners will apply to working with communities nationwide in a broad set of decision-contexts.

Product 2 in this Output will develop a set of resources for partners in the Regions who have created networks of regional staff, academic allies, and communities to enhance the transfer and use of SHC decision tools. Lessons learned will also apply broadly to other regionally-based partnerships. Through ongoing activities with "SPIRAL" and similar Regional networks, improved educational and training materials will be created and distributed via a new website designed with Agile principles. Materials will be comprehensive for EnviroAtlas and DASEES Quick Use, two SHC tools identified as having high impact for community decision-making. An assessment of metrics for tool use and effectiveness will be produced in collaboration with Product 1 to inform ORD's ongoing tool evaluation and Regional evaluations of their own training and outreach programs.

Product 3 will develop resources for community decision-making around a specific high priority decision context- planning for waste disposal in post-disaster situations- with emphasis on social and organizational factors that affect planning success.

Output Format: Journal article- Peer-reviewed; Presentation and Technical Summaries- Presentation, Technical Fact Sheet; Report- Internal report, Manual, Methods, Report, Summary; Software/Software Application- Other
Output Lead: Emily Eishenhauer (CPHEA)

EPA Program/Regional or State/Tribal Partner(s): OLEM, OCR, OEJ, Region 2, Region 3, Region 4, Region 7, Region 9

Partner Engagement Plan: Partners will be updated regularly (every 4-6 months) on the Products supporting this Output via a Community Capacity virtual roundtable and direct feedback will be

requested during these updates. Communication also will occur as needed at critical Product decision points.

Interdependencies : Supports work in 10.5 (Guidance for Resilience), HSRP 19.02 (Waste Area), 9.3 (Evaluating the Contribution of Site Remediation and Restoration to Community Revitalization and Health Promotion), 9.4.1 (Applying EnviroAtlas to Brownfields assessments and redevelopment), 9.4.4- (Tools Awareness, Identification, Selection, and Use in Brownfields Cases), 10.1 (Data and Approaches for Identifying and Mapping Assets and Vulnerabilities).

Start Date: 10/2019   Delivery Date: 09/2022

Product 10.3.1 An Examination of EPA Tools through a Capacity Lens

Brief Description and Research Use:
This product is a report on a community capacity lens for tool development and resiliency planning processes. This product will aid EPA tool developers, staff in program office and regions, as well as state, local, and tribal partner organizations by providing a framework to assess and build community capacity for addressing complex environmental health issues.

For many EPA tools an underlying assumption is organizations and communities will use the tool effectively to bring about improvements in environmental and human health. However, not all organizations and communities are the same in terms of capacity. Factors such as organizational bandwidth, slack, expertise, and funding may influence the organization's capacity to effectively use an EPA tool. From a community perspective, capacity is "a community's potential for addressing presenting health issues," a definition developed by leading experts on community capacity at a 1998 Centers for Disease Control and Prevention symposium. Dimensions of community capacity are measurable constructs that include: participation and leadership, skills, resources, social and interorganizational networks, sense of community, understanding community history, community power, community values, and critical reflection.

In the context of a specific EPA tool (based on a set of criteria), we ask: 1) what is the underlying theory of change; 2) what internal and community-level capacity is necessary to effectively use of the tool; and 3) in what ways does the tool influence community-level capacity and increase resilience? Understanding these aspects of capacity will inform efficient and strategic use of resources and help answer questions like "this is a great tool, why aren't more people using it?" This product involves primary data collection through a mixed-methods design including interviews, focus groups, observations, and surveys. Analytical methods include qualitative thematic and quantitative statistical techniques.

Product Type: Report- Internal Report

Product Form: Report- Report, Internal report; Journal article- Peer-reviewed; Presentation and Technical Summaries- Presentation

- EPA report that shares a framework for assessing capacity to effectively use EPA tools from an intraorganizational and capacity perspective.
- Additional EPA reports that are interim progress indicators associated with other proposed products
- Community reports that share project summary findings geared toward community participants
- Peer reviewed manuscripts

Partners: OCR, OEJ

Start Date: 10/2019   Delivery Date: 09/2022

Product 10.3.2 Building Community Capacity in Revitalization and Resilience Planning through Partner Training

Brief Description and Research Use: Using Agile andHuman-Centered Design processes, we will develop materials to train Regional staff and their stakeholders to use ORD tools, including EnviroAtlas and DASEES. Training may consist of webinars and workshops, developing "train-the-trainer" style materials to increase Regional capacity to train others, and co-developing "how-to" use cases demonstrating real-world uses of these tools. We will gather feedback from stakeholders and tool users on the effectiveness of these trainings, to understand their tool needs, and to design targeted materials based on this feedback. We will also provide streamlined access to tools and training materials via a public website. These activities will culminate in a "Lessons Learned" summary report to be shared with current partners (e.g., Region 3's Sustainability Partners Incorporating Research into Academia and Localities, or SPIRAL program) and more broadly throughout the Regions to increase usage of ORD tools and understanding of successful dissemination and training techniques.

This will help ORD broadly disseminate their tools as well as measure their usage and value while helping Program Offices and Regions use the tools that have been developed. This product will take place through existing successful partnerships with Regional (e.g., R3 SPIRAL) and Program Office staff. Providing in-depth tool trainings will build community capacity for using these tools in revitalization, resilience planning, and contaminated site remediation and allow for collaborative development (community, Regional, and ORD) of real-world use cases and applications. Providing a public web page will give Regional staff and their stakeholders streamlined access to tools and accompanying materials.

Product Type: Report, Subtype: Summary

Product Form: Trainings (workshops, webinars), EPA external webpage, use cases/case studies, written tutorials and training materials, EPA report, technical presentations
- New, Drupal-based EPA external Web page where tools and tool resources for SPIRAL and similar efforts will be made broadly available
  - This Web page will include supplemental materials for EnviroAtlas and DASEES developed in Milestones 2 and 3, as well as an EPA-internal Web portal to be developed

for DASEES with improved technical and user guidance available as well as online video training material.

- EnviroAtlas training workshops and webinars, use cases/case studies, tutorial and training materials
- DASEES and SystemSketch training workshops and webinars, use cases/case studies, tutorial and training materials
- External EPA report on the effectiveness of ORD tool trainings and tool metrics, using SPIRAL as a case study

Interdependencies : 9.3 Evaluating the Contribution of Site Remediation and Restoration to Community Revitalization and Health Promotion; 9.4.1 - Applying EnviroAtlas to Brownfields assessments and redevelopment; 9.4.4- Tools Awareness, Identification, Selection, and Use in Brownfields Cases; 10.1 Data and Approaches for Identifying and Mapping Assets and Vulnerabilities; 10.3.1 Understanding factors within communities that affect use of decision tools; 10.6 Guidance for Effective Resiliency Actions

Partners: Region 3; Region 4

Start date: 10/1/2019 Delivery date: 09/2022

The work under this product falls under three milestones:
- Web-based resource to support the SPIRAL network in Region 3 and other external-facing tool training efforts, including assessment of the impacts of tool training in participant communities
- Training of Regional and community-based partners on using EnviroAtlas tools and resources for projects in their Region
- Training of Regional and community-based partners on using DASEES and associated tools like SystemSketch for projects in their Region

Milestone 1: Web-based resource with regular content updates to support the SPIRAL network in Region 3 and other external-facing tool training efforts, and an assessment of the effectiveness of user-engaged ORD tool training efforts through interviews and focus groups during in-person training workshops, through follow-up conversations with trainees, and through monitoring web analytics where possible.

Milestone 2: Training of Regional and community-based partners on using EnviroAtlas tools and resources for projects in their Region, includes co-developing "how-to" use cases, written training materials for specific user groups, workshops, informational webinars, and other resources as identified by Regional partners, e.g., through the SPIRAL network. We will work directly with Regional partners to identify what their greatest needs are for training their staff and community stakeholders and will iteratively develop materials based on feedback. Work is already underway for applying EnviroAtlas tools and resources to real-world scenarios in Region 3, including for NEPA, Brownfields redevelopment, and citywide/regional planning (Philadelphia Planning and Delaware Valley Regional Planning Commission).

Milestone 3: Training of Regional and community-based partners on using DASEES and associated tools like SystemSketch for projects in their Region. Training for DASEES will focus initially on Regional users only, e.g. CICs, possibly expanding to other Agency users. Training will be only for the ranking and prioritization tool, which is easy to learn, quick to use, and amenable to a wide variety of Regional and community concerns. In alignment with Agile and Human Centered Design principles, feedback from users will inform user guides and other training and communication materials for delivery to the web-portal developed in Milestone 1. Previously delivered and ongoing DASEES case studies, presentations, and fact sheets can also be added/co-developed for specific user groups, workshops, informational webinars, as identified by Regional partners, e.g., through the SPIRAL network.

Product 10.3.3: Social Acceptance of Disaster Waste and Debris

Brief Description and Research Use: This research seeks to understand the social, economic, political, and cultural factors that affect disaster waste acceptance. Natural and human-caused disasters produce tons of waste and debris that must be disposed of in a way that is cost effective, minimizes environmental and health risks, and supports resilience and sustainability. Disaster waste management involves: pre-incident planning, waste estimation, on-site treatment or decontamination, staging, transportation, and off-site disposal for multiple waste streams and contaminated materials. In recent incidents, unwillingness to accept waste negatively affected community recovery and resilience. This product uses a two-fold approach, analyzing a) disaster waste decision contexts; and b) factors that affect social acceptance of this waste. The first research phase is a comparative case study. We will do a comparative analysis of case studies of waste acceptance in recent incidents. Case studies will be identified alongside EPA Regional staff, e.g.: California wildfires, hurricanes in R2 and R4, tornadoes near NPL sites. We will analyze disaster decision contexts generally (e.g. sheltering), waste decisions specifically (e.g. staging), and characterize social acceptance issues (e.g. EJ). The product is a report synthesizing case study results. It will provide an initial understanding of the social factors shaping disaster waste acceptance. These factors will be analyzed further in the second phase (in the next StRAP cycle) which will involve a) research on social factors (e.g. risk perception, disaster-related trauma) in disaster-affected and waste disposal communities; b) testing applications of EPA resources (e.g. EJ Screen, EnviroAtlas, Incident Waste Assessment and Tonnage Estimator (I-WASTE)) to address waste acceptance in different decision contexts. OLEM and Regional staff can use this product to inform disaster planning, response, and recovery.

Product Type: Presentation and Technical Summaries- Technical Fact Sheet

Product Form:
- Technical brief on best practices and resources to address disaster waste acceptance
- Presentations on findings, e.g. to EPA Regional Disaster Recovery Coordinators, Federal Emergency Management Agency, National Emergency Management Association, US Army Corps of Engineers.
- Peer-reviewed journal article

Interdependencies : Case studies will include CBRN (chemical/biological/radiological/nuclear) and natural disasters, which will feed into distinct Homeland Security Research Program (HSRP) 19.02 (Waste Area) and SHC 10.5 research products. This research is separate from the social science of decontamination project.

Partners : Region 2, Region 9, OLEM

Start Date: 01/2020   Delivery Date: 09/2022

Output 10.4: Impacts from Environmental and Natural Disasters

Output Description: SHC will identify critical information and develop approaches to support communities in assessing their vulnerabilities to hazards, especially those related to extreme event-related unintended releases of toxic chemicals from Superfund, hazardous waste disposal, storage and treatment sites, and industrial sites and evaluating their preparedness. Approaches will include mapping, metrics, and methods developed for RA10 Output 1 (Appendix 1), along with other relevant research, to consider the changing conditions to the natural, built, and social environments, (including ecosystem services) that will affect resilience to natural hazards and community health and well-being. It will include recommendations for how to use and apply data and tools to estimate and manage impacts, given changes in land use, ecosystem services, climate conditions, and extreme weather events. Identifying expected impacts will require using forecasts of future changes in weather and climate that lead to chronic conditions and hazardous events. Additional research will examine how changes to stressors anticipated in the future, such as increased flooding, more intense and frequent wildfires, prolonged drought, and extreme heat, can lead to cascading shocks to communities through infrastructure failure, heat- and flood-related deaths, property and crop damage, and other outcomes.

Output Format: Presentation and technical summary
Output Lead: Thomas Johnson (CPHEA)

EPA Program/Regional or State/Tribal Partner(s): Listed within each product description

Partner Engagement Plan: Products have been directly aligned to stakeholder needs wherever possible. Interested partners have been identified in advance for each product. Regular communication and partner feedback on product development and implementation will be handled on a product-by-product basis, led by Product leads.

Start Date: 10/2019   Delivery Date: 09/2022

Product 10.4.1 Models and Simulations for Community Vulnerability and Climate Resiliency to Flood Impacts on Contaminated Sites in Partnership with Regions and States

Brief Description and Research Use:
We will produce model, simulations, datasets, technical publications and targeted tech transfer to Regions and States for increasing community resilience to flood impacts at contaminated sites. Contaminated soils from hazardous waste sites present challenges, especially when subjected to extreme weather that can move contaminants into nearby communities via surface and sub-surface flow. Communities have expressed the need to understand flood-induced contaminant transport, especially in the context of changing climate. This product will address these needs by developing (1) site-specific spatiotemporal hydrodynamic-fate and transport coupled model simulations with climate scenarios of flood induced contaminant releases in sediment, soil and surface water in regional partners' identified contaminated site(s) and communities, (2) screening level metrics to characterize NPL sites (e.g., contaminants, media, sediment erosion, etc.) and community vulnerabilities to flooding in Region 3 and (3) a sediment model within a physics-based hydrologic model at high spatial (30~100 m) and temporal resolution (hourly) to simulate the transport of sediments for the past and future 30 yrs for communities near Superfund National Priority List (NPL) sites. Simulation results will lead to a set of technical publications on flood-induced multimedia contaminant release and sediment transport; a tech transfer use case targeted for community and other potential partners' adoption; and GIS data layers for public access via EnviroAtlas. Product outcomes will be communicated through Region and State community involvement coordinators and will be used by (1) contaminated site managers to inform remedial planning, monitoring, cleanups and community engagement, (2) Region 3 to inform NPLs vulnerabilities to flood and hurricane preparedness and determine most vulnerable site/communities for further assessment, and (3) other regions and states via tech transfer to protect community assets.

Product Form: Maps (Primary), data layers, models, journal articles, tech transfer EnviroAtlas use case, and community communication reports

Interdependencies: Milestone 1 leverages with RESES Flood and Contaminant project and SHC RA10.1.5. Milestone 3 leverages with a Pathfinder Innovation Project (PIP) effort, supports the SHC RA10 Output 1 and essential to the SSWR Output 16.
Partners: Region 1, Region 2, Region 3, Region 6, Region 8, OLEM. Additional external partners: New Jersey Department of Environmental Protection

Start Date: 12/2019   Delivery Date: 09/2022

Milestone #1: *Contaminated Site Specific Flood-Induced Contaminant Fate-and-Transport*
   (1) RESES Project (12/FY2019-01/FY2021)
   (2) Case study on coastal community climate resiliency at R3 LDCA/John Heinz National Wildlife Refuge (10/FY2020-09/FY2022)
   (3) Community Communication Materials and EnviroAtlas Use Case (for tech transfer) (09/FY2022)
   (4) STICS-approved manuscripts (09/FY2021-09/FY2022)
Milestone #2: *Screening Level Metrics for Flood-Contaminants NPL Vulnerability Region 3*

(1) R3 Data Layers and Attribute Weighted Metrics (10/FY2020-09/2022)
(2) Tech Transfer (e.g., EnviroAtlas Use Case) (09/FY2022)
(3) STICS-approved manuscripts (09/FY2022)

Milestone #3: *Sediment Model within Physics-based Hydrologic Model to Simulate High Spatiotemporal Sediment Transport at NPL Sites for Past and Future 30-yr*
(1) Past 30-year model run (10/FY2020-09/FY2021)
(2) Future 30-year model run (10/FY2021-09/FY2022)

Product 10.4.2: Best practices for assessing community and contaminated site vulnerability to extreme events

Brief Description and Research Use: We will produce best practices and guidance for assessing community and contaminated site vulnerability to extreme events. The first milestone builds on case studies with Phoenix, AZ, and Waterbury, CT, that used an indicator-based approach to represent fate and transport processes to communicate the risks of exposure to contaminants from fires, floods, and extreme heat. Using these indicators, we will develop hazard maps of contaminant exposure pathways and potentially vulnerable populations/resources. The hazard maps support communities in their development of emergency preparedness plans and prioritization of facilities/sites for future investigation and action. We will also explore using an indicator-based approach to evaluate Brownfield revitalization options in light of changing future conditions. "Best Practices" documents will be produced to enable use by Brownfields Coordinators and communities other than the study sites. The second milestone focuses on assessing contaminated sites that pose a risk to communities to plan recovery prior to an event by building on a list of chemical and contaminated site attributes that depict site vulnerabilities and resiliency opportunities. Data on site characteristics and chemical contaminants will be used to determine potential human health and environmental impacts, fate and transport phenomena, and releases and exposures. Models of contaminant transport under changing conditions will be used to better understand how model inputs contribute to site vulnerabilities and resiliency. Threshold values indicative of extreme events will be determined based on site-specific characteristics and chemical contaminants. This information will be useful for prevention and site recovery after an extreme event, both to realize the effects and how attributes can be modified in the future. We will produce a fact sheet of attributes most relevant to assessing and responding to contaminated site vulnerabilities.

Product Form: Presentation and technical summary that covers indicators and accompanying vulnerability maps of potential hazards and exposures, guidance for developing maps and conducting hazard/disaster planning, and attributes most relevant to assessing and responding to contaminated site vulnerabilities.

Interdependencies: This product is relevant to SHC RA10.4.1, which addresses Region 3's need for a screening method to identify NPL sites vulnerable to floods and contaminant releases. It is also relevant to the product in SHC RA9.4 that creates an interactive EnviroAtlas map dashboard showing brownfield grantee information geographically in their spatial context to help city planners evaluate, document and revitalize brownfield sites.

<u>Partners:</u> OLEM, Region 4

<u>Start Date:</u> 10/2019   <u>Delivery Date:</u> 09/2022

Milestone 1: *Best practices for indicator-based approaches for assessing and reducing community vulnerability to changing conditions and extreme events*
Using human-centered design principles, we will compile critical information, specified by communities, for assessing current and future vulnerability to exposure from contaminants due to changing environmental conditions and extreme events. Clear, transparent, and credible indicator-based approaches will be piloted with communities to geographically depict the impacts of extreme events on waste facilities and contaminated sites at varying stages of identification, characterization, and regulatory control. Based on user-specified parameters, hazard maps will display exposure pathways and potentially vulnerable populations/resources. These maps will support communities in their development of emergency preparedness plans and prioritization of facilities and sites for future investigation and action. A program-specific application of this indicator-based approach will also be piloted for Brownfields and will include the capacity to evaluate revitalization options in light of changing future conditions. Guidance documents will be developed to accompany these indicator-based approaches, enabling broader use by Brownfields Coordinators and communities other than the study sites.
<u>Milestone Form:</u> prototype hazard maps, which may include a web-based component
<u>Start Date:</u> 10/2019   <u>Delivery Date:</u> 09/2021 (first component), 09/2022 (second component)

Milestone 2: *Identifying and Relating Attributes of Chemicals and Contaminated Sites to Extreme Event Vulnerabilities and Resiliency Opportunities*
Using chemistry and engineering knowledge this research examines data collected about site characteristics and chemical contaminants found at sites to determine potential human health and environmental impacts, fate and transport phenomena, and releases and exposures. Models will be used and/or developed to describe the movements of chemicals based on physicochemical properties, chemical environments, and potential changing conditions related to extreme events. Threshold values, indicative of extreme events (e.g., due to extended periods of high temperatures or prolonged flooding), will be determined based on these site-specific characteristics and chemical contaminants. Through the understanding of these models and how they describe vulnerabilities/resiliency, the research will back out the model inputs (i.e., chemical, environmental, and changing condition attributes) that contribute to vulnerabilities/resiliency. This information will be useful for prevention and perhaps preparing for potential extreme events. The recovery period after an extreme event will also be an opportune time to use this information, both to realize effects that are occuring and how attributes can be modified for the future.
<u>Milestone Form:</u> Peer-reviewed publication, EPA Fact Sheet
<u>Start Date:</u> 10/2019   <u>Delivery Date:</u> 09/2022

Product 10.4.3: Community health effects of hurricane-related flooding

Brief Description and Research Use: The Product of this research will be data sets, tools, and peer-reviewed publications that quantify a hurricane's medical impacts in communities, especially disadvantaged communities. Flooding from extreme weather events, including hurricanes, is anticipated to increasingly affect communities over the next several years. Flooding can result in both immediate and long-term impacts for the communities affected, including: housing instability, property damage, food insecurity, water contamination from nearby sites, mold growth, interruption of services, and economic insecurity. After flooding, communities may suffer from related health effects, including gastrointestinal illness and asthma. These impacts may be magnified in already disadvantaged communities, including rural communities, low-socioeconomic status communities, and racial minority communities. In addition, recovery from flooding can be slower in these communities compared to more advantaged communities. We will study communities located in eastern North Carolina, including low-income and American Indian communities, that suffered flood damage from Hurricanes Matthew (2016) and Florence (2018), as well as communities in Puerto Rico that suffered flood damage from Hurricane Maria (2018). Under this Product, we will produce tools such as visualization tools and a use case map of EnviroAtlas, as well as supporting datasets on mold growth after flooding and peer-reviewed journal articles. This Product will be used by the Regions to inform planning for medical response and steps to produce community resiliency.

Product Form: Primary: tools (visualization tools, EnviroAtlas use case map); secondary: dataset on mold growth after flooding, peer-reviewed journal articles

Partners: Region 1, Region 2, Region 4, Region 6, Office of Children's Health Protection. Additional external partners: : University of Puerto Rico, University of North Carolina, Environmental & Community Health Initiative in Robeson County, North Carolina

Start Date: 10/2019   Delivery Date: 09/2022

Milestone 1: *Asset and vulnerability mapping in areas affected by hurricane-related flooding*
We will map assets and vulnerabilities for health in flood-affected areas of Robeson County, NC, a rural, low-socioeconomic, majority-minority community that was affected by Hurricanes Matthew (2016) and Florence (2018). We will use EnviroAtlas and other data sources to create these interactive maps. Vulnerabilities include contaminated sites, concentrated animal feeding operations (CAFOs), and areas where large groups of vulnerable people (children, elderly) gather. Assets include health care facilities, grocery stores, and mental health facilities. We will also overlay sociodemographic information to indicate which areas may be particularly vulnerable.
Milestone form: Tool: Interactive map, a use case of EnviroAtlas that can be used by communities for emergency planning purposes; one or more peer-reviewed journal articles.
Delivery Date: 10/2021

Milestone 2: *Evaluation of the community health effects of flooding from recent hurricanes throughout central, NC*

Brief Description and Research Use: Using maps of flooding from hurricanes in 2016 (Matthew) and 2018 (Florence), developed in Milestone 1, we will evaluate community health effects, including gastrointestinal and respiratory illnesses, associated with such flooding and the features of communities which experienced greater health effects (hazard identification) or those that appear to experience lessened health effects (benefit). Consideration of nearby brownfield, Superfund, or other toxic sites will also be taken to evaluate the degree to which release of toxics from these sites affects community hazards and benefits as relates to flooding from extreme weather events. Health effects will be assessed in the short-term (days to weeks) after the event as well as long-term (months to years) as health effects may take time to appear and persist for extended periods. Using the health impacts from past floods we will evaluate community impacts based on current community characteristics and potential future characteristics, e.g. population growth, reduction of community hazards, increasing storm strength, in order to evaluate future community health impacts and community resilience under changing community and weather conditions.

Milestone Form: Visualization tool of hurricane impacted communities and associated benefits or hazards; one or more peer-reviewed publications

Delivery Date: 10/2021

Milestone 3: *Asthma and mold growth in Puerto Rican housing*

This Milestone will contribute to the overall Product by developing a quantitative set of data on the changes in mold growth and asthma exacerbations in the aftermath of Hurricane Maria. Working with colleagues in Puerto Rico, we will document the changes in mold populations in housing, for example in the Pinones area. Through the University Hospital's records, changes in asthma-hospitalization rates that occurred after Hurricane Maria will be documented. This Product will be used by Region 2 and other vulnerable Regions like 4 and 6 to inform hurricane-response planners about the level of increased medical needs to be expected. This Product should also help inform Building Code Developers to codify the use of housing and construction materials less prone to mold growth.

Milestone Form: Quantitative data on mold-growth and asthma after a hurricane and flooding. This data will be used to predict, and even prevent, the impacts of such disasters on the respiratory health of children.

Start Date: 10/2019   Delivery Date: 09/2022

Product 10.4.4: Vulnerability of Waste Infrastructure to Extreme Events

Brief Description and Research Use:
Extreme weather events create an immense challenge to the resilience of communities across the U.S. More frequent and intense weather events such as hurricanes, storm surges, and tornados may increase the frequency and extent of damage to waste infrastructure. Impacts to supporting infrastructure such as transportation routes, energy supplies, and water supply and treatment can also significantly affect waste facility operations. Potentially large amounts of debris and the release of

pollutants to the environment can have cascading effects such as the failure of additional facilities. Therefore, the impacts of changing climate on waste infrastructure is an immediate concern.

This product will refine methods to assist communities in assessing potential vulnerabilities with the waste infrastructure and the need for developing solid waste management plans incorporating resilience metrics. The method was initially demonstrated for Norfolk, VA. The method can be applied to any other coastal community to evaluate their vulnerabilities; however refinement is essential. The prior analysis found that there can be opportunities to be leveraged if intensity and frequency of precipitation events continue to increase for the region. Planners could utilize these opportunities to better design the system to be more resilient and responsive at cheaper costs, and in some cases resulting in better environmental outcomes.

This product will report how resilience metrics can be incorporated to the analysis framework to better evaluate and compare system resiliency. The method will expand on capturing interdependency across other critical infrastructure sectors. In parallel to this effort, we will ground truth the I-WASTE predictions on waste and debris from natural disasters. I-WASTE is an EPA tool in use for dealing with the aftermath of waste from natural disasters. We will utilize data from recent coastal events to calibrate I-WASTE's quantity predictions of waste and debris.

Product Form: Report (Extramural document)

Partners: OLEM

Start Date: 10/2019   Delivery Date: 09/2022

Milestones: 1) Decision makers guide for customizing solid waste management plans that reduce vulnerabilities and increase resilience to extreme weather events and natural disasters; 2) A report for stakeholders in TX or LA showing the results of the I-WASTE assessment and providing updated/improved guidance for waste aspects of resilience planning for those communities; 3) A report for ORD highlighting commonalities between these two study locations and making more general recommendations for incident waste management and resilience planning in communities across the USA at risk of extreme weather events; 4) updates as required and suggested by stakeholder feedback to the functionality and coverage of I-WASTE to better meet the resilience planning needs of communities and SMM professionals.

Output 10.5: Guidance for Effective Resiliency Actions

Output Description:
The goal of this output is to provide guidance for partners and stakeholders as they develop effective plans to increase communities' resilience. In partnership with the regional sustainability and response coordinators, relevant program offices, and other ORD resiliency programs, SHC will evaluate current approaches, practices, and information quality and flows for effectiveness, and create evidence-based guidance, tools, methods, or other support that communities can use to develop effective and

workable resilience and recovery plans. This will include metrics and methods to compare how human-built, social and natural features contribute to resilience, as well as how these features benefit human health and well-being, and how these relationships shift over time.

Output Format: Presentations and technical summaries
Output Lead: Mike Nye (CPHEA)

EPA Program/Regional or State/Tribal Partner(s): Partners are listed as appropriate for each product. Broad level partners are Region 6; OCR and OEJ. Additional external partners: States of Montana; Louisiana; Delaware; Rhode Island; New Jersey; and Massachusetts and communities and organizations within them.

Partner Engagement Plan: Regular check ins will be scheduled with partners as appropriate. Products have been directly aligned to stakeholder needs wherever possible.

Interdependencies: These are listed on a product by product basis.

Start Date: *10/2019*   Delivery Date: *09/2022*

Product 10.5.1: Protecting Coastal Communities and Contaminated Sites with Resilient Coastal Wetlands

Brief Description and Research Use: This product will develop guidance for coastal resilience and contaminated sites with a focus on coastal wetlands. States and their constituent coastal communities recognize that wetlands are a critical environmental component of resilience because of their ability to protect adjacent upland areas, including areas with potential vulnerabilities of contaminated sites, by mitigating the impacts of storms/ floods. The first component of this product is a collaboration with partners in Region 3 (DE, NJ) to integrate ORD's wetland vulnerability framework with partner decision tools, in order to facilitate linkage of vulnerability information to wetland management decisions (such as project siting for maximizing community protections and preventing impacts to contaminated sites) and implementation of resilience-based project designs to enhance ESS throughout the Delaware Bay region. The second component is a collaboration with stakeholders in Region 1 (RI, MA) to produce a management adaptation strategy for Northeast states that analyzes existing wetland adaptation efforts and identifies areas of success, opportunities for improvements, and methods to better integrate social-ecological system dynamics to maximize co-benefits of multiple ES through quantification of social outcomes from improved condition of restored wetlands and associated ES. The final product is a workshop with partners to integrate these approaches to resilience in the multiple locations. This includes examination of techniques for engaging stakeholders, dealing with issues of scale, assessing trade-offs, accounting for uncertainty, translating vulnerability information to match the decision context, etc. The aim is to increase transferability of methods among states and communities through shared production of lessons learned and develop a more consistent approach. The translational research framework will aid as a structure to compare-and-contrast different resilience strategies.

Product Form: Proceedings from a workshop(s) (co-produced by EPA and partners) on unified conceptual approaches and common principles for coastal community protection through resilient coastal wetlands

Interdependencies (as appropriate): This project informs—and is informed by—projects in A-E RA6 Output 6.4

Partners: Region 1, Region 3, OW's NEP and various associated external partners (e.g., Partnership for the Delaware Estuary, Narragansett Bay Estuary Program, US National Estuarine Research Reserve, RI Natural History Survey, RI Save the Bay), Additional external partners: Rhode Island Department of Health, Rhode Island Coastal Resource Management Council

Start Date: 10/2019   Delivery Date: 9/2022

Product 10.5.2: An Ecosystem Services and Ecological Integrity Decision Support System: Strengthening Resiliency in Coastal Watersheds

Brief Description and Research Use: This research will develop a coastal watershed resiliency decision support system (DSS) to strengthen the resiliency and sustainability of coastal communities. The DSS integrates measures of EGS and ecological integrity within a geospatial platform, allowing for spatially explicit analysis of individual ecological units and their associated EGS at multiple scales, combined with socio-demographic data important to vulnerability assessment. The DSS and the metrics within it are intended to promote a more integrated and structured assessment of coupled ecosystem service and human wellbeing improvements that could result from different desired end states, resilience goals, or stages of restoration and resilience planning. The DSS provides web-based and mobile applications developed for a range of users from technical users to the general public. The framework integrates six EGS or benefits and associated metrics (protection against extreme events/floods, water quantity/quality protection, habitat and air quality protection and open space conservation), considered important in informing decision-making to strengthen community resiliency and inform community revitalization goals. The DSS provides an evidence-based platform to help decision makers identify which community assets and vulnerabilities (contaminated sites within communities; vulnerable populations) are being protected or enhanced by existing EGSs in their watershed, and to assess the relative contribution of proposed EGS improvements or restoration options to improve social and ecological resilience. The easily understandable/ comparable metrics in the DSS will allow users to compare and assess the impact of different restoration options and to (re)assess progress at different stages of restoration. Translating ecosystem services to resilience, and ecosystem service improvements to strengthen resiliency fills an important capability gap for resilience planning professionals.

Product Form: Software/Software Applications. Specifically: A set of three interlinked Decision Support System applications: 1) an ArcMap GIS application with a set of toolboxes for technical users; 2) a publicly-accessible web-based mapping application for non-technical users-this web-based DSS has the same capabilities as the technical application, yet requires no specialized software or GIS skills; 3) a

'Story Map' application used for highlighting case study community application results of the DSS and for connecting with stakeholders using exploratory and interactive maps at various scales to translate science and inform decision-making. The Story Map is web-based and has mobile application capabilities. We will develop materials for workshops, resiliency roundtable discussions, tutorials, factsheets, decision-making strategy and scenario building matrices. We will communicate and interact with EnviroAtlas team about integration of this coastal community resiliency DSS product where appropriate and relevant.

Interdependencies: This Product has essential linkages to the meta-synthesis Product, *Practical Strategies for Ecosystem Services & Benefits Assessments in R2R2R Contexts* (RA9 O2, P5). It also has essential linkages to the following Outputs/products under RA 10: Community Driven Solutions: SHC RA 10-Output 3: *Pathways to Revitalization and Resilience that Build Community Capacity*; SHC RA 10.4 - Product: *Develop a Screening Tool to Assess and Map Community Vulnerabilities to Flood Impacts from Contaminated Sites*; SHC RA 10-Output 5 Product: *Integrated Methods for Resilient Coastal Wetlands*; SHC RA 10-Ouput 5.1 : *Protecting Coastal Communities with Resilient Coastal Wetlands.*

Partners: US EPA – Region 1, Region 2, Region 3, and Region 6 (possibly other regions with coastal states); OW. Additional external partners: Coastal states, coastal communities, environmental planners; Rhode Island Department of Environmental Management; Massachusetts Department of Conservation & Restoration; Mass Audubon; Narragansett Bay Estuary Program; Resilient Taunton Watershed Network (RTWN); The Nature Conservancy; Cape Cod Commission

Start Date: 10/2019   Delivery Date: 09/2022

Milestones:
- Acquiring, developing and aggregating EGS, socio-demographic and contaminant community data layers for communities within coastal watersheds of the Northeastern US. Q2 FY2021.
- Build geospatial decision support system (DSS) framework and DSS applications (see Product Form) with integrated EGS, socio-demographic and vulnerabilities data (contaminated sites within communities; vulnerable populations) for communities in coastal watersheds in the Northeastern US. Q4 FY2021.
- Expand Coastal Community Resiliency DSS framework to coastal communities at national scale. Q4 FY2022.

Product 10.5.3: Ecosystem service assessment as a tool for building community resilience to flood risk

Brief Description and Research Use: Community resiliency to storm events is a high priority goal for sustainability in historically vulnerable communities. We will work with existing state-federal partnerships in Louisiana on resiliency planning at the community level. We will use existing ORD tools and approaches including data collected as a part of recent RESES research in the city of Monroe, LA to develop a resiliency roadmap based on the sustainability of ecosystem services. We will take a

Structured Decision Making (SDM) approach with the SHC tool DASEES to gather data on community priorities and map those priorities onto available ecosystem services and important domains of human well-being. The Roadmap is a living guidance document based on connecting proposed community actions to their impact on human well-being as a resiliency endpoint. The roadmap will be based on existing ORD roadmap models and include visualization tools being developed within ORD as a method for communicating well-being connections to community stakeholders. This roadmap will be used for resiliency planning in select communities in Louisiana and outcomes will be used to develop resiliency guidance documents that will be transferable to other similar communities throughout the US. DASEES – an EPA tool designed to engage community stakeholders and decision-makers in SDM for careful and organized analysis of natural resource management decisions – will be used to link ecosystem services and community resilience to flooding in a structured manner (https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100DSGE.txt.). DASEES integrates community objectives and preferences with assessment methods and measures. The FEGS scoping tool – an EPA tool designed to characterize the complete list of beneficiaries for a given community and decision context. This tool will be used within DASEES to focus on beneficiary component of final ecosystem services.

Product Form: Report (Extramural)

Interdependencies: This product is connected to products in SHC 9.2, 9.3, and 10.5.1 and 10.5.2 (community resilience) for EGS comparison across sites and application and refinement of similar tools (Roadmaps). These connections will involve comparison of workshop results and information sharing on distinct final products. PI will attend all workshops hosted in 10.5 to allow for information sharing.

Partners: Region 6. Additional external partners: Louisiana Office of Community Development, Louisiana Governor's Office of Homeland Security; Acadiana Planning Commission.

Start Date: 10/2019   Delivery Date: 09/2021

Milestone 1: Workshop: Integrated resilience planning and management in Lafayette, LA*:* Resilience planning and management for the target community will be coordinated and facilitated with the SHC tool DASEES. Milestone Form: Workshop report discussing prescriptive resilience action analysis**.**
Start Date: 10/2019   Delivery Date: 09/2021

Milestone 2: Formal guidance for resilience planning and management in Lafayette, LA*:* Resilience planning and management outcomes from the DASEES workshop will be used to form a more formal set of guidance for increasing flooding resilience in the target community. This guidance will be in the form of a series of steps based on the decisional framework developed in SHC Coordinated Case Study Task. Milestone Form: Formal guidance document for flooding resilience in Lafayette, LA. Start Date: 10/2020. Delivery Date: 09/2021.

Milestone 3: Development of a flood resilience Roadmap for Lafayette, LA: We will develop a resilience road map (set of strategies and a framework for using them) for flood decision support, both for the target community and as a transferable deliverable around these existing practical strategies. This milestone is dependent on completion of Milestone 1 (workshop) and Milestone 2 (guidance). It is

also a part of a set of deliverables in RA9 and RA10 focused on the roadmap concept as a decision support approach. <u>Milestone Form:</u> Resilience roadmap document/visual for flooding resilience in Lafayette, LA. <u>Start Date:</u> 10/2020. <u>Delivery Date</u>: 09/2021

Product 10.5.4: ORD Contaminated Sites Problem Formulation and Translational Bridge Workshops

<u>Brief Description and Research Use:</u> This research will produce a series of workshop reports focused on better defining and translating the science of contaminated sites remediation and its intersection with resilience. OLEM is particularly interested in the relationship between site cleanup and the risks to people and the environment posed by extreme weather events and changing conditions. There is a need to better define the dimensions and priority issues for this complex, socio-ecological systems problem beyond the site level resilience assessment checklists currently in use within EPA and the more general resilience planning guidance used in communities. This area of research is spread across different ORD research programs and encompasses research from a wide variety of disciplines. In order to ensure that ORD's research in this area is well-coordinated and addresses the needs of partners, we propose a problem formulation workshop for internal EPA researchers and partners within the first 6 months, and a translational bridge workshop at the end of year 2 that will bring together researchers and partners within and external to EPA to plan for translation and transferability of research results.

The problem formulation workshop will:
- Develop an integrated mind map/conceptual map of the overarching problem and focus in on where research efforts can help inform solutions.
- Identify the connections between individual research projects/tasks to develop more integrated products.
- Foster collaborations across research areas.

The translational bridge workshop will:
- Convene ORD researchers, EPA regional and program office partners, state and local representatives and NGO's for feedback on product deliverables to ensure translation and transferability
- Identify additional opportunities for implementing and translating research to address stakeholder needs
- Begin synthesizing research results, identifying key gaps, and soliciting stakeholder input to inform the next round of StRAP planning.

<u>Product Form</u>: Proceedings (Workshop reports)

<u>Interdependencies</u>: Contaminated Sites and extreme events and Mapping/ ATLAS work elsewhere in SHC – in particular 10.1; 10.4; 10.5 and 9.2.

<u>Partners</u>: OLEM, Regions. The broader audience for this work is anyone who does research in this area (e.g., other federal agencies, academic institutions, NGOs).

<u>Start Date:</u> 08/2019   <u>Delivery Date</u>: 09/2022

Product 10.5.5: Analysis and Story Mapping of Community Plans and Projects for Resilience

Brief Description and Research Use: This product will mine novel grant and project databases (e.g. EPA, Rockefeller, Educational Partnerships for Innovation in Communities-Network (EPIC-N)) to help EPA staff identify a set of high priority resilience guidance needs as defined by the communities we serve, and to understand what has worked on the ground in terms of providing resilience solutions. Building on this analysis, this product will incorporate existing EnviroAtlas tools, data, and information in an interactive, visual resilience Story Map for use by regional and local-scale stakeholders. The Story Map will leverage the functionality of EnviroAtlas data, tools, and resources for use in different resilience planning contexts, while simultaneously highlighting diverse community resiliency themes and ongoing efforts across the U.S. Community examples profiled in the Story Map will be color-coded and tagged to reflect the suite of risks and challenges that inform their projects (e.g. drought, fire hazard reduction, air quality, flooding & water quality, etc.), helping users to quickly identify examples and data collections that are relevant to their needs, and further identifying data, tools, and resources that can help them address their individual needs. The Story Map can be updated to reflect ongoing feedback on active projects, regional needs, and challenges in communities through the support of existing partnerships and programs.

Product Form: Report (EPA Report); Scientific Data (Atlas Story Map).

Interdependencies: Part 1 will rely on a partnership with EPIC-N to gain access to a database of EPIC projects relevant to resilience. While an MOU may be developed, it is not necessary to initiate the work, as the relationship with EPIC-N is already in place. The team will meet regularly with the product team from 10.3.1 to ensure that the two efforts are not duplicative and to promote cross-pollination of ideas.

Partners: Region 9

Start Date: 10/2019   Delivery Date: 09/2022

Product 10.5.6. Resilient Community Planning Module on contaminated sites, waste and vulnerable populations

Brief Description and Research Use: The product will be a Resilient Community planning tool to assist communities in planning for and dealing with the impacts of contaminated or hazardous sites and waste in the aftermath of a natural or man-made disaster in a way that explicitly considers the impacts on and needs of vulnerable populations. Hazardous sites are often located in or near vulnerable communities, and disasters or extreme events create additional risks for these communities such as the spread of contaminants due to flooding or release of hazardous substances in the aftermath of a storm. The product will include the development of a social vulnerability/environmental justice module

as a milestone and will draw on the results from SHC product 10.4.2 and the combination of the EPA's Multisector Evaluation Tool for identifying Resilience Opportunities and Community Environmental Resilience Indicators, called METRO-CERI, a joint project with HSRP. The product will allow EPA program and regional office staff and community level users including site managers, planners and community-based organizations to assess the risks to vulnerable populations and provide communities with suggested actions for addressing vulnerabilities and adapting to projected risks. It will be tested in a case study with a community to be identified in conjunction with OLEM and Regional office partners.

Product Form: Report (Manual)

Interdependencies: Will draw on results from SHC 10.5.2 and HSRP HS19-03.07-0700. The contaminated sites problem formulation workshop (10.5.4) will provide an early opportunity to focus this product.

Partners: Office of Water; Office of Community Revitalization, Office of Environmental Justice, Region 2, Region 10

Start Date: 10/2019   Delivery Date: 09/2022

Milestone: Vulnerability module
This milestone will develop a social vulnerability assessment method and resources to address the concerns of EJ communities in planning for and recovering from disasters. The method will be designed for use independently by community level users or as part of common resilience planning processes such as Hazard Mitigation Planning which currently lack good methods of assessing the needs of the most vulnerable populations. We will work with other federal agencies including CDC and NOAA which have existing vulnerability and resilience tools and are interested in integrating EJ concerns. We will also work with PO and Regional partners to ensure that it serves their needs well and will develop a best practices and resource manual for users.

Product 10.5.7: Modeling Urban Dynamics in a Global Change Context to Improve Community Resilience

Brief Description and Research Use: This project will integrate new and existing projections of social and environmental change (i.e., land use, population, climate) into OCR technical assistance programs. OCR needs scenario tools and datasets that help the communities that they collaborate with make more informed decisions about land use and development policies. OCR's Regional Resilience Toolkit[8] will serve as a framework for integrating climate, land use, and demographic projections into regional planning decisions made in collaboration with multiple jurisdictions, communities and stakeholders. Specific pilot study areas will be identified by the project team. The Integrated Climate and Land Use Scenarios (ICLUS)[9] project produces population, land use, and impervious surface projections intended

---

[8] https://www.epa.gov/smartgrowth/regional-resilience-toolkit
[9] https://www.epa.gov/iclus

to support vulnerability assessments that integrate multiple stressors across time horizons that span multiple decades. The suite of ICLUS outputs are well-suited for regional (i.e., multi-county) assessments, but lack detail needed to simulate intra-urban dynamics and produce projections useful for city- or neighborhood-scale projects. Using ICLUS scenarios of population change, block-level simulations of future land use will be produced using UrbanSim – an open source tool for simulating metropolitan real estate and transportation markets. Information from these high-resolution scenarios of land use change will be presented in conjunction with climate change projections identified using ORD's Locating and Selecting Scenarios Online, or LASSO,[10] tool to provide a more comprehensive and long-range view of community vulnerability, resilience, and robust adaptation responses. Where appropriate, ORD scenario tools and datasets may also be used in OCR technical assistance projects to inform site-scale design activities intended to address issues such as stormwater or contamination (brownfields).

Product Form: Report (Internal Report). We anticipate working with one or two regions (or communities or states) in each of FYs 2020 and 2021. The product from each of these engagements will depend on the needs of the given community but will generally resemble typical products resulting from OCR technical assistance such as action plans, "next steps" memos, or a workshop report. Additionally, the UrbanSim model created for each community will be made publicly available with documentation and discussion, serving as a template for other communities. An FY 2022 deliverable will be an assessment of the projects, synthesizing lessons learned, best practices, and options for further integration of ICLUS into OCR technical assistance activities and programs, including the potential development of a web-based tool to support similar resilience planning activities (e.g., workshops, analyses) in the future.

Interdependencies: Requires A-E RA6 Output 24

Partners: OCR

Start Date: 10/2019   Delivery Date: 10/2022

---

[10] https://lasso.epa.gov/