

The Environmental Health Workforce in Hawai'i: Current Status and Recommendations for Improvement

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Abstract

Environmental health (EH) is a critical branch of public health that addresses current and emerging health threats related to issues such as climate change and pollution. The state of Hawai'i faces distinct EH challenges, including air pollution from volcanic activity, widespread vulnerability to sea level rise, wildfire, exposure to pollution from accidental spills from military sites, and a tropical environment that contributes to heat-related illness and that is conducive to mosquito-borne illnesses. A robust EH workforce is essential to respond to these concerns. This article uses a combination of targeted literature review and qualitative interview methods to synthesize evidence relevant to the issue for the state of Hawai'i. Such a workforce includes professionals in state and federal agencies, academia, and the non-profit and community sectors. Many academic disciplines and professionals can contribute to the EH workforce, including environmental scientists and epidemiologists, toxicologists, exposure assessment scientists, risk characterization scientists, environmental policy and communication experts and community-based EH workers. Currently, there is an insufficient EH workforce in Hawai'i and addressing this gap will require strategic investments in academia and the Hawai'i Department of Health, as well as expanded collaboration. Training programs are also critical, in particular cross-sector ones. Finally, a proficient EH workforce in Hawai'i needs to be able to communicate effectively with the diverse populations of the state and demonstrate commitment to and understanding of the unique populations of the state and their EH concerns.

Abbreviations

DOH = State of Hawai'i Department of Health
EH = environmental health
EHA = Environmental Health Administration
EPA = Environmental Protection Agency
HEER = Hazard Evaluation and Emergency Response
PFAS = per- and polyfluoroalkyl substances

Introduction

Hawai'i has distinct environmental exposures from volcanic activity and the impacts of climate change in a tropical environment which lead to specific environmental health (EH) needs. The recent devastating wildfires in Maui have underscored the importance of understanding climate change in the state and the environmental and health con-

sequences of the hundreds of resulting contaminants.^{1,2} In addition, the media attention on releases of jet fuel and per- and polyfluoroalkyl substances (PFAS) at the United States (US) Navy Red Hill Bulk Fuel Storage Facility on O'ahu have spotlighted critical EH issues in Hawai'i.³ Residents also need to be safeguarded from the health effects of potential environmental exposures experienced in daily life through diminished air or water quality, pests, exposure to pesticides and other industrial chemicals, and the associated psychological stress factors that negatively impact human health.⁴

The work needed to conduct research; promote, monitor and remediate environmental quality; develop policies to reduce exposures; address inequities in harm from environmental degradation (environmental justice); and effectively confront environmental disasters requires a considerable workforce of environmental technicians, environmental scientists, environmental epidemiologists, ecotoxicologists, exposure assessment scientists, risk characterization scientists, environmental policy and communication experts, and community-based EH workers.

According to the American Public Health Association, "Environmental health is the branch of public health that: focuses on the relationships between people and their environment; promotes human health and well-being; and fosters healthy and safe communities."⁵ One of the earliest public health interventions, the removal of London's Broad Street water pump handle to decrease cholera transmission in 1854, was an EH breakthrough.⁶ Water and air quality are so vitally important to human health that 2 federal laws, the Clean Water Act and the Clean Air Act, were passed in the 1970s to ensure basic quality standards and regulate discharges of pollutants.^{7,8} An individual's environment can affect their health in many ways and some populations may be more vulnerable than others due to personal factors such as genes, age, medical history, and social factors such as discrimination and living in marginalized communities.^{9,10} Environmental exposures are often higher in areas where the population is likely to be disenfranchised leading to environmental justice and health equity issues.¹¹

In Native Hawaiian culture, the environment is more than the natural elements (land, water, wind, wildlife); rather, each is considered an interdependent family member that requires *mālama* (care) and *kia'i* (guardianship).¹² This belief and the outdoor lifestyle that many residents of Hawai'i enjoy translates into an important respect for the environment. According to some rankings, Hawai'i is one of the "greenest" states in the US based on environmental quality, eco-friendly behaviors, climate-change contributors and habits.^{13,14} In fact, exposure to "blue spaces", like

the ocean, is associated with numerous positive mental and physical health outcomes.¹⁵ Yet, maintaining a healthy environment takes dedicated work. Factors such as a global economy and associated climate change, worldwide pollution of the oceans, and the persistence of many chemicals challenge health promotion and environmental stewardship.

EH is critical to understanding human health, and EH professionals are faced with the difficult tasks of understanding: the toxicity of pollutants; exposures to humans; dose/response relationships; individual susceptibility; associations and interactions between pollutants and disease states; risks and benefits to humans; environmental justice; and community resources and action. Given these complexities, the objectives of this article are to discuss the EH workforce in Hawai'i, structures of EH organizations, and recommendations for improvement.

Methods

This article synthesizes relevant practical considerations on this issue from a targeted review of the relevant scholarly and applied literature. Ideas for this article were formed after discussions with 10 representatives from the US Environmental Protection Agency (EPA) and the State of Hawai'i Department of Health (DOH) who prefer to remain anonymous. It is also informed by the authors' engagement in 2 EH interagency working groups.

Environmental Health Organizations in Hawai'i

Federal, state, county and private institutions in Hawai'i engage in EH. Hawai'i is a small state and the majority of agencies are located on the island of O'ahu in Honolulu; these factors allow for personal connections and relatively easy collaboration and sharing of information.

Federal

The EPA was established by President Nixon in 1970 to protect human health and the environment by implementing and enforcing laws passed by Congress.¹⁶ Laws such as the Clean Water Act; the Clean Air Act; the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) set limits on certain types of exposures, including PFAS, air pollution, pesticides and many more contaminants, that could impact public health.^{7,8,17,18} The EPA collaborates with states to develop work plans with environmental goals; states execute the work and provide progress reports to the EPA.

Hawai'i sits within EPA's Region 9 which oversees the Pacific Southwest states including California, Arizona, Nevada, Pacific Islands and 148 Tribal Nations.¹⁹ The Region 9 headquarters is located in San Francisco, and a local field office in Honolulu helps with the logistics of overseeing programs in Hawai'i and Pacific territories. This field office has a small staff of 3-10 employees with a broad

scope necessitating a highly-skilled local workforce. The workforce within EPA is generally fluid; staff always have their main tasks and workload, but when a crisis arises, they are sent to help address the environmental issues as needed.

The federal government dictates funding for EPA's and states' environmental programs. In 2021 the Bipartisan infrastructure Law and the Inflation Reduction Act were passed by Congress to strengthen water infrastructure, address climate change and work towards an equitable future.²⁰ These new laws have created employment opportunities, but require a qualified EH workforce.

State

One of the 3 main administrations of DOH is the Environmental Health Administration (EHA). Within EHA are several departments as shown in [Figure 1](#).²¹ The fact that Hawai'i's EHA sits within the DOH is unusual. In the 1970s, when the US EPA was established, most states elected to mirror the federal government's structure and create stand-alone entities to govern EH issues. For example, California created CalEPA which houses several agencies including the California Air Resources Board, Department of Toxic Substances Control, Department of Pesticide Regulation, Office of Environmental Health Hazard Assessment, State Water Resources Control Board, and the Department of Resources Recycling and Recovery.²² In addition to the DOH EHA, Hawai'i's Department of Land and Natural Resources and Department of Agriculture also ensure compliance with federal environmental regulations, especially those pertaining to pesticide use.^{23,24}

The majority of EH work in Hawai'i focuses on meeting regulatory limits set by EPA or by the state. Hawai'i's limits are often more stringent than EPA's.²⁵ An example of an enforceable regulatory limit related to drinking water is the maximum contaminant level (MCL) which is the "highest level of a contaminant that is allowed in drinking water."²⁶ Hawai'i's Environmental Management Division ([Figure 1](#)) and Hazard Evaluation and Emergency Response (HEER) Office have several branches whose work involves monitoring environmental chemicals (in air, water, and waste), managing releases, and enforcement. These activities aim to prevent hazardous exposures and protect the environment and human health. Environmental monitoring is particularly important for ensuring that exposures to humans do not exceed regulatory limits. The work performed within the EH Services Division is concerned with vector control, indoor environmental quality, and food and drug safety. This work is often conducted by environmental professionals rather than public health professionals or scientists, but both are imperative to protect human health.

In Hawai'i, many people are working to monitor and improve the environment, but a focus on studying the effects of the environment on human health is lacking. Historically, Hawai'i's DOH had no environmental epidemiologist on staff, but it has begun making changes. Recently, the state of Hawai'i created and filled an environmental epidemiologist position after an extensive search. DOH has also established a Climate and Health Program and an Of-

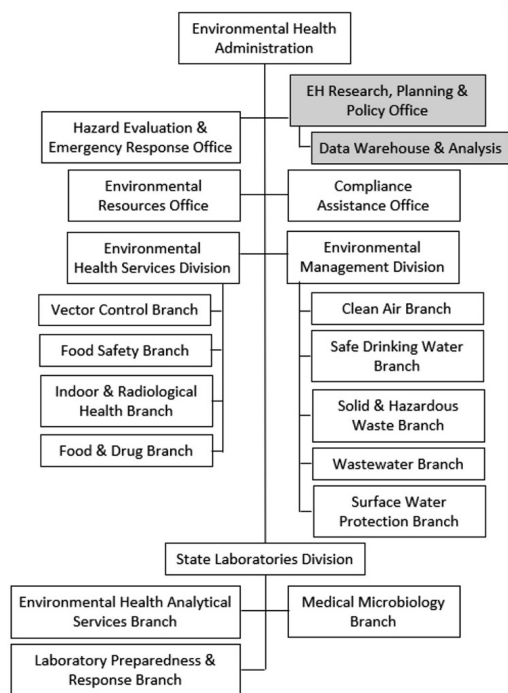


Figure 1. Proposed Organizational Chart for the State of Hawai'i Department of Health, Environmental Health Administration

Current organizational chart of the Hawai'i Department of Health, Environmental Health Administration (unshaded, adapted from 2024 Department of Health organization chart.²¹) and proposed Environmental Health Research, Planning and Policy Office (shaded) in place of the former Environmental Planning Office.

fice of Health Equity, which would ideally have a section dedicated to environmental justice. However, finding the right individuals to work in these new positions or in existing vacancies (approximately 25% currently) can be challenging. Also, many EHA staff are approaching retirement (personal communication). EH positions demand advanced, specialized training that require years of schooling and compensation at DOH is low compared to the private sector. The high cost of living in Hawai'i also makes retention of local talent and recruitment of qualified individuals from the continental US difficult (personal communication).

The workload carried by EHA to meet state and federal laws is extensive and there is little capacity to take on extra work including grant writing, research, health surveillance, data tracking, and strategic planning. Although funding for state-level biomonitoring programs and for research to study effects of environmental exposures in humans is available through the Centers for Disease Control and Prevention (CDC), EPA, the National Institute of Environmental Health Sciences, and private entities, planning for research proposals, developing relationships, and writing and formatting proposals all take time, as does carrying out and disseminating the research results. In late 2022, strategic planning workshops were held to discuss EHA's future. Plans have not yet been finalized because of several EH emergencies, but these workshops led to several potential areas of growth including ways to engage the com-

munity to encourage sustainability and addressing climate change and environmental justice issues.

Environmental epidemiological research also requires accessible environmental monitoring data in a format that can be easily transformed into a dataset. Hawai'i lacks such a program, but 31 states are currently funded by the CDC's National Environmental Health Tracking Program to have public-facing dashboards of environmental monitoring data along with illnesses associated with environmental exposures. For example, California's dashboard contains information on a myriad of indicators, including air quality, asthma, birth defects, cancer, carbon monoxide poisoning, childhood lead poisoning, climate change, and many more.²⁷ The Hawai'i Health Data Warehouse contains tracking and surveillance data on some health indicators in Hawai'i and a few environmental indicators, such as air quality and climate factors (eg, UV and drought), are available in its Hawai'i Health Matters site at the county level.²⁸ In 2015 EHA's HEER Office began transitioning to a searchable online database (iHEER) of incidents of hazardous substance releases. However, the transition is not yet complete and, in many cases, the environmental monitoring data are only available in PDF format, thus requiring extra work to be useful for research and surveillance purposes.²⁹ EHA's Clean Air Branch also has a database of air quality monitoring data that can be queried for dates, locations and air pollutants. Still, the number of monitors statewide is limited: 1 on Kaua'i, 3 on O'ahu, 2 on Maui, and 10 on the island of Hawai'i.³⁰ EHA also maintains a portal called EHACConnect that is searchable for real-time data from several of EHA's programs.³¹ As of 2019, Hawai'i's Department of Agriculture began requiring pesticide applicators to annually report use of restricted use pesticides, but the data available on their website are aggregated by active ingredient per island and a special data request is required for more detailed location of use.³² A single environmental health data portal and the staff to write grant proposals, manage research and maintain a database would be beneficial to researchers and the public. In addition, environmental justice can only be ensured with statewide data and dedicated analysis.

Education

Table 1 provides an overview of EH-related training at institutes of higher education in Hawai'i. Universities and community colleges are often the pipeline to Hawai'i's DOH and prepare students for the workforce. Academic faculty have the skills to develop proposals for and direct scientific EH research that provides students with hands-on experience and training in the field. Research grants also support the EH workforce. Increasing publicity of EH in Hawai'i, and widespread concern about climate change among youth³³ have led to more university-level students seeking to learn how to protect the population from environmental threats. In particular, the perspectives of students who are Native Hawaiian or long-time residents and/or who have a connection to the islands are critically needed. As these students enter the workforce, they may also be more likely to want to stay in Hawai'i, thus bolstering the EH workforce. Finally, these students have connections to the community

that may help bridge language or cultural barriers to communicating EH concerns to authority figures or to being a part of decisionmaking processes.

Specific EH degrees are important, but not necessary to fill EH labor gaps. Other areas of study including chemistry, biology, geology, engineering, law, business, planning and political science may also translate to opportunities in EH. Internships and other training opportunities with potential employers are needed to help students connect theoretical concepts learned in school and practical skills needed by the EH workforce.

However, appreciation for and care of the environment must be taught much earlier than young adulthood. Several public and private schools of all grades have already begun to train the next generation of environmental stewards through sustainability curricula and partnerships with non-profit organizations such as Pop-Up Labs for STEAM (science, technology, engineering, arts, and mathematics).³⁴ Hawai'i's youngest *keiki* (children) are learning about climate change, air and water pollution, and the effects of chemicals on the environment and in humans. More importantly, youth are also starting to think about how to solve and mitigate effects of these EH issues.³⁵ These early life lessons will encourage youth to protect the environment and health.

Other Organizations

Numerous non-profit organizations are committed to protecting Hawai'i's environment and ecosystems, but few focus on how environment impacts health. Sierra Club of Hawai'i is an exception.³⁶ Through litigation, advocacy, political action and physically connecting people to the environment, the Sierra Club communicates EH issues to the public. Another organization, Kupu Hawai'i, is a youth mentorship program for individuals aged 16-24 years to gain experience in green economy sectors.³⁷ This program which hosts the Hawai'i Youth Sustainability Challenge is currently focused on sustainability and environmental education, but could be expanded to include EH with the right partnerships.

Lastly, there is also a role for private businesses in EH. Laboratories throughout the US may be contracted to assist with analysis of environmental samples. In addition, businesses could provide resources or funding to support sustainability and other EH programs.

Hawai'i's Environmental Health Issues in the Post-COVID-19 Era

COVID-19 is a reminder of the importance of EH. Research has shown how air pollution increased susceptibility to COVID-19 viral infection and death.^{38,39} When quarantine orders were in effect, indoor air quality and exposures from basements, fireplaces, natural gas appliances, cookware, furniture, and personal care products became concerns.⁴⁰ Efforts to make homes airtight for energy efficiency contradicted recommendations for increased ventilation to reduce COVID-19 transmission.⁴¹ COVID-19 severity may also be affected by exposure to PFAS, which appears to alter im-

mune response leading to dampened vaccine efficacy and increased disease severity.^{42,43}

There were a few silver linings of the pandemic. Increased use of video conferencing allowed for more collaboration between EH organizations and better access to EH leaders, especially when meetings were recorded and transcripts were made public (Amy Miller, JD, oral communication, May 12, 2023).⁴⁴ In addition, lock-down policies had temporary beneficial effects on the environment including improvements in air and water quality, and reductions in greenhouse gas emissions and noise pollution.⁴⁵ This natural experiment may present an opportunity for EH scientists and epidemiologists to examine potential benefits of reduced exposures on population health.

The pre-pandemic EH concerns in Hawai'i remain: monitoring for air pollution, particularly from volcanic activity and wildfire; water quality; and pesticide use. In addition, legacy contaminants such as agricultural chemicals, lead and industrial contaminants, and recent contaminants such as PFAS require monitoring and surveillance to assess trends in the environment and in humans. Climate change will impact weather patterns and sea levels. Hawai'i's EHA must plan for the future in terms of infrastructure and population health. This work has begun as exemplified by the wastewater treatment plant at Sand Island in Honolulu.⁴⁶ This plant required an upgrade and EHA determined that its location near the ocean was vulnerable. Thus, this plant was built several feet higher than it had been previously to ensure effective operation in the setting of rising seas to avoid potential health impacts from improperly treated sewage releases.

Discussion

Clean air, water, and land are vital to the health and sustainability of our communities. The day-to-day regulatory compliance EH work in Hawai'i is immense and requires a workforce that ranges from relatively unskilled field workers to highly skilled doctoral-level scientists. There is currently a shortage of EH labor as demonstrated by the vacancies in DOH's EHA and there are concerns of further shortages due to retirement. Moreover, the myriad environmental emergencies in recent years in Hawai'i (Red Hill fuel spills, volcanic eruptions, and the Maui wildfire) have strained the current workforce.

Hawai'i's youth are interested in protecting the environment for themselves and future generations. This could lead to improved EH overall and potentially lead to more interest in EH jobs. Various disciplines and skill levels are needed to supply the EH workforce, but students may not be aware of EH career paths. Internships and traineeships are needed to introduce students to EH and prepare the future EH workforce.

Recommendations

The EH workforce in Hawai'i is critical to ensuring that environmental standards are met to protect public health.

Further improvements are needed; the authors make the following recommendations as detailed in [Table 2](#).

1. EHA should replace the former Environmental Planning Office with an Environmental Health Research, Planning and Policy Office (**Figure 1**) with a data warehouse.
2. EHA and the Office of Health Equity should collaborate to assess whether certain populations are disproportionately exposed. Also, communities must be able to express EH concerns and actively participate in policy decisions to build trust and impact sustainability efforts.⁴⁷
3. Collaboration between federal and state agencies, universities and nonprofit organizations should be increased for both training and research.
4. Hawai'i's universities must develop specialized EH programs and train individuals who have a connection to Hawai'i.

5. Medical and environmental health professionals should work together to ensure appropriate assessment of symptoms of environmental exposures or chemical poisonings.
6. Easily understandable EH data must be publicly available.
7. EH research must be conducted in Hawai'i.

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Conflict of Interest

None of the authors identify a conflict of interest.

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Table 1. Institutes of Higher Education in Hawai'i with Environmental Health (EH)-Related Programs

	Undergraduate educational opportunities	Graduate educational opportunities
University of Hawai'i at Mānoa ⁴⁸	<p>Cross-disciplinary degree between the Department of Oceanography and the Office of Public Health Studies that offers a Bachelor of Science in Global Environmental Science, whereby 1 track is EH</p> <p>15-credit One Health Interdisciplinary Undergraduate Certificate, which integrates coursework with a supervised practicum</p>	<p>Two EH courses offered by the Office of Public Health</p> <p>Studies: Fundamentals to One Health and Environmental Determinants of Health</p> <p>No graduate degree specializing in EH</p>
Hawai'i Pacific University ⁴⁹	<p>Public health bachelors degree that requires EH courses</p> <p>No EH specific tracks</p>	<p>Masters degree that requires EH courses</p> <p>No EH specific tracks</p>
Chaminade University of Honolulu ⁵⁰	<p>Bachelor of Science degree in Community and Public Health with a specialization in EH</p>	<p>Unavailable</p>

Table 2. Recommendations to Build and Sustain an Environmental Health (EH) Workforce in Hawai'i

Entity/ group	Recommendation	Considerations
Department of Health (DOH)	1. EHA should replace the former Environmental Planning with an Environmental Health Research, Planning and Policy Office (Figure 1) where environmental epidemiologists, climate change researchers, data analysts and policy experts could work collaboratively along with professionals in the Office of Health Equity, HEER and other DOH entities.	Ideally, this proposed office would also house a data warehouse that could be used for EH research purposes in combination with health indices that are available at the state level. Federal or state funding and possibly a legislative mandate would be needed to implement and support such a data warehouse.
	2. Collaboration between EHA and the Office of Health Equity is needed to assess whether certain populations are disproportionately exposed to pollutants and infectious agents.	Affected communities should be given a voice to express EH concerns and actively participate in policy decisions regarding community and EH.
Universities	3. Increased collaboration with federal and state agencies, as well as non-profits, is needed in the training of the EH workforce, such as through internships, as well as in the classroom.	Internships at federal, state or nonprofit agencies would allow for mentors to impart real-world skills to students so that they are adequately prepared when they arrive in the workforce. Guest lectures by representatives from EPA and Hawai'i's EHA and facilitated meetings between representatives and students could foster relationships and generate research ideas.
	4. Training programs specializing in EH are needed to prepare a local workforce to address diverse EH threats (eg, natural, climate-related, or from human error).	As the largest public university in the state, the University of Hawai'i system should offer a graduate degree program in EH so that the state's future EH leaders will understand the cultural and environmental nuances of performing EH work in the state and will be more likely to apply for and continue working in jobs in Hawai'i.
Health care sector	5. Collaboration between medical professionals and EH professionals is needed to ensure that symptoms of environmental exposures or chemical poisonings are appropriately assessed.	Increased training in EH at the medical school and in nursing programs would be beneficial.
Community	6. The public must have access to information that is explained in a manner that is easy to understand, available in a variety of languages and reflective of the diversity and culture of the target population.	Entities engaging with community groups need to tailor their efforts to communities and assure at a minimum to communicate in languages spoken by community members
University, federal and state agencies	7. Much more EH research should be conducted in Hawai'i. Critically, this research should be sensitive to and inclusive of the diverse groups present in the state.	Research should be conducted with the trust and input of the community, cultural sensitivity, and a willingness to listen rather than making assumptions to minimize the possibility of jeopardizing future studies

Abbreviations: DOH=Department of Health, EH=environmental health, EHA=Environmental Health Administration, EPA=Environmental Protection Agency, HEER=Hazard Evaluation and Emergency Response

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