PROMOTING HEALTHY ENVIRONMENTS FOR CHILDREN BY USING INDICATORS

Technical Brief for Countries in the East Asia and Pacific Region

Vital Strategies

unicef | for every child

A technician from Indonesia's Ministry of Environment and Forestry installs air quality monitoring equipment.

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Cover: Children haul water from a river in Fiji.

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INTRODUCTION

The Importance of Children's Environmental Health

Globally, more than 1 in 4 childhood deaths under 5 years of age are attributable to unhealthy environments—a statistic that will continue to rise as climate change magnifies the world's most important environmental risk factors.[1] Inadequate water and sanitation and unstable food systems further contribute to the environmental burden of disease with an estimated 57% of deaths from both lower respiratory infections and diarrheal disease under 5 years of age attributed to the environment. Environmental hazards have been linked to a range of significant health risks, including premature birth, stillbirth, increased lifelong risk for brain and behavior problems, respiratory disorders, cardiovascular disease, cancers, dysfunction of hormonal and reproductive systems, and more. As highlighted in the 2021 UNICEF publication "Healthy Environments for Healthy Children: Global Programme Framework,"[2] environmental degradation and climate change are global priorities for a safe and sustainable environment for all children. This issue is particularly important in Asia which has the second-highest death rate attributable to environmental factors after sub-Saharan Africa.[3]

Children born today (and in the future) are at greater risk because they will be exposed to climate change across their entire life course. New modeling developed by an international team of climate researchers, led by the Vrije Universiteit Brussel, finds that under Paris Agreement pledges, a child born in 2020 will experience on average twice as many wildfires, 2.8 times the exposure to crop failure, 2.6 times as many drought events, 2.8 times as many river floods and 6.8 times more heat waves across their lifetimes, compared with a person born in 1960.[4]

Children's environmental exposures are also an environmental justice issue. The poorest and most marginalized residents in low-income communities are often disproportionately affected by environmental

[1] Sheffield PE, Landrigan PJ. Global climate change and children's health: threats and strategies for prevention. Environ Health Perspect. 2011;119(3):291-298. doi:10.1289/ehp.1002233

[2] UNICEF. Healthy Environments for Healthy Children: Global Programme Framework. 19 Jan 2021. Available: https://www.unicef.org/media/91216/file/Healthy-Environments-for-Healthy-Children-Global-Programme-Framework-2021.pdf

[3] Prüss-Ustün A, Wolf J, Corvalán CF, Bos R, Neira MP. Preventing disease through healthy environments: a global assessment of the burden of disease from environmental risks. World Health Organization, 2018. ISBN 9789241565196

[4] Methodology: The findings draw on five sources of data, including newly generated simulations of climate impacts across five extreme event categories; the United Nations World Population Prospects; global mean temperature scenarios compiled in support of the Intergovernmental Panel on Climate Change's Special Report on Global Warming of 1.5 °C; population reconstructions and projections; and country-scale cohort size data provided by the Wittgenstein Centre's Human Capital Data Explorer, http://dataexplorer.wittgensteincentre.org/wcde-v2/. The research calculates the exposure of an average person to climate impacts across their lifetime in 178 countries, 11 regions and the globe under climate action commitments originally announced by governments in nationally determined contributions developed after the introduction of the Paris Agreement. It then compares different age groups to calculate conservative estimates of lifetime extreme event occurrence as a consequence of climate change, while controlling for changes in life expectancy.

[5] Landrigan PJ, et al. The Lancet Commission on pollution and health. Lancet. 3 Feb 2018;391(10119):462-512. doi: 10.1016/S0140-6736(17)32345-0. Epub 2017 Oct 19. Erratum in: Lancet. 2018 Feb 3;391(10119):430. PMID: 29056410

risk factors. Nearly 92% of deaths related to pollution occur in low- and middle-income countries, and in countries at every income level, disease caused by pollution is most prevalent among ethnic and racial minorities and the marginalized.[5] Poverty and its associated political disenfranchisement also limit people's capacity to improve the environments in which they raise their children. Children themselves are rarely empowered with information or the opportunity to participate in decision-making about the environment in which they grow up.

Figure 1: Windows of Vulnerability During the Life Course

Toxic Metals

Lead, mercury, cadmium, arsenic, and other toxic metals impair children's healthy development. One in 3 children worldwide is estimated to have lead poisoning.

Toxic Chemicals

A number of widely used chemicals can be damaging to the health of mothers, infants, and children. These include highly hazardous pesticides, asbestos, benzene, dioxins and PCBs, excess fluoride, and additional chemicals from household products.

Hazardous Waste

Both household waste and waste/recyling sites can expose children to a wide range of toxic chemicals and metals. Unsafe burning of e-waste and medical waste can release toxicants into the air and water of a community. Conflict-related contamination can include toxic oil fires and chemical weapons.

Environmental Risks

Air pollution kills hundreds of thousands of children under 5 each year and contributes to chronic respiratory infections, lung disease, cancer, and other health effects. Mould, noise, and radiation are other health threats in children's communities.

Climate Change

Climate change is a great threat to children's environmental health. This includes increased frequency, intensity, and uncertainty of extreme weather events, extreme heat, and effects on natural systems. The effects of climate change impact many aspects of our society: disease transmission, prevalence, and severity; food security; trauma and mental health; and access to health and education services.

Children are the most vulnerable

During pregnancy and the first years of life, children's organ systems are developing rapidly. For example, the developing brain witnesses the birth of billions of brain cells, which grow, travel to specific areas in the brain, and make connections that give us the capacity to sense, move, communicate, and learn. These early years are known as 'windows of vulnerability' for children's development. Children are extremely sensitive to their social and physical environments to guide their healthy development. Yet, growth during this sensitive period is threatened by exposure to the above-mentioned environmental risks.

Pregnancy

A mother's body can store harmful chemicals, sometimes over many years, and she can pass these along to her child during pregnancy and breastfeeding. Exposure to these pollutants in utero, during infancy, and in childhood impacts a child's ability to grow and reach their full potential.

Infancy and Childhood

Child-specific behaviours, such as breastfeeding, crawling, and hand-to-mouth-behaviour expose children unequally to toxic chemicals and pollutants. Children have a greater intake of air, water, and food per kilogram of body weight than adults, and their detoxification mechanisms are not fully in place.

Adolescence

Important body systems mature during adolescence, including those related to hormone function, reproduction, bone growth, and brain development and behaviour. Yet adolescents often face additional environmental health risks, such as unsafe work conditions and hazards at school.

Adulthood

Illness caused by early exposure to toxic chemicals or climate change-related events may not be visible until adolescence or later. Ensuring healthy environments in early life can have a positive impact for years and decades.

Source: UNICEF Healthy Environments for Healthy Children: Global Programme Framework, January 2021

Nomadic children in Mongolia outside a mobile kindergarten where they can use water, sanitation and hygiene facilities often not available in their homes.

The Vulnerability of Children

Children are especially vulnerable to environmental hazards due to their distinct biological and social characteristics. Beginning at the fetal stage and continuing through adolescence, they are physiologically different from adults. Children are in a dynamic state of growth, with cells multiplying and organ systems developing at a fast rate. At birth, their nervous, respiratory, reproductive and immune systems are not yet fully developed. Young children breathe more rapidly and take in more air in proportion to their body weight compared with adults. They also have higher metabolic rates and a higher absorption of nutrients and contaminants from food and liquids compared with adults. Furthermore, children behave differently than adults (e.g., more hand-to-mouth activity), increasing the potential for exposure to environmental hazards.

Background and Purpose

Systematic data are needed to reduce, minimize and prevent environmental risk factors and improve children's health. Many low- and middle-income countries in Asia have limited technical capacity, sufficient and reliable data, and the associated infrastructure needed to systematically address environmental health risks for children. However, children's environmental health indicators (CEHIs) can enable tracking, assessment and reporting on the impact of the environment on children's health.
In January 2020, the UNICEF East Asia and Pacific Regional Office and the Seoul National University College of Medicine published a discussion paper, "Children's Environment and Health in East Asia and the Pacific," that recommended the use of children's environmental health indicators as a key decision-making tool for stakeholders in Asia.

This technical guidance document is intended to support governments, academia and civil society in developing a tracking system for children's environmental health indicators in their own countries, and it builds on the previous work reported in the discussion paper. It is also based on our pilot programs to develop such tracking systems for China and Myanmar.

Indigenous children living on the waters between Malaysia and other countries have little access to learning and health care.

CHAPTER 1:
WHAT ARE ENVIRONMENTAL HEALTH INDICATORS?

An environmental health indicator is a way of presenting summarized, aggregated and nonidentifiable data to describe a population's health status in relation to environmental factors. Unlike raw datasets, or effect estimations from research findings, environmental health indicators are descriptive and typically use ecologic and cross-sectional data. They may describe the frequency of a health or environmental occurrence, an average exposure or the proportion of a population affected. Indicators broadly fall into four categories:[6]

1. Health outcome—diseases or conditions that can occur as a result of suspected environmental hazards.
2. Exposure—natural or synthetic substances that can affect human health.
3. Context—social, economic and demographic conditions that can affect potential exposure to a contaminant or hazard.
4. Action—activities, policies and interventions that reduce or prevent exposure to environmental hazards.

Researching the precise relationship between an environmental exposure and health outcomes is challenging. High-quality epidemiologic research is costly and time-consuming because it requires individual-level monitoring of both exposures and past or future health outcomes. Despite

Table 1: Sample Children's Environmental Health Indicators

Category	Subcategory	Indicator
Health	Respiratory illnesses	Prevalence of asthma among children under 18 years of age
Exposure	Household cooking/ heating (indoor air pollution)	Percentage (or number) of children under 5 years of age living in households using coal, wood or dung as the main source of heating and cooking fuel
Context	Poverty	Percentage of households falling under 50% of the median household income in that province
Action	Clean energy	Percentage of households using liquified petroleum gas or electric cookstoves

[6] Not all environmental health programs categorize indicators this way. Some include the category of "hazards" to distinguish environmental risks that are not measured as exposures or not yet considered to be definite exposures. Proximity to industrial or mining activity, for example, may be categorized as a hazard because children's exposure may or may not occur.

this limitation, when the scientific literature has established that such relationships exist, estimated the strength of these relationships, and estimated their effect size, it is generally **not necessary to continually validate well-established relationships in new settings or for different populations through new research.**

Indicators that describe the extent of exposure and/or distribution of health outcomes are valuable for characterizing who may be at risk, whether trends are moving in a positive or negative direction, and whether actions are supporting reduction of risks. Once calculated and tracked, these environmental health indicators may be described at common geographies or for common subpopulations, and their variations may be compared ecologically (at group or geographic levels, rather than based on individual-level data). However, because ecologic associations are often confounded due to the fact that so much else varies within a group or geographic area, clear relationships between exposures and health outcomes may not always be apparent. That does not mean the relationship does not exist; it may be blurred because of variation within the group being analyzed. Nevertheless, the indicators themselves remain meaningful because we know from well-designed studies that an exposure and illness are associated.

For these reasons, the selection of environmental health indicators that are appropriate to track should be based on a review of the scientific evidence for their meaning and relevance. Carefully selected environmental health indicators can serve as the core of environmental health surveillance and are an economical and widely understood way of using data.

In summary, environmental health indicators can be used to:

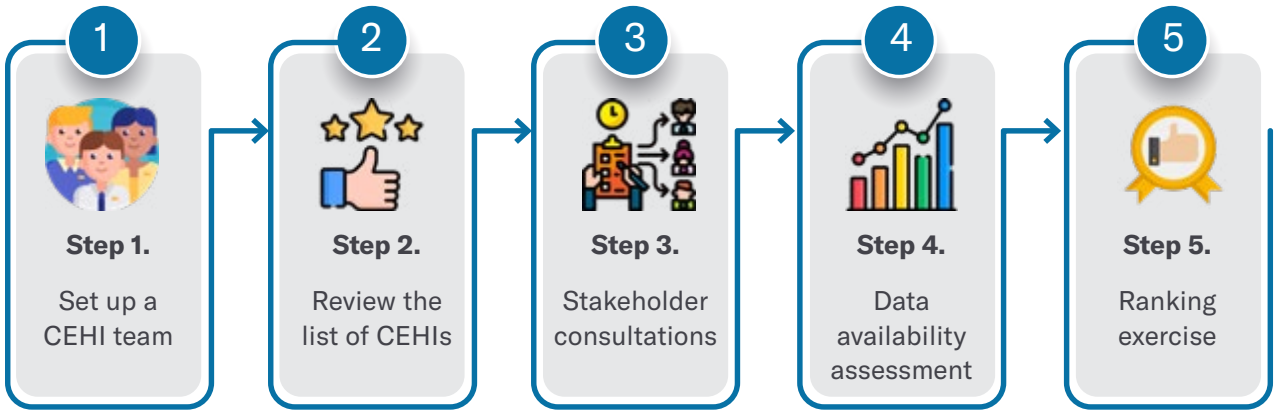
- Quantify the magnitude of a public health problem associated with environmental risk factors.
- Detect temporal trends in environmental exposures and health outcomes.
- Identify subpopulations at risk of environmentally attributable illnesses.
- Generate hypotheses about the relationship between health and the environment.
- Direct and evaluate measures for control and prevention.
- Evaluate the effectiveness of environmental interventions on health outcomes.
- Facilitate the development of evidence-based policies and actions.

In the Philippines, a boy scavenges in a landfill where his family lives.

CHAPTER 2:
ESTABLISHING AN INITIAL SET OF CHILDREN'S ENVIRONMENTAL HEALTH INDICATORS

This chapter outlines the process for establishing children's environmental health indicators that are appropriate for a country or region. As the chapter explains, some of the basic steps depicted in Figure 2 can be enhanced or conducted in parallel timelines.

Figure 2: Steps To Establish a Set of CEHIs

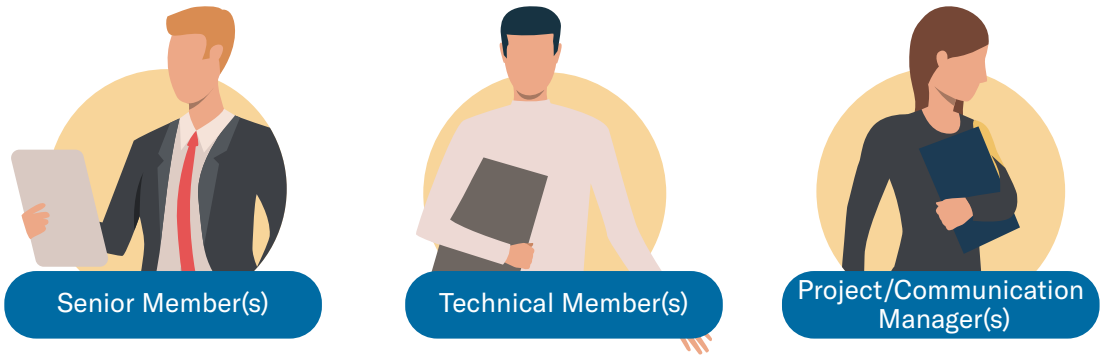


Step 1: Set Up a CEHI Development Team

It is often helpful to identify a lead institution to guide the process of developing the CEHIs. Ideally, this institution would hold the plurality of necessary data needed to develop and populate the indicators. This lead institution should be selected with the expectation that it would lead the compilation, analysis and sharing of data. In some countries, there may already be a central ministry charged with compiling and sharing data. In others, a ministry of health may be the most appropriate arm of government to lead the process, given its mission of using and sharing data to describe the health status of the population.

The core CEHI development team should have representatives from a cross-section of sectors dealing with health, the environment and other relevant issues. Expertise should be sought in at least three domains: (1) senior members with deep public health and environmental health knowledge, (2) technical members who can manage data exchange and coordinate data analysis, and (3) skilled project managers with strong communication skills.

Figure 3: Essential Roles for the CEHI Development Team



In addition to the core CEHI team, it is also critical to engage stakeholders concerned with the environment, climate and related issues. Environmental health issues—such as air pollution and climate-sensitive diseases—require effective cross-sectoral collaboration bringing together mandates, skills and resources from all relevant sectors for integrated responses.

Throughout the planning process, it is useful to engage stakeholders external to the government to provide feedback, prioritize indicators and cultivate public support for the effort. Where possible, it would be beneficial to consult with stakeholders from academia, civil society and groups for children or youth, especially those who may be more vulnerable because they live in marginalized or impoverished communities.

Step 2: Review and Revise the List of CEHIs

The core team should review the list of CEHIs in Appendix A to determine which of those indicators are relevant for their own country context. This list derives from our pilot programs to select sets of CEHIs for China and Myanmar as a way to establish an initial scope of environmental health issues that a country can track. CEHIs on this list were gathered by conducting a desktop review of seminal reports, peer-reviewed journal articles and gray literature on CEHIs. This review was not specific to location. Rather, we aimed to identify standard indicators currently used to track changes in children's environmental health. After assessing the most frequent citations in the desktop review, we prioritized three seminal reports on children's environmental health to derive the basis of our list of children's environmental health indicators. We began by including all indicators from these sources, while excluding duplicates and indicators with conceptual overlap. The final list in Appendix A reflects the results of significant in-country consultation with stakeholders. This list should not be treated as all-inclusive. We suggest reviewing the three seminal reports from the World Health Organization (WHO),[7] the United States Centers for Disease Control and Prevention (U.S. CDC),[8] and UNICEF[9] that informed this selection. We also encourage additional brainstorming about issues of local importance that may not be reflected in this list, but for which data may be available.

[7] World Health Organization. Monitoring. Retrieved from: https://www.who.int/ceh/indicators/en/

[8] United States Centers for Disease Control and Prevention. Children's Environmental Health. 2020. Retrieved from: https://ephtracking.cdc.gov/showChildEHIndicators

[9] UNICEF. Briefing notes on SDG global indicators related to children. April 2018. Retrieved from: https://data.unicef.org/resources/briefing-notes-on-sdg-global-indicators-related-to-children/

Teen activists in Mongolia's capital city document air quality data they collected.

Step 3: Stakeholder Consultations

The involvement of stakeholders is critical to the successful development of a CEHI program. This is because environmental health is by nature a cross-sectoral discipline, and in recent years has also expanded into emerging areas such as climate change, built environment, and food and product safety. Many of the data and indicators relevant for CEHIs are tracked by a multitude of governmental and nongovernmental stakeholders that would be too plentiful to list. Stakeholders, especially local stakeholders, can improve the data and evidence base for developing CEHIs, increase the likelihood that such indicators will be used in decision-making, communicate the benefits of the indicators to the public, and ensure the sustainability of a tracking system. That said, stakeholder engagement can also be challenging because it may reinforce power imbalances, require significant time and resources, and delay decision-making. These potential negative impacts should not be viewed as reasons to avoid stakeholder engagement, but instead they underscore the importance of carefully planning a detailed, inclusive and balanced engagement.

Stakeholders who should be consulted include those who would be the most likely providers and/or users of children's environmental health data and indicators. Ultimately, the purpose of stakeholder consultations is to raise awareness of children's environmental health issues, get buy-in on the importance of CEHIs, acquire additional data and knowledge, and solicit feedback to refine a set of country-specific indicators. Stakeholders may suggest CEHIs that should be eliminated or new ones that can be added.

A variety of tools can be used to conduct the stakeholder feedback process, including focus group sessions, interviews, shared documents, surveys or forms, and email. For our pilot program in China, we used the Delphi method to solicit

feedback from a group of about 20 Chinese experts. The Delphi method is a process for arriving at a group opinion or decision by surveying a panel of experts. The participating experts respond to several rounds of questionnaires, and their responses are aggregated and shared with the group after each round. We made effective use of this method to produce consensus about a selected set of CEHIs for China. Once stakeholders have been consulted, it is important to keep them engaged for the rest of the CEHI development process.

Step 4: Data Availability Assessment

This step involves collecting relevant data for the CEHIs that emerge from the stakeholder consultations. It is important to remember that while an optimal dataset may exist to support a particular indicator, the data may be unavailable to the public, have quality control issues, or be unavailable for a desired time frame or location. Surveillance systems may be lacking in certain countries, leading to an insufficient amount of data to characterize the problem across populations. It is therefore important to cast a wide net when searching for data to support CEHIs. Just as there are many indicators to describe a problem, there are often many sources of data that can support a particular indicator.

It may be important to consider proxy indicators that can sufficiently describe the status of the indicator based on available data. For example, childhood lead exposure is an important measure used to understand population vulnerabilities, environmental contamination from lead, and need for policies and interventions. Unfortunately, the gold standard biomarker for childhood lead exposure—blood lead levels—is often difficult to obtain in many low- and middle-income countries. Fortunately, several proxy indicators can describe facets of this problem, which is often good enough to characterize population exposures as a whole. Examples of proxies for childhood lead exposure might include the volume or economic value of lead mining operations at subnational levels or average soil lead concentrations. In this step, indicators for which there are available data or proxy data should be prioritized. Indicators for which there are no relevant data sources now or in the foreseeable future should be eliminated.

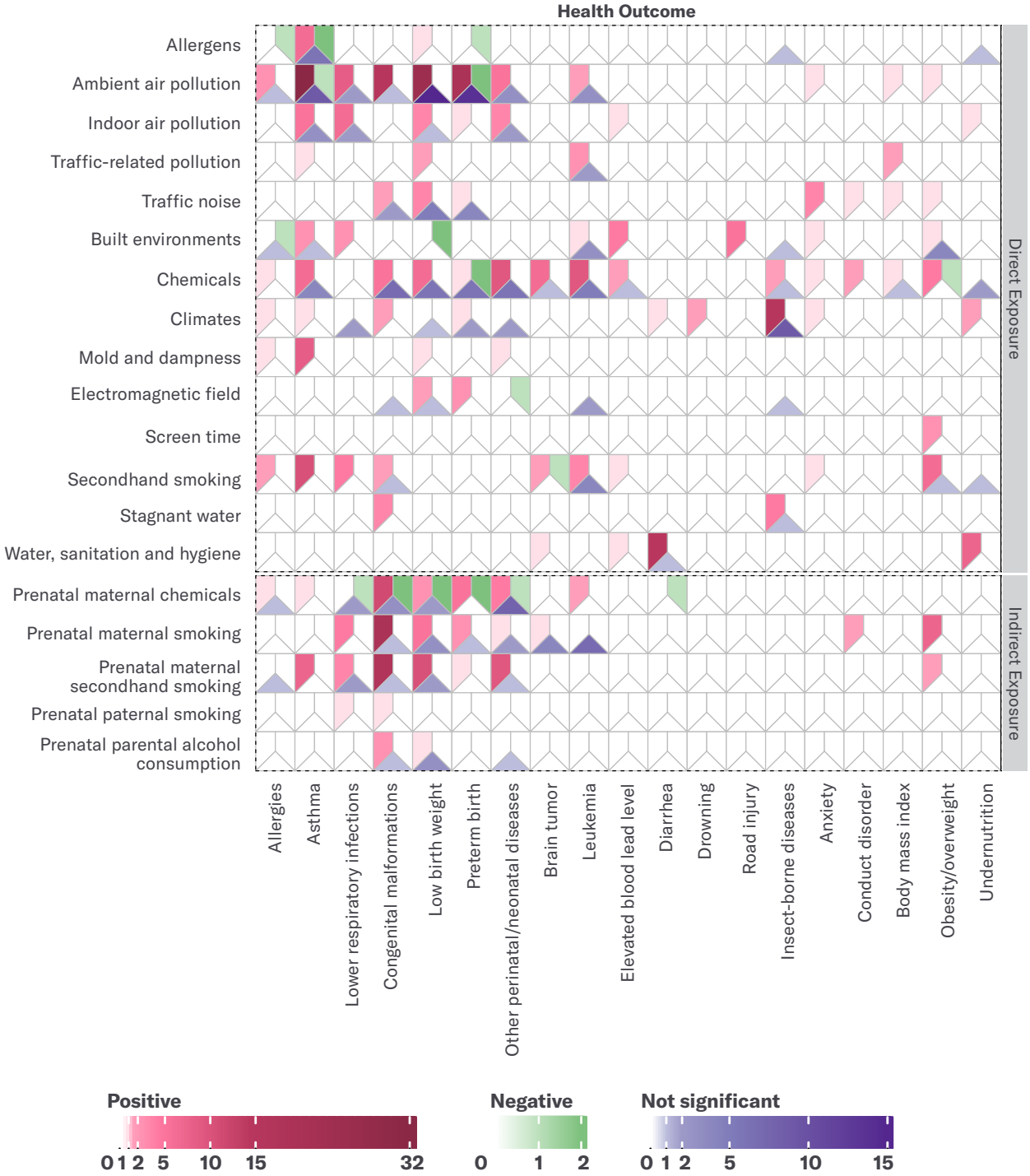
Step 5: Ranking Exercise

As a final step, a ranking exercise should be conducted to determine and prioritize the final list of CEHIs for initial tracking and analysis. We recommend selecting an initial list of no more than 50 CEHIs, because it can take considerable effort and time to track even a single indicator. We also recommend prioritizing 20-25 indicators in the initial list, with a good balance of health and exposure indicators so that potential correlations can be deduced from the data. In our pilot program in China, to facilitate a common understanding of the relationship between environmental exposures and health outcomes and to help the program team and experts prioritize the most important indicators, we created a heatmap (Figure 4). It shows the results of our systematic literature review[10] of environmental risk factors that are associated with the most burdensome diseases for Chinese children. The process for and detailed results of this review are currently being documented in a manuscript for future publication.

[10] The literature review was prepared by colleagues from UNICEF China (Jiarui Xiao, Hui Sun), China CDC (Qiang Wang, Ning Xu, Bei Zhang, Yuzhu Guo, Yuqing Zhang, Yanling Liu, Shuai Zhang, Yushu Liu) and Vital Strategies (Yue Zhang).

Figure 4: Heatmap of Literature Review Showing the Amount of Evidence for Associations Between Environmental Exposures and Health Outcomes

Red colors in the top-left section of each small cell represent numbers of systematic reviews that found significant positive associations between the given environmental exposure and a health outcome; purple colors in the middle triangle of each cell represent numbers of systematic reviews that found no significant associations; green colors in the top-right section of each cell represent numbers of systematic reviews that found significant negative associations.



Source: UNICEF China

Whatever number of CEHIs are under consideration, it is useful to conduct a ranking exercise to determine which indicators are considered the most important and to guide strategies for communicating about them. Table 2 illustrates an example of a simple but quantifiable ranking exercise (listing just one indicator).

Table 2: Criteria in a Scoring Sheet That Can Be Used in a CEHI Ranking Exercise

Sample Indicator	Criteria	Indicator Score
Percentage of children under 5 years of age with elevated (> 10 µg/dL) blood lead levels	Availability of local data to support the indicator	1 2 3 4 5
	Relevance to health (health burden, if known)	1 2 3 4 5
	Prevalence of health outcome or environmental exposure in the country	1 2 3 4 5
	Precautionary principle*—unknown potential of harm	1 2 3 4 5
	Public awareness of the children's environmental health issue	1 2 3 4 5
	Availability of international data and knowledge	1 2 3 4 5

*In an environmental context, the precautionary principle urges: "When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically." (Raffensperger C, Tickner J, editors. Protecting Public Health and the Environment. Washington: Island Press, 1999.)

CHAPTER 3:
ACCESSING AND MANAGING DATA FOR CHILDREN'S ENVIRONMENTAL HEALTH INDICATORS

The previous chapter outlined the steps to develop an initial prioritized list of CEHIs. Along with creating the list comes the additional responsibility of accessing and managing data associated with the CEHIs. This chapter will provide information on how to do that.

Engaging Stakeholders as Data Providers

Stakeholders are important when it comes to identifying data to support indicators at either the national or subnational levels. Many data providers are likely to be government agencies, whether at a national or subnational level. However, nongovernmental organizations, academic institutions, the private sector or even community organizations may provide data.

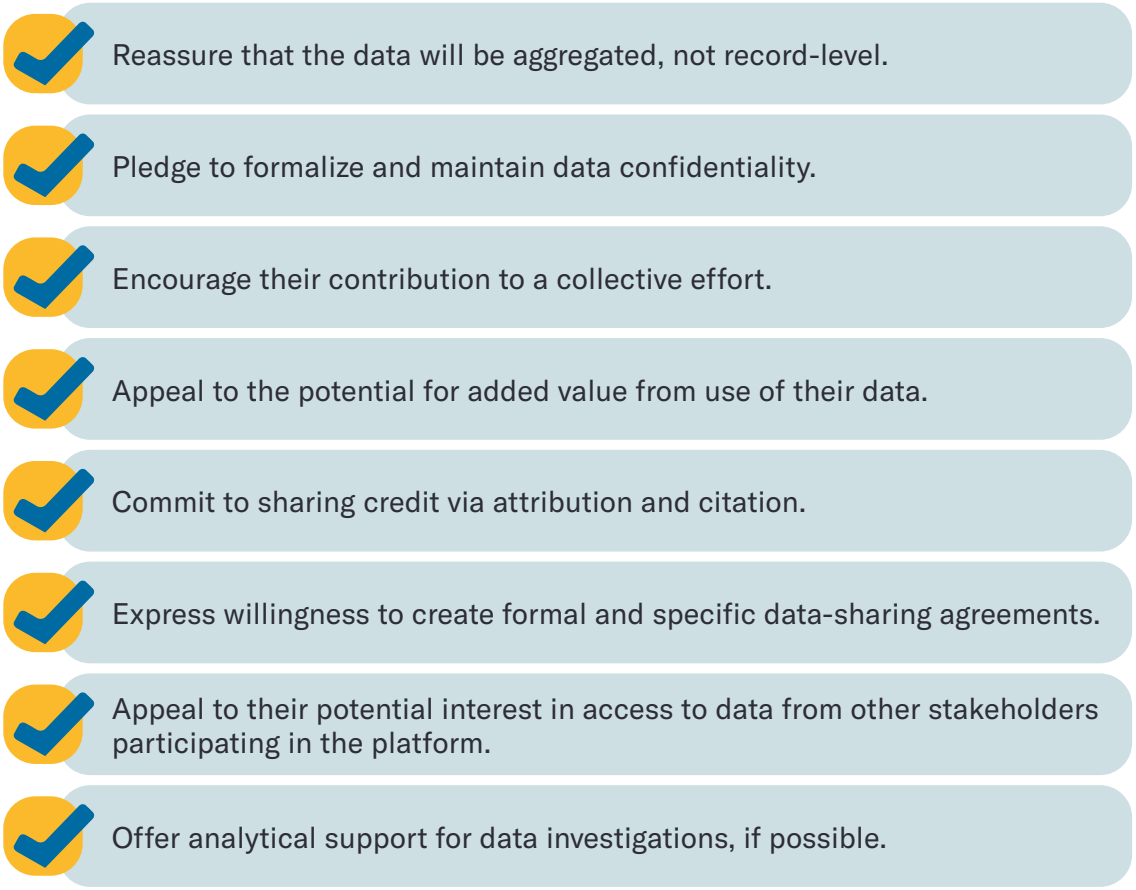
It is important to engage in socialization efforts for these data providers, demonstrating how their data will be used, how the data will be accessed, what the providers' role will be and what impact the use of their data can have. It can often be equally important to be explicit about how their data will not be used, highlighting security and privacy concerns.

Before data are shared or displayed publicly—whether in tabular or graphic form—it is necessary to establish approval flows and get agreement to them. Appropriately crediting data providers is an essential step to establish trust and ensure that additional datasets can be made available going forward. Without accurate and updated data, a data system for children's environmental health cannot be sustained long-term and cannot be the basis for sound evidence and recommendations. Figure 5 below offers a checklist of items to communicate to data providers.

Health and environment ministries are often the chief architects of CEHI databases. But environmental health data can also be provided by a multitude of other government agencies, including those dealing with labor/manpower, energy, agriculture, immigration and finance. Usually, each government sector is only aware of and concerned about data pertaining to its own portfolio, and the CEHI program may therefore need to actively manage multisectoral government stakeholders, by encouraging them to collaborate and by playing a role in interagency collaboration. Further recommendations for a cross-sectoral action framework can also be found in "Children's Environment and Health in East Asia and the Pacific," published by the UNICEF East Asia and Pacific Regional Office and the Seoul National University College of Medicine.[11]

[11] UNICEF East Asia and Pacific Regional Office; Seoul National University College of Medicine. Children's Environment and Health in East Asia and the Pacific. 2020. Available: https://www.unicef.org/eap/reports/childrens-environment-and-health-east-asia-and-pacific

Figure 5: Checklist for Communication With Potential Data Providers



Identifying, Inventorying and Choosing Data Sources for CEHIs

Often, indicators are proposed without full knowledge of whether data sources exist to calculate the indicators. Other times, a familiarity with the data sources drives the creation of indicators. Ideally, both of these processes should be encouraged when selecting CEHIs. Inventorying potentially relevant data sources is an important step. Many, but not all, national and local governments already maintain a centralized inventory of data that are collected across ministries and agencies, often by a central information technology body or a central statistics bureau. Inventories may exist at the ministerial level. These should be consulted early in the process of indicator selection. In the absence of a preexisting inventory, local stakeholders should be consulted to inform the CEHI team about relevant data that are collected and the extent to which they are publicly accessible.

When mapping proposed indicators to potential data sources, there may be multiple datasets that could support particular indicators. In those cases, the highest-quality and most complete dataset that best supports the selected indicator should be chosen. For those indicators that do not appear to map to locally derived data, it may be possible to identify appropriate proxies, as described above, or to fill the data gap with existing or modeled international data. What is particularly challenging in terms of children's environmental health data and indicators is the lack of integration and interoperability of data and information systems between health and environmental sectors. Many low- and middle-income countries still face

significant challenges concerning environment and climate data and information management systems. Any program to develop CEHIs will need to consider these existing challenges.

Creating the CEHI Databases

A database must be created to house all relevant data for the CEHIs. Broadly speaking, two datafiles are required: the indicator database, and the metadata database. Both should be maintained as a spreadsheet or database (DBF files, Access software, etc.). The indicator database records attributes about the available indicators, including their value/magnitude, units and geography (e.g., national, regional, district specifiers); time frame (e.g., year, season, month); and context descriptors (e.g., gender, age group, socioeconomic stratum), among others. Collaborating with information technology specialists, the core team will create a relational database for metadata that enables efficient entry and validation of data. Table 3 presents a typical structure for a basic indicator database with examples of indicators.

Metadata are "data about the data" and offer more information about the definition, purpose, source and origin of the indicators.[12] Metadata are essential to construct a framework for data exchange and communication among data originators, providers and users.[13]

Table 3: A Basic Indicator Database Structure

Unique ID	Indicator ID	Indicator Name	Measure	Geo Type	Geo Name	Time Period	Date	Indicator Value	Data Unit	Confidence Interval
1444	1	Fine particulate matter ($PM_{2.5}$)	Annual average	City	Name of City	Year	2018	50.7	$\mu g/m^3$	-
1445	1	Fine particulate matter ($PM_{2.5}$)	Annual average	City	Name of City	Year	2019	42.6	$\mu g/m^3$	-
1446	1	Fine particulate matter ($PM_{2.5}$)	Annual average	City	Name of City	Year	2020	38.8	$\mu g/m^3$	-
3533	75	Chronic respiratory illness	Prevalence of asthma among children under 15 years of age (urban boys)	Nation	Name of Country	Year	2020	3.69	Percent	3.31-4.19
3534	75	Chronic respiratory illness	Prevalence of asthma among children under 15 years of age (rural boys)	Nation	Name of Country	Year	2020	1.82	Percent	1.37-2.53

[12] A more technically precise definition is "structured information that describes, explains, locates, or otherwise makes it easier to retrieve, use, or manage information." This is the definition used by the National Information Standards Organization (NISO), a nonprofit association accredited by the American National Standards Institute (ANSI) to identify, develop, maintain and publish technical standards. http://www.niso.org/

[13] https://nces.ed.gov/pubs2009/metadata/ch1_component.asp

A set of metadata attributes should include, at a minimum:

- Indicator domain (i.e., type, such as health outcome, exposure, action or context)
- Indicator name
- Indicator definition
- Rationale for the indicator's selection
- Data computation method (e.g., formula, including numerator and denominator)
- Unit
- Data source
- URL for data access or description
- Contact information
- Data collection method
- Frequency of data collection

These attributes may be supplemented by additional data sources beyond the primary data source, contact information for additional data sources, available disaggregation (e.g., by gender or income) and limitations. Metadata, when recorded correctly, can be incorporated into indicator reports and reporting tools to inform users about the sources, periodicity and interpretation of the data.

Table 4: Example of a Metadata Database From Our Pilot Program in China

Metadata Attribute	Metadata Descriptor
Indicator ID	114
Domain	Health outcome
Indicator name	Prevalence of acute lower respiratory infections in children under 5 years of age
Indicator definition	Acute lower respiratory infections are diagnosed by physicians and other clinicians from an evaluation of symptoms. They may be caused by viruses or bacteria or be secondary to other acute respiratory injuries. Prevalence is a measure of the risk of such an infection in young children and varies considerably by environmental, social and economic risk factors.
Rationale	Lower respiratory infections are a leading cause of death and disability for Chinese children. Household and ambient air pollution, exposure to secondhand smoke, and household crowding can increase the risk of acute lower respiratory infections.
Computation method	Number of acute lower respiratory infections among children under 5 years of age by region in the past two weeks divided by number of children under 5 years of age by region in the past two weeks multiplied by 100
Unit	Percent (%)
Data source	National Health Commission Information Service Center
URL	http://www.nhc.gov.cn/mohwsbwstjxxzx/s8211/new_list.shtml
Contact person	Name, email, phone
Data collection method	National (representative) survey
Frequency of data collection	Every five years

CHAPTER 4:
SUPPLEMENTAL SOURCES OF DATA TO ADDRESS GAPS

As we discussed in Chapter 2, many health departments and ministries have yet to implement or lack the resources for robust public health surveillance or data collection systems that enable broadly representative characterizations of children's environmental health. In some cases, agencies are unable or unwilling to share their data due to privacy concerns or restrictions enacted by their governments.

To fill data gaps, international sources of data can be mined. In this chapter, we identify several potential international sources of data, provide a basic overview of their methodologies, and describe their strengths and limitations.

The Global Burden of Disease Study

The Global Burden of Disease (GBD) study represents the most comprehensive worldwide observational epidemiological study to date, according to the study's coordinator, the Institute for Health Metrics and Evaluation (IHME). The GBD study examines trends from 1990 to the present and includes data on morbidity and mortality in more than 200 countries and territories. The study currently includes data on 369 diseases and injuries and 87 risk factors, and tracks progress both within and across countries. To reduce variance among competing disease burden estimates, the World Health Organization announced a formal partnership with IHME in 2018 to produce a single set of estimates intended to strengthen the validity of the GBD. This change also ensures that GBD publications are subject to independent peer review. The Lancet has published GBD estimates and publications since 2010 and will continue to do so.

Current GBD metrics include incidence, prevalence, mortality, years of life lost (YLLs), years lived with disability (YLDs) and disability-adjusted life years (DALYs). To create the GBD estimations, data are extracted from censuses, household surveys, civil registration and vital statistics, disease registries, health service use, peer-reviewed research, and a range of less common sources including air pollution monitors and satellite images. Results are then considered in the context of a sociodemographic index (SDI), and uncertainty values are generated for every metric.

The result is a far-reaching assessment of global health determinants and outcomes. GBD Compare is an interactive tool in 14 languages (including Chinese and Indonesian) that allows anyone to generate maps and tree maps, arrow diagrams, and other charts to compare risk factors and health outcomes within a given country or across countries. Data can be downloaded to analyzable spreadsheets, and results are standardized using a meta-regression modeling tool to facilitate

comparisons. Limitations include a fairly complex user interface that can be hard to learn and limited subnational estimates for most countries.

The Demographic and Health Survey

The Demographic and Health Survey (DHS) program was established by the U.S. Agency for International Development in 1984 as an expansion and follow-up to the World Fertility Survey and Contraceptive Prevalence Survey projects. The program provides technical assistance to more than 350 surveys in over 90 countries around the world, improving our understanding of health and population trends in low- and middle-income countries. The main objective of the DHS program is to "improve the collection, analysis, and dissemination of population, health, and nutrition data and to facilitate use of these data for planning, policy-making and program management." These efforts have resulted in improved tools to collect population health data, increased in-country capacity for identifying data needs, and expanded use of DHS data by stakeholders worldwide.

The DHS methodology encompasses a mix of survey tools including questionnaires, biomarkers and geographic information. There are currently four model questionnaires—for household, woman, man and biomarker—and a range of biomarkers assessed to represent conditions including infectious diseases, chronic diseases, micronutrient deficiencies and environmental exposures. Geographic information is presented both nationally and subnationally in given reporting areas. The sample is typically representative at the national, regional and residential (e.g., urban vs. rural) levels. Data are tabulated in more than 175 tables contained in 15 chapters. Standard DHS surveys in each selected country contain large sample sizes (often between 5,000 and 30,000 households) and are conducted every five years.

Key advantages of the DHS surveys include high response rates, high-quality training of interviewers and standardized data collection procedures. Furthermore, a variety of robust observational data analysis methods have been used to facilitate DHS surveys, including but not limited to intrahousehold designs and cross-comparative analyses. The limitations of using DHS surveys are: (1) data analytic skills are necessary to mine the datasets, (2) access to full datasets is limited to research purposes, and (3) summarized data is generally available only in PDF formats for most country reports.

The World Health Organization Global Health Observatory

The World Health Organization Global Health Observatory (GHO) data repository is a gateway to health statistics for WHO's 194 member states. The repository provides access to more than 1,000 indicators on priority health topics including mortality and burden of disease, the sustainable development goals, noncommunicable diseases and their risk factors, health systems, environmental health, injuries, and more. The data are collected and synthesized from a number of sources, including but not limited to civil registration statistics, population censuses, cross-sectional and longitudinal surveys, the United Nations, national or subnational surveillance programs, and local departments of health. The repository contains both modeled data and actual counts.

Many of the GHO's datasets represent the best available estimates that permit comparability across nations and time. GHO estimates are not

A boy rows a raft through flood waters in Thailand.

always the same as official national estimates, although WHO gives member states an opportunity to review and comment on data and estimates.

The GHO repository uses a sophisticated interface to select and present data graphically and in tabular form. It provides detailed metadata such as rationale, definition, disaggregation (e.g., by age, sex, location, etc.), methods of measurement and estimation, and expected frequency of data dissemination. The database also links to similar indicators for ease of use. One limitation is that while the list of indicators is comprehensive, subnational data are often lacking or are not as detailed as they are in other databases.

The World Bank

The World Bank's open data platform HealthStats is a portal to its comprehensive database of Health, Nutrition and Population (HNP) statistics. The database includes more than 250 indicators on topics including health financing, immunizations, infectious diseases, noncommunicable diseases, nutrition, water and sanitation, and reproductive health. The database also includes population estimates and projections. Users can access HNP data by country, socioeconomic status, topic or indicator. The resulting data are made available through tables, charts and maps that can be easily downloaded and shared.

The World Bank's HNP platform makes use of country, regional and topical dashboards to present data and uses the data to develop and promote publications intended to raise awareness about key health and population issues and synthesize high-quality data for decision-makers. A limitation is that while the data topics are robust and the presentation of metadata is comprehensive, the

user interface for presenting data by sustainable development goal is outdated.

Other Notable Sources of International Data

Although the sources of international data described above are wide-reaching, they do not capture data related to less traditional environment, climate and health indicators. In these instances, it might be more useful to rely on other sets of data including but not limited to UNICEF data on the situation of children and women (https://data.unicef.org/), the UNICEF Children's Climate Risk Index (CCRI) Interactive Atlas (CCRI Interactive Atlas (beta) (arcgis.com), UNICEF Core Indicators, UNICEF Multiple Indicator Cluster Surveys, the United Nations Environment Programme's Environmental Data Explorer, and UNICEF EQUIST (Equitable Strategies To Save Lives). Because climate change is expected to significantly increase burden of disease among children, it is important to include children's environmental health indicators about climate where relevant. Climate data sources should be identified in collaboration with the national climate services, which provide climate information tailored to specific decision-making processes. In some country contexts, national hydrometeorological agencies, ministries of environment and disaster management authorities collaborate across other government sectors to produce tailored information (e.g., weather bulletins may be sent to ministries of education that can then plan adjustments to the school calendar). In other contexts, where national hydrometeorological services have lower capacity to deliver such services, data from the national climate services can be supplemented with data from global and regional climate services. See Appendix C for a list of global and regional climate services.

Additional sources of reputable data could include international nongovernmental organizations and peer-reviewed research or manuscripts published in scientific journals. Both sources have their merits. While international nongovernmental organizations often have the in-country staff and personal relationships to collect nonofficial data, they may have poorly documented data collection methodologies that are typically required by public health agencies and large governing bodies. Peer-reviewed research, often conducted by research organizations and universities, is held to more rigorous methodological standards, but can be small-scale, cross-sectional and not representative of larger populations. Ultimately, the people collecting data will have to balance these realities or find suitable proxy indicators to adequately describe their measures of interest.

A girl cycles through a polluted neighborhood in Indonesia.

CHAPTER 5:
PRESENTATION AND VISUALIZATION OF CHILDREN'S ENVIRONMENTAL HEALTH INDICATORS

Replanting mangrove forests can be a defense against climate change and sea-level rise in the island nation of Kiribati.

CEHIs, once selected and calculated, can be presented in many formats. In this chapter, we review several of the most common data presentation formats, with consideration for the purposes of using and presenting data. The presentation formats can be neatly, if imperfectly, divided into **static** and **dynamic** reports.

Static Reports

Static reports are data presentations that may be tabular, graphic, visual or narrative. Once presented, they are fixed in time, and are not interactive. Static reports allow for the acquisition of necessary and underlying data, appropriate coding to enable the calculation of the indicators, and the presentation of findings at predetermined intervals. There are three main ways that static reports can be displayed.

1. Tabular reports (with narrative)

Tabular reports typically present multiple indicators at once. They can also present one overall indicator, and the same indicator stratified by available variables. Tabular reports may also include additional columns containing confidence intervals for the estimates and the estimation method used to calculate the indicators. Tables can be organized to present time series or trend data, with columns for each of several years for which data are available and analyzed. Simple explanations enhance the utility of these tables for wider audiences. Table 5 provides an example of a tabular report with basic narrative.

Table 5: Example of a Tabular Report

Incidence of Low Birth Weight (2019) in Country X		Count	Rate (% Live Births)
Nationwide		**155,500**	**11.5**
By region	North	35,000	12.4
	South	28,000	15.5
	East	44,000	4.7
	West	48,500	9.1
By poverty level in region of birth	Lowest third	20,282	4.5
	Middle third	49,580	11.0
	Highest third	85,638	19.0
By annual average $PM_{2.5}$ level at region of residence	< 30 µg/m^3	63,522	9.4
	30 - < 60 µg/m^3	48,732	12.0
	> 60 µg/m^3	43,215	16.0

Narrative: Low birth weight (LBW) is a term used to describe babies who are born weighing less than 2,500 grams. LBW is a serious condition that requires early intervention and can be associated with a variety of problems that last well into childhood and adulthood, including neonatal mortality, stunting, failure to thrive and cognitive deficits. In country X, 155,500 low-birth-weight babies were born, representing 11.5% of all live births. Regionally, the South had the highest rate (15.5%) of LBW, and the East had the lowest (4.7%), a more than threefold difference. Family poverty is strongly associated with LBW, with the poorest families having a rate of LBW more than four times higher than that of affluent families. Ambient annual average particulate matter ($PM_{2.5}$) is also associated with a higher rate of LBW.

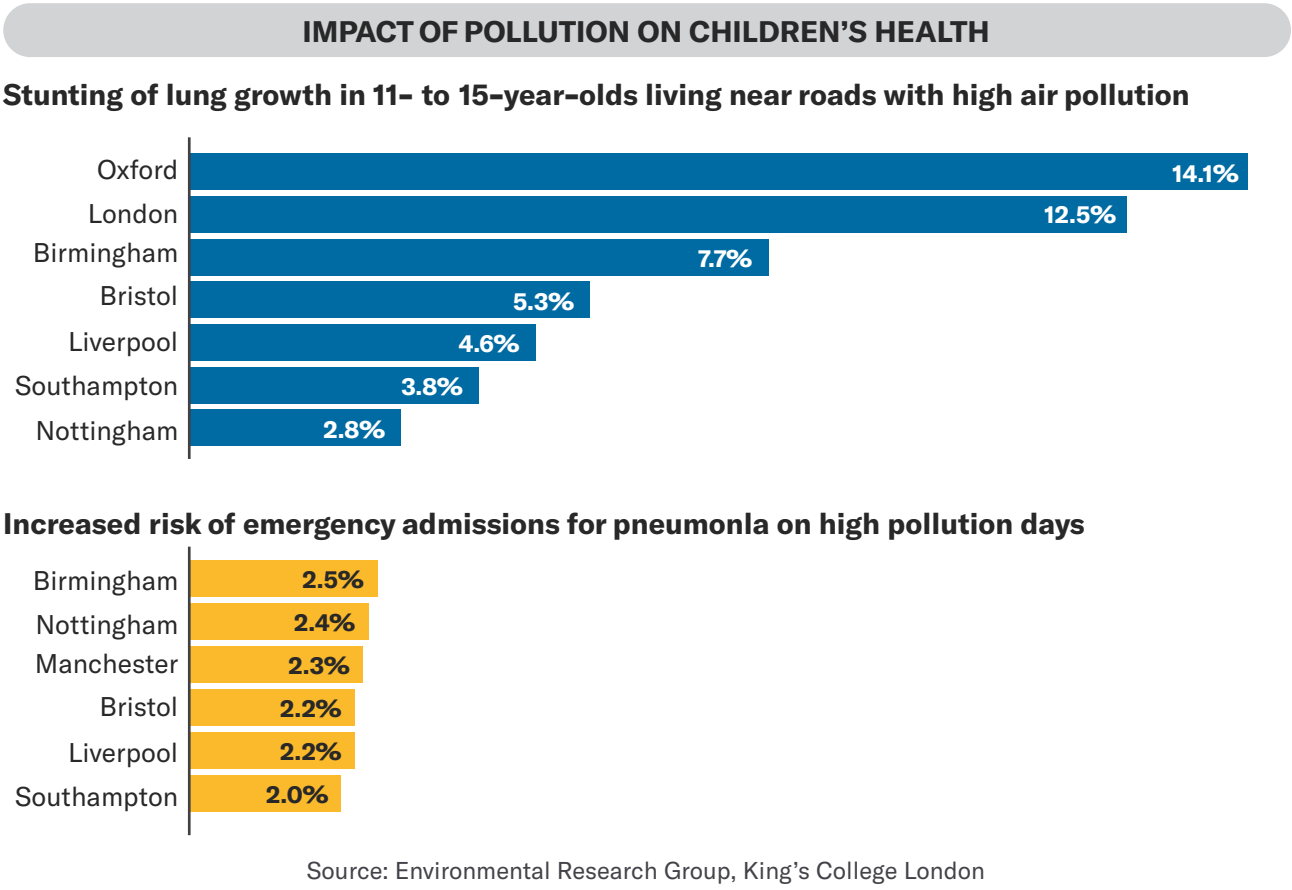
2. Data briefs and thematic reports

Data briefs are typically organized to present findings from the analysis of a single dataset (e.g., Children's Health Indicators from the National Nutritional Survey) or for the purpose of justifying additional attention to an issue or policy proposal. A data brief can also be organized around a risk factor and its consequences. For example, a data brief titled "Environmental Risks Associated With Low Birth Weight" may present data on the incidence of LBW alongside data on exposure to air pollutants, exposure to toxic metals, access to clean water or access to prenatal care. A data brief serves two purposes: It presents a robust portrait of an issue and it offers sufficient context to generate and test hypotheses about the causes of and contributors to a specific issue.

A data brief typically includes tabular and graphic presentation of data. Individual maps of indicator variability may be presented alongside one another to enable the reader to recognize the presence, or absence, of patterns or associations. Scatter plots showing the relationship between two indicators (e.g., LBW and air pollution exposure) may also be included. Short explanatory text should be

provided for each of the data presentations, whether tabular or graphic. Figure 6 presents an example that a group of investigators from King's College produced to summarize the impact of air pollution on children's lung health in major U.K. cities.[14]

Figure 6: Sample Visual Presentation From a Data Brief on Air Pollution's Impact on Children's Respiratory Health

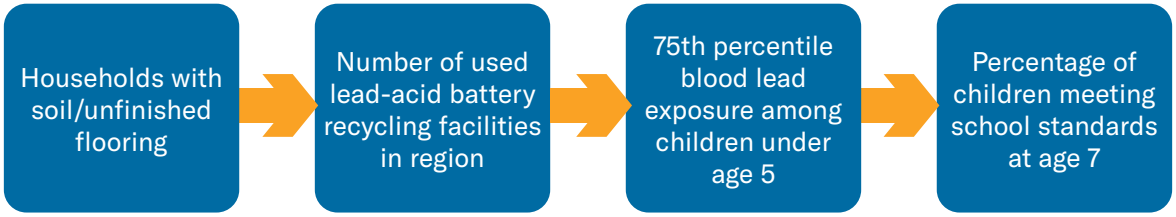


Source: Environmental Research Group, King's College London

A data brief that is intended to make the case for an intervention—e.g., adoption of legislation or funding for an initiative—would organize the flow of the presentation to lead the reader toward the intended conclusion. If we wanted to make the case for investment in climate-resilient clean water facilities in a particular region, for example, we might include indicators in this sequence:

[14] Williams M, Evangelopoulos D, Katsouyanni K, Walton H. Personalising the Health Impacts of Air Pollution—Summary for Decision Makers. Environmental Research Group, King's College, London. November 2019.

To make the case for improvement in policies that reduce children's exposures to lead, indicators could be presented as follows:



The general flow of data presented here starts with the problem(s) that could be addressed by policies, moves toward its relationship to exposure, and ends with the health or social consequences of failing to address the problem. Incorporating data from other regions to make a case for the reduction of regional disparities will enhance the presentation. So would incorporating national and international goals and standards to identify indicator benchmarks.

Data briefs can also estimate the potential benefits of an action. In the example above, the author may estimate that "if this region's drinking water infrastructure has been affected by increasing climate hazards such as flooding, we may expect there to be more severe cases of and deaths from diarrhea among children."

Local people search for clean water during a drought in the central highlands of Viet Nam.

3. Infographics

Infographics are visual representations of data that are accessible to a wide range of audiences. They offer concise, clear and visually appealing representations of information, and can be easily shared by readers via social media or printed material. Their visual clarity also enables the media to adopt them, ensuring that the intended message is not manipulated or misinterpreted. An infographic may present multiple indicators, and if so, use more than one approach.

The UNICEF infographic on childhood pneumonia presented in Figure 7 uses a map, directional signs with data and comparative shapes corresponding to mortality statistics. The creation of infographics typically involves the close collaboration of data analysts, program personnel, communication specialists and graphic designers.

Figure 7: Example of an Infographic

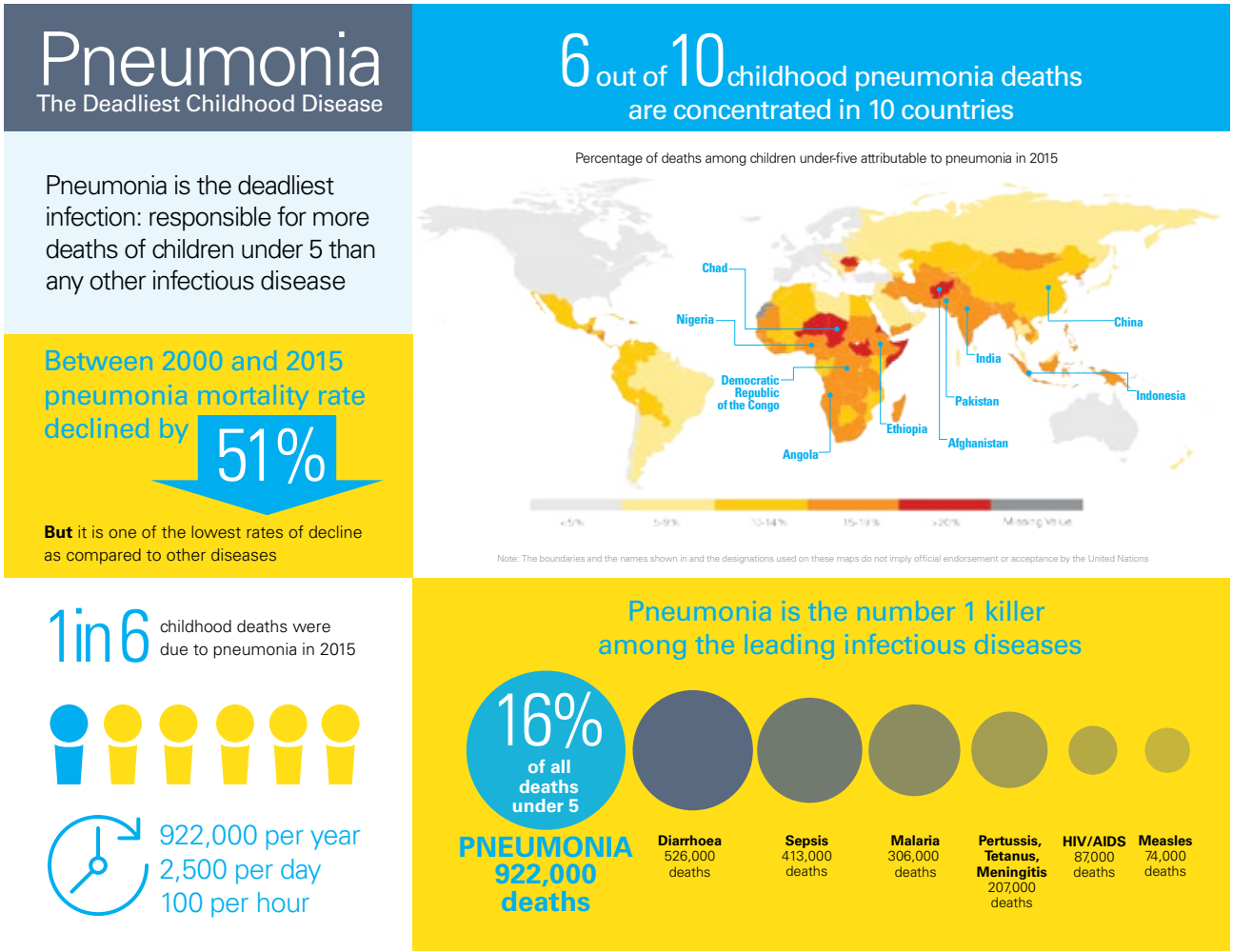
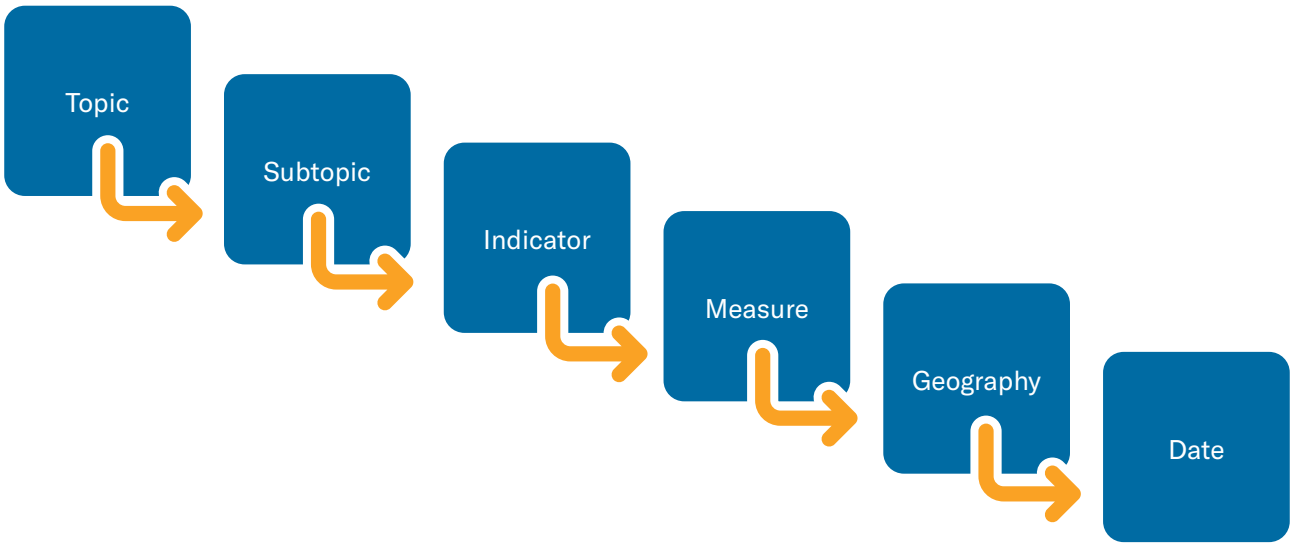


Figure 8: Example of an Environmental Health Indicator Data Model



Dynamic Reports and Data Portals

The dynamic reporting of data involves the display of a data presentation tool (front end) linked to a data storage platform (back end). Dynamic reporting of data offers several distinct advantages over static reporting:

- Dynamic reports enable developers to provide options for data visualization.
- Any given CEHI may be presented in tables, charts (including line, bar, pie, area, scatter plot, high-low graphs), maps and infographics.
- Dynamic data portals are typically additive, in the sense that each period of data (e.g., day, month, year) adds to the continued store of older data.
- Portals may be viewed from and on a variety of electronic platforms. They may exist as downloadable sophisticated spreadsheets, viewable online from a desktop screen, tablet or smartphone, and they can be projected in group settings.
- User feedback can inform iterations of functionality and clarity in data presentation.
- Links to specific indicators and their display may be shared via email, social media or text.
- Portals enable the sharing of underlying data from their data store, giving data-adept users the opportunity to further analyze and manipulate data for alternate visualizations and presentations.
- Portals enable the incorporation of metadata—data about the data—including source, quality, and explanations about what the data show and suggestions for their interpretation.

As mentioned, data portals require a back-end data store and a front-end visualization platform. Back-end data stores are typically relational databases that enable straightforward modifications with cascading changes to data that are efficient from a redevelopment perspective. The database diagram presented in Figure 8 illustrates one such data structure created with the participation of one of this brief's authors for the city of New York, USA.

The ease with which front ends, or data presentation platforms, can be created has improved markedly in recent years, with commercial and open-source software available

to create data dashboards, analytic platforms, visualization generation, and data sharing and exchange capabilities. Unlike the back end, which requires the skills of information technologists, the front end is often developed by a team of data analysts and communication specialists. Some data portals rely on live statistical analysis of cleaned record-level data. The options should be carefully considered by developers who are mindful of cost, security and data confidentiality, bandwidth, computational capacity, and hosting issues.

Development software should be selected based on the result of a functional and end-use case analysis. Packages like Tableau,[15] PowerBI[16] and QlikView,[17] and hybrid solutions that incorporate HTML, Java and other programming with these data visualization packages, are possible solutions. Tableau is a powerful and flexible data visualization tool. PowerBI also provides for robust data visualization and can be used for data warehousing and mining. QlikView is especially useful for retaining associations among disparate data sources. A useful comparison of their features can be found at: https://www.educba.com/power-bi-vs-tableau-vs-qlik/. CEHI teams seeking to create data portals should consider these core functions:

- Intuitive indicator selection.
- Within-indicator selection by measure, date, geography.
- Presentation of stratified indicators by selectable variables.
- Flagging of unreliable data (i.e., small cell size).
- Curation of X-Y (scatter plot) charts to enable and disable certain comparisons based on scientific and logical rationale.
- Analysis of trends across multiple dates of like indicators.
- Custom table creation.
- Downloadable source data.
- Explanatory text associated with topics, subtopics, data source, methods and indicators.
- Indicator-appropriate visualization options, including bar charts, trend charts and scatter plots.
- Savable and/or printable charts, tables and other visualizations.
- Preassembly of indicators into thematic reports.
- Linkage to a "How To Use" guide.
- Hyperlinks to more information about indicators and relevant programs.

Appendix D provides a list of health and environment portals/resources currently available around the world. The key features of the data portals are described and compared.

[15] https://www.tableau.com/

[16] https://powerbi.microsoft.com/en-us/

[17] https://www.qlik.com/us/

Solar panels used with portable “ger” dwellings help to provide clean energy and reduce indoor air pollution during Mongolia’s harsh winters.

CONCLUSION AND THE PATH FORWARD

Data are the lifeblood of public health practice and also environment and climate actions. Understanding the range of risks, exposures and health effects that children face from myriad environmental sources requires more than simply tracking children's well-being. It requires the compilation of data to tell the larger story of how the lives of children, from the fetal stage through adolescence, are being affected. Developing a children's environmental health indicator program is a sustainable way to compile known information, identify gaps in knowledge, track progress, and inform policies, financing and actions on the ground.

It is a common axiom in public health that more data are left on the shelf than are ever analyzed, used or shared. CEHIs attempt to remedy that by engaging a range of data providers, analysts and stakeholders in a deliberate effort to collect and present data that collectively tell a larger story than any one source or survey can. This guidance document describes a process by which CEHIs can be formulated, prioritized and shared. This work requires:

- A champion institution that is prepared to commit to a multiyear process of data identification and collection.
- Cross-sectoral coordination and a holistic approach through the engagement of multiple ministries, policymakers and civil society stakeholders that is uncommon in many contexts.
- A common vision of greater data sharing and transparency, without compromising confidentiality.
- An understanding that no data are perfect, but that improving the quality and breadth of data occurs from acknowledging the gaps, rather than merely accepting them.
- Sufficient human and financial resources to maintain program momentum.

There is no single correct way to envision and launch a CEHI program. In some nations, existing data integration and visualization platforms can be leveraged for new sources of data, indicators and thematic presentations. In many nations, ministries of health are the logical home for this effort because they routinely possess, analyze and report data. They are adept at characterizing risk, aware of the importance of subpopulation and subnational reporting, and experienced in reporting aggregated data in a way that preserves confidentiality and anonymity. Yet ministries of health often lack strong institutional connections to environment ministries and other agencies that collect data on environmental conditions relevant to public health. Ministries of health may also be unaware of national or subnational initiatives that influence environmental health.

In some settings, a central statistical agency or the office of the executive may already collect data from multiple ministries, and they may be best positioned to create the databases and visualization platform needed to realize the full potential of a CEHI program. In others, a governmental entity focused on information technology may be an appropriate lead. The creation of children's environmental health indicators can contribute to integrated data and information management between health, environment and other relevant sectors.

Civil society, children, and youth-led and community organizations are among the stakeholders who are the most nimble and least politically constrained. They often care deeply about local environment and health issues and have earned the trust of local residents. Sharing CEHIs and data with them can enable them to make use of the information to advocate for interventions to improve the environment for children. Youth networks can provide useful insights about how children's environmental health issues should be managed. The engagement of youth can extend to children in secondary and postsecondary schools as an important audience. Youth networks can assist in selecting indicators, organizing stakeholder consultations and identifying providers of quantitative or qualitative data, as appropriate.

Traditional and new media play a role in flagging environmental health threats. They can use evidence and data from the CEHI program to substantiate their claims, translating the information so it can be widely understood by a larger audience. Special training workshops or events can be held for media content providers.

Finally, we recommend that throughout the conception and creation of a CEHI program, the interests and needs of the general public should be central to decision-making. Making children's environmental health data available through an online platform assures the public that their environment is being monitored for potential threats. It also empowers individuals to learn more about their environment and alter their lifestyles and habits to improve their health. Ultimately, openness and transparency of localized aggregated data underpin good public health systems and will help to improve environmental sustainability. Government agencies should strive to build trusting relationships with and among the data stakeholders to maximize their willingness to prepare, share and expose data, even when the data may not tell a positive story. When executive-level officials express to governmental entities their commitment to data discovery and sharing, they can lubricate the sometimes slow machinery of government. Above all, a shared commitment to improving the health of children in current and future generations is at the heart of a program for children's environmental health indicators.

APPENDIX A:
CHILDREN'S ENVIRONMENTAL HEALTH INDICATORS IN CHINA AND MYANMAR (PROPOSED)

In 2020, Vital Strategies worked closely with UNICEF's East Asia and Pacific Regional Office and its China and Myanmar country offices to develop proposed sets of CEHIs. As described in this document, both the process and the outcome of indicator selection must be context-specific and mindful of stakeholder interests, national and subnational priorities, and the existence and availability of data. The table below summarizes the preliminary outcome of these assessments for China and Myanmar. There is substantial but nonuniversal overlap, and some indicator definitions differ based on the original source of the indicator, the source of data, the surveillance systems and the priorities identified by stakeholders.

Category	Subcategory	Indicator Definitions	
		China*	Myanmar
Exposure	Ambient air pollution exposure	Annual mean concentration of $PM_{2.5}$ in the given administrative location (μg/m^3)	Average annual population-weighted $PM_{2.5}$ exposure
			Percentage of population exposed to levels exceeding the WHO guideline values
			Annual mean levels of fine particulate matter (i.e., $PM_{2.5}$ and PM_{10}) in cities (population-weighted)
			Average annual population-weighted ozone exposure
			Average annual population-weighted particulate (PM_{10} and $PM_{2.5}$) exposure

* In the case of China, indicators that are colored black are prioritized as core indicators. Indicators in blue are secondary indicators.

Category	Subcategory	Indicator Definitions	
		China	Myanmar
Exposure	Indoor air pollution exposure	Percentage of children under 18 years of age living in households where solid fuels are used for cooking and heating	Percentage (or number) of children under 5 years of age living in households using coal, wood or dung as the main source of heating and cooking fuel
			Percentage of population with primary reliance on clean fuel technology
	Industrial waste gas emissions	Volume of industrial waste gas emission (tons)	
	Smoking environment	Number of children under 18 years of age living in households in which at least one adult smokes on a regular basis	Percentage of children living with an adult who smokes daily/weekly in the home
	Pesticide exposure	Percentage of soil failing national pesticide standard	
	Soil contamination	Percentage of soil failing national heavy metal standard (mercury, cadmium, lead, chromium, copper, nickel, zinc, arsenic)	
	Extreme weather events	Number of children under 18 years of age affected by disasters	Number of individual heat waves that occur each year
		Number of flooding events	Droughts per year
		Number of days of heat wave	Number of annual dry spells
	Exposure to contaminated water	Percentage of lakes and rivers whose water quality index is below national standard level III	

Category	Subcategory	Indicator Definitions	
		China	Myanmar
Exposure		Percentage of drinking water supplies failing national water quality standards	
	Safe products for children	Percentage of children's products failing national standards	
	Lead exposure	Average blood lead level among children under 18 years of age	Estimated population (number) living in townships with lead mining
			Number or percentage of children under 5 years of age with elevated (> 10 µg/dL) blood lead levels
	Famine risk		Percentage of food insecurity by state or region
	Vector-borne disease transmission	Number of children under 18 years of age living in areas of endemic insect-borne diseases	Percentage of population who slept under an insecticide-treated net the previous night
	Child labor		Number of children 5 to 17 years old engaged in child labor, per sex and age group
	Hygiene	Percentage of population with basic hand-washing facilities	
		Percentage of schools with hand-washing facilities	
	Sanitation	Percentage of schools with safely managed toilets	
		Percentage of population using safely managed toilets	

Category	Subcategory	Indicator Definitions	
		China	Myanmar
Exposure	Food safety	Percentage of infants' and young children's food products failing national food security standards	
		Percentage of food products failing national food security standards	
	Hazardous housing	Percentage of schools evaluated as dilapidated buildings	
	Noise	Percentage of cities failing national noise standards	
Health Outcome	Chronic respiratory illness	Prevalence of asthma among children under 18 years of age	Prevalence of respiratory illness (including tuberculosis) in children under 15 years of age
	Acute respiratory illness	Incidence of acute respiratory disease among children under 5 years of age	Percentage of deaths among children under 5 years of age caused by acute lower respiratory infections, expressed as percentage of total deaths
	Diarrheal diseases	Incidence of diarrhea among children under 5 years of age	Number of deaths due to diarrhea among children under 5 years of age
			Disability-adjusted life years due to diarrhea in children under 5 years of age
	Congenital malformations	Incidence of congenital malformations in children under 1 year of age	

Category	Subcategory	Indicator Definitions	
		China	Myanmar
Health Outcome	Preterm birth	Incidence of preterm birth	
	Children's cancer	Prevalence of leukemia among children under 18 years of age	Cancer incidence and mortality among children under 15 years of age
	Insect-borne disease	Incidence of dengue among children under 18 years of age	Number of deaths due to dengue fever in children under 5 years of age as a percentage of total dengue cases
			Number of cases of dengue fever in children under 15 years of age as a percentage of total dengue cases
			Mortality rate of Japanese encephalitis among children under 16 years of age
			Morbidity rate of Japanese encephalitis among children under 16 years of age
	Neonatal mortality	Number of perinatal deaths per 1,000 births	
	Childhood stunting	Prevalence (percentage) of stunting (height-for-age z-score is below minus 2 standard deviations below the mean) in children under 5 years of age	Prevalence of stunting in children under 5 years of age (height-for-age value < –2 standard deviations of the WHO Child Growth Standards median)
	Low birth weight	Incidence of low birth weight (< 2,500 grams)	Low-birth-weight babies (percentage of live births)

Category	Subcategory	Indicator Definitions	
		China	Myanmar
Health Outcome	Physical injuries	Incidence of road injury among children under 18 years of age	Mortality rate for children under 15 years of age due to physical injuries
		Incidence of drowning among children under 18 years of age	Incidence rate of physical injuries to children under 15 years of age
	Mental illness	Prevalence of anxiety among children under 18 years of age	
	Overweight	Percentage of children under 18 years of age who are overweight (as defined by National Institute of Environmental Health, China CDC)	
	Pesticide poisoning		Number of hospital or health center admissions due to acute pesticide poisoning (separated by intentional vs. accidental)
	Anemia		Prevalence of anemia among children 5 to 9 months old and 6 to 59 months old
Action	Governments' environmental health plans	Percentage of local governments that have implemented an environmental health plan that reduces the risks of disasters and climate change	
	Industrial pollution	Percentage of "key pollutant discharge units" that monitor and report their pollution status	

Category	Subcategory	Indicator Definitions	
		China	Myanmar
Action	Government spending on environmental health	Annual government budget spent on environmental health	
	"Hygiene city/ village"	Percentage of cities/villages designated "national hygiene city/village"	
	Childhood vaccinations		Percentage of children 12 to 23 months old who received all basic vaccinations
	Access to oral rehydration solutions		Number of children under 5 years of age with diarrhea who receive oral rehydration solutions
	Children covered by vector-management systems		Percentage of households with at least one insecticide-treated mosquito net
	Climate change risk assessment	Percentage of local governments that conduct regular climate change risk assessments including actions to address the needs of children	
	Environmental health literacy	Percentage of people who pass the national government's environmental health literacy test	
Context	Childhood poverty	Percentage of households falling under 50% of the median household income in that province	Percentage of children under 15 years of age living in poor households

Category	Subcategory	Indicator Definitions	
		China	Myanmar
Context	Malnutrition in women of childbearing age	Percentage of women of childbearing age (15-49 years) who are malnourished (BMI < 18.5)	Percentage of women with a body mass index below 18.5
	Children's education	Percentage of children aged 12-14 years who completed primary school	Percentage of children who have completed primary school education
			Percentage of children who have completed secondary school education
			Percentage of children who have completed tertiary school education
	Education of women of childbearing age	Percentage of women aged 18-49 years who completed tertiary education	
	Migrant/ left-behind/ displaced children	Percentage of children under 18 years of age who are migrant or left behind	Number of displaced persons
	Overcrowding		Population density (number of people per square kilometer of land area)
	Access to maternal/child health specialists		Percentage of all births that are attended by skilled health staff
	Employment status of women of childbearing age		Percentage of women 15 to 49 years old employed
			Percentage of women 15 to 49 years old employed in various sectors

APPENDIX B:
ONLINE RESOURCES

Below is a list of relevant links to resources that may be useful when developing an environmental health indicator program. While the list is not exhaustive, it can provide a strong foundation and rationale for this type of work.

Foundational Reports

UNICEF: Healthy Environments for Healthy Children: Global Programme Framework
https://www.unicef.org/media/91136/file/Healthy-Environments-for-Healthy-Children-Global-Programme-Framework.pdf

UNICEF: Children's Environment and Health in East Asia and the Pacific
https://www.unicef.org/eap/media/6731/file/Children's%20Environment%20and%20Health%20in%20East%20Asia%20and%20the%20Pacific.pdf

Children's Environmental Health Indicators for Low- and Middle-Income Countries in Asia
https://www.researchgate.net/publication/321250660_Children%27s_Environmental_Health_Indicators_for_Low-_and_Middle-Income_Countries_in_Asia

Overview of Environmental Health Monitoring and the Use of Indicators
https://www.ncbi.nlm.nih.gov/books/NBK215456/

U.S. Environmental Protection Agency: Environmental Public Health Indicators Impact Report
https://cfpub.epa.gov/si/si_public_record_report.cfm?dirEntryId=341077&Lab=NCER

WHO: Children's Environmental Health Indicators
https://www.who.int/publications/i/item/WHO-HSE-PHE-EPE.09.1

Other Resources

UNICEF: Indicator Manual
https://www.unicef.org/media/55526/file/UNICEF%20Strategic%20Plan%20Goal%20Area%203%20Indicator%20Manual%20Ver.%201.7.pdf

Institute for Health Metrics and Evaluation (IHME): Global Burden of Disease (GBD)
http://www.healthdata.org/gbd/2019

WHO: Global Health Observatory (GHO)
https://www.who.int/data/gho

World Bank Open Data
https://data.worldbank.org

U.S. CDC: National Environmental Public Health Tracking
https://www.cdc.gov/nceh/tracking/

Environmental Health Intelligence New Zealand, at Massey University: Environmental Health Indicators
https://www.ehinz.ac.nz/indicators/overview/about-the-indicators/

International Network on Public Health & Environment Tracking
https://inphet.org/

APPENDIX C:
CLIMATE SERVICES

List of main international climate services (updated from Medri S, et al. Overview of the main international climate services. Centro Euro-Mediterraneo sui Cambiamenti Climatici. June 2012. See this report for additional information on some of the climate services).

Climate Service	Country	Website	Scale
ICSU World Data System (WDS) (including WDC Climate)	/	https://www.worlddatasystem.org/ https://www.dkrz.de/up/systems/wdcc	Global Regional
World Meteorological Organization (WMO)	/	https://public.wmo.int/en	Global
		https://climatedata-catalogue.wmo.int/ https://climpact-sci.org/ https://www.worldclim.org/data/index.html	Regional
Global Climate Observing System (GCOS)	/	https://gcos.wmo.int/ https://www.ncdc.noaa.gov/gosic	Global Regional
Intergovernmental Panel on Climate Change (IPCC)	/	https://www.ipcc.ch/	Global Regional
International Research Institute for Climate and Society (IRI) and Earth Institute's Lamont-Doherty Earth Observatory (LDEO)	/	https://iridl.ldeo.columbia.edu/index.html	Global Regional
Committee on Earth Observation Satellites (CEOS)	/	https://ceos.org/	Global Regional
Group on Earth Observations (GEO)	/	https://earthobservations.org/index.php	Global Regional
Food and Agriculture Organization of the United Nations (FAO) Climate Change Resources	/	http://www.fao.org/climate-change/knowledge-hub/resources	Global Regional
Red Cross/Red Crescent Climate Centre (RC/RC CC)	/	https://www.climatecentre.org/	Global
World Resources Institute's Aqueduct Water Risk Atlas	/	https://wri.org/applications/aqueduct/water-risk-atlas	Global

The World Bank Group Climate Change Knowledge Portal (CCKP)	/	https://climateknowledgeportal.worldbank.org/	Global Regional National
Climatic Research Unit at the University of East Anglia	U.K.	https://crudata.uea.ac.uk/cru/data/availability/	Global Regional National
NASA's Goddard Institute for Space Studies	USA	https://data.giss.nasa.gov/gistemp/	Global Regional National
National Oceanic and Atmospheric Administration (NOAA) Climate Services Portal (NCS Portal)	USA	https://www.climate.gov/#climateWatch	Global Regional National
Australia's Bureau of Meteorology	Australia	http://www.bom.gov.au/climate/	Global Regional National
China Meteorological Administration (CMA)	China	http://www.cma.gov.cn/en2014/	Global Regional National
Caribbean Community Climate Change Centre (CCCCC)	Caribbean Community (CARICOM)	https://www.caribbeanclimate.bz/	Regional National
Fiji Meteorological Service	Fiji	https://www.met.gov.fj/	Regional National
Southern African Development Community Climate Services Centre (SADC CSC)	South Africa	http://csc.sadc.int/en/	Regional Subregional
U.K. Met Office Weather and Climate	U.K.	https://www.metoffice.gov.uk/	Global Regional National Local
Climate Service Center Germany (GERICS)	Germany	https://www.climate-service-center.de/index.php.en	Global Regional National Local
Météo-France	France	https://meteofrance.com/	Global National
SERVIR Mekong	Lower Mekong region (Cambodia, Lao PDR, Myanmar, Thailand and Viet Nam)	https://servir.adpc.net/	Regional National Local

APPENDIX D:
ENVIRONMENT AND HEALTH DATA PORTALS FROM INTERNATIONAL, NATIONAL AND SUBNATIONAL SOURCES

International

			Metadata			Data Presentation Features						
Name	Location	Lowest Level	Source	Description	Context	Interaction	Table/Bar	Longitudinal	Map	Advanced Disaggregation	Additional Resources	Download Data
UNICEF Multiple Indicator Cluster Surveys (MICS) https://mics.unicef.org	Global	State/ County	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
The DHS Program: Demographic and Health Surveys https://dhsprogram.com	Global	State/ County	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
United Nations Environment Programme Environmental Data Explorer http://geodata.grid.unep.ch/extras/indicators.php	Global	State/ County	No	No	No	No	Yes	Yes	No	No	No	Yes
UNICEF EQUIST https://www.equist.info/en/pages/dashboard	Global	State/ County	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
European Core Health Indicators https://ec.europa.eu/health/non_communicable_diseases/indicators_en	Europe	National	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Surveillance, Epidemiology, and End Results Program (SEER) https://www.nlm.nih.gov/toxnet/index.html#NCI_SEER	North America	Point Source	Yes	No	No	No	Yes	Yes	Yes	No	Yes	Yes

International

			Metadata			Data Presentation Features						
Name	Location	Lowest Level	Source	Description	Context	Interaction	Table/Bar	Longitudinal	Map	Advanced Disaggregation	Additional Resources	Download Data
Toxic Sites Identification Program https://www.contaminatedsites.org	Global	Point Source	Yes	No	No	No	No	No	Yes	No	Yes	No
Global Alliance on Health and Pollution https://www.pollution.org	Global	Point Source	Yes	No	No	No	No	No	Yes	No	Yes	No
The European Surveillance System https://www.ecdc.europa.eu/en/publications-data/european-surveillance-system-tessy	Europe	National	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes
The European Environment and Epidemiology Network https://geoportal.ecdc.europa.eu/e3-network/generaldescription	Europe	National	Yes	No	Yes	No	Yes	Yes	Yes	Yes	No	Yes
Environment and Health Information System https://gateway.euro.who.int/en/datasets/enhis/	Europe	National	Yes	Yes	No	No	Yes	Yes	Yes	No	Yes	Yes
Human Biomonitoring for Europe https://www.hbm4eu.eu	Europe	National	Yes	Yes	No	No	Yes	Yes	Yes	No	No	Yes
Pacific Public Health Surveillance Network https://www.pphsn.net	Pacific, Solomon Islands	National	Yes	No	No	No	Yes	Yes	No	No	Yes	No

National

			Metadata			Data Presentation Features						
Name	Location	Lowest Level	Source	Description	Context	Interaction	Table/Bar	Longitudinal	Map	Advanced Disaggregation	Additional Resources	Download Data
U.S. CDC National Environmental Public Health Tracking https://www.cdc.gov/nceh/tracking/	United States	State/ County	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Environmental Health Intelligence New Zealand, at Massey University: Environmental Health Indicators https://www.ehinz.ac.nz/indicators/overview/about-the-indicators/	New Zealand	State/ County	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes
China National Environmental Health Tracking http://inphet.org/wp-content/uploads/2018/06/3_China-National-Environmental-Health-Tracking_20160831.pdf	China	Point Source	Yes	Yes	No	No	Yes	Yes	Yes	No	No	Yes
Canadian Urban Environmental Health Research Consortium https://canue.ca	Canada	Neigh-borhood	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes
National Institute for Public Health and the Environment https://www.rivm.nl/en	Nether-lands	National	No	No	Yes	No	No	No	No	No	No	No
Institute of Public and Environmental Affairs (IPE) China http://wwwen.ipe.org.cn/AirMap_fxy/AirMap.html?q=1	China	Point Source	Yes	No	No	No	Yes	Yes	Yes	No	Yes	No

Subnational

			Metadata			Data Presentation Features						
Name	Location	Lowest Level	Source	Description	Context	Interaction	Table/Bar	Longitudinal	Map	Advanced Disaggregation	Additional Resources	Download Data
New York City Environment and Health Portal http://a816-dohbesp.nyc.gov/IndicatorPublic/PublicTracking.aspx	New York City, USA	Neighborhood	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Tracking California http://www.trackingcalifornia.org	California, USA	State/County	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Government of South Australia, Public Health Indicators https://www.sahealth.sa.gov.au/wps/wcm/connect/public+content/sa+health+internet/about+us/legislation/public+health+act/state+public+health+plan/public+health+indicators	South Australia, Australia	State/County	Yes	No	Yes	No	Yes	Yes	Yes	No	Yes	No
Acute Care Enhanced Surveillance Ontario https://www.kflaphi.ca/acute-care-enhanced-surveillance/	Ontario, Canada	Neighborhood	Yes	No	No	No	No	Yes	Yes	No	Yes	Yes
EpiQuery NYC https://a816-health.nyc.gov/hdi/epiquery/	New York City, USA	Neighborhood	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No

Vital Strategies

unicef | for every child

PROMOTING HEALTHY ENVIRONMENTS FOR CHILDREN BY USING INDICATORS

Technical Brief for Countries in the East Asia and Pacific Region