Global environmental health: an interview with Sally Perreault Darney

By Li Xu and Bin Zhao

Pollution-induced health problems are of concern across the world. In China, the recent and rapid surge of economic development has been associated with public health problems as well as environmental degradation. We recently spoke with Sally Perreault Darney, Ph.D., the Editor-in-Chief of Environmental Health Perspectives (EHP), the foremost journal about environmental health. Published by the National Institute of Environmental Health Sciences (NIEHS), a part of the US National Institutes of Health, this fully open-access journal publishes peer-reviewed research and commentary, as well news and opinion across the many disciplines that contribute to the field of environmental health, including toxicology, epidemiology, risk assessment and exposure science. We wanted to learn her perspectives on the role that research plays in defining and solving environmental health problems in today’s world. Dr. Darney holds a Ph.D. in Biomedical Science and enjoyed a productive research career in the US Environmental Protection Agency (EPA)’s Office of Research and Development, before joining NIEHS in 2015.

NSR: What are your perspectives on environmental health? How does our environment affect our lives, and how can environmental health scientists contribute to a better understanding of the relationship between environment and health?

Darney: My interest in environmental health goes back to the early 1970s when I was teaching biology at a community college. This was a period of time when awareness was growing in the United States about environmental pollution and its potential adverse effects on human health. I became aware that my students did not know a lot about either their health or the environment on which life depends, and the relationship between the two. As my passion for teaching my students about health and environment, and I become aware of the gaps in knowledge that needed to be filled to find solutions to environmental health problems, I decided to return to graduate school and commit to a research career.

After graduate school and postdoctoral research in a school of public health, I directed a research program in health effects of pollution in the Office of Research and Development of the US Environmental Protection Agency. Over more than 30 years with the EPA, my perspective on the environment and health was broadened by rewarding interactions with exposure scientists, engineers and ecologists, as well as colleagues in the health field.

Now as the Editor-in-Chief of EHP, I am applying this broad view to ensure that we publish the most important environmental health research that provides reliable information to decision- and policy-makers in government, the private sector and biomedicine. Clearly, we need to make decisions based on scientific findings, but also consider other factors such as economic realities, cultural norms and political will. We have and continue to suffer the legacy of harmful exposures based on either poor decisions or lack of decisions in the past, and face a pressing need to clean up the environment. On the other hand, we must look forward in time to prevent pollution at its source, and avoid introducing potentially harmful substances into our food, air, water and soil. We now have much more scientific knowledge and data to help us do this.

Cleaning up the environment and predicting which substances might pose a risk is becoming ever more feasible with new technology, engineering and computational power. We can apply this knowledge to the life cycle of products, from ‘cradle to grave’ so to speak, by evaluating not only potential chemical hazards in final products, but also the energy and chemicals used in synthesizing the product, using the product and, finally, disposing of the product at the end of its useful life. Importantly, we should be doing this sort of analysis before making decisions to move a product into production.
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—Sally Perreault Darney

With foresight and by taking a "systems approach" to environmental problems we should be able to make informed decisions that create safer and more sustainable products, prevent pollution, generate jobs and save money, all at the same time.

**NSR**: Can you tell us the current status of environmental problems?

**Darney**: The environment and our societies that rely on the environment are complex. Therefore, our environmental problems are complex; and, accordingly, complex problems require complex solutions. So, we need to think not only about the nature of those problems but also about the kinds of technology and expertise we need in order to solve them. Such solutions typically require a multi-disciplinary approach that involves scientists with expertise in toxicology, exposure science, biomonitoring, epidemiology, biomedicine, health, engineering, social sciences, economics and political science in order to consider all the complex part of the problem, and come up with solutions.

As for specific issues, air pollution is a top priority in my opinion. We have severe air-pollution problems in a number of places in the world, including China. Epidemiology research has convincingly shown association between air pollution and respiratory health as well as cancer; and, there is growing evidence that air pollution can also influence neurodevelopment (e.g., children’s IQ, and risk of metabolic disease). From exposure research, we have learned a lot about the components of air pollution, and the need to understand how they interact with each other to impact health is widely acknowledged. In the past, the focus was on studying one component and one health outcome at a time. But air-quality experts are calling for more information about all components (those that are tracked based on regulatory air-quality standards, as well as a variety of metals and volatile substances generated by industrial activities) where more information is needed. Furthermore, we need a better understanding of how climatic factors (temperature, direct sunlight, wind, precipitation) influence the concentrations and composition of air pollution in specific places and use such information to develop predictive models that can inform public health preparedness.

Problems related to chemical exposures and contaminated water likewise benefit from approaches that evaluate complex exposures and effects.

**NSR**: What makes environmental health a unique discipline?

**Darney**: The field of environmental health is highly multi-disciplinary in nature. Finding solutions often requires that scientists and decision-makers in multiple disciplines work together. Therefore, they need to understand each other’s discipline-specific insights, priorities and technical terminology. It is also a field where achieving progress can be slow but is at the same time very urgent. It is well accepted that our society activities coupled with continually increasing human populations are consuming the Earth’s natural resources much faster than they can be regenerated; and, of course, we only have one Earth. The consequences are becoming more and more evident as food sources dwindle (e.g., fish in our oceans), oxygen-generating forests are destroyed, coral reefs (which support much aquatic life) are dying, and people are becoming sick from air and water pollution. We must generate the will to solve environmental problems to ensure the sustainability of future generations and of our planet. It is imperative to invest in prioritizing the problems, deciding which are the most important, and focusing the will and resources necessary to solve them. This is difficult when there are many pressing immediate needs such as provision of medical care and employment opportunities. Furthermore, many environmental problems are international in nature and require international efforts and cooperation among nations who may not be on good terms with each other. This is not easy. Our educational systems must teach young people about environmental health, in all its complexity, and encourage them to enter this field.

I mentioned that cross-disciplinary research requires the interchange of information among experts who have different vocabularies and different approaches. For example, toxicology is very reductionist. We use animals or *in vitro* systems to isolate one variable and try to keep everything else the same, so we can show causation. But obviously we live in a world that is full of complex exposures and populated with people who respond to environmental stressors in different ways. The latter can be based on genetic and epigenetic variations, as well as age, gender, diet and other factors. To look at all these factors in a real-world scenario requires epidemiological approaches where the various determinants of health can be identified and assessed. Let’s consider asthma as an example. Biomedical research has shown that some people are genetically predisposed to becoming asthmatic, while environmental science has provided a great deal of evidence that people exposed to air pollution and/or certain allergens and other substances in the environment are more likely to get asthma and to suffer more severely from it. We need to put inherent (biological) risk factors together with environmental risk factors to understand how best to regulate air pollution to prevent the environmental triggers. We can’t change our genetics, but we can change our environment to prevent risk and improve health.

**NSR**: What’s new in environmental health research in terms of methodology? How does modern technology benefit environmental health research? How can we better integrate methods and concepts of related disciplines into this field?

**Darney**: Many areas of environmental health are benefitting from advances in new methods. Advances in molecular genetics provide tools (e.g., gene arrays, RT–PCR, global and specific epigenome analysis) for evaluating changes in gene expression related to environmental exposures, and elucidating specific mechanisms of action (e.g., gene knock-out/knock-in models in mice and cells). Advances in analytical chemistry instrumentation and metabolomics not only enable us to detect chemicals in the environment, but also monitor the level
of chemicals, their metabolites and their interactions with endogenous chemicals in people, animal models and cells. Such information is enabling the development of improved surveillance systems for monitoring changes in chemical exposures across human populations, and can be fed into physiologically based pharmacokinetic models to understand disease causation. Furthermore, improved bioinformatics methods and computational power are combining to provide toxicologists with the tools needed to screen thousands of chemicals for their ability to impact a variety of molecular initiating events in biological pathways to disease causation. Such approaches, collectively called ‘Toxicology in the 21st Century’, are enabling predictive toxicity in high throughput mode, which is a much more time- and resource-efficient manner than traditional approaches.

Engineering advances applied to monitoring devices are also revolutionizing the field. For example, miniaturization of monitors is enabling environmental monitoring at much finer scales and allows ‘citizen scientists’ to collect personal monitoring data where they live, work and play. Some of these tools combine detection of chemicals with monitoring of internal processes such as heart rate and blood pressure. Such information can contribute not only to environmental research, but also to personal decisions about healthy behaviors and activities. Furthermore, the Internet can enable ‘crowd sourcing’ of such information.

NSR: Developmental toxicity is one of the important issues in environmental health. How do you think these new technologies could help with the developmental toxicology research? What makes children more vulnerable compared with adults in exposure risk?

Darney: My previous job at the EPA centered on research specifically designed to explore developmental and reproductive toxicology. Back in the 1990s and early 2000s, we added tests to EPA’s reproductive and developmental test guidelines to expand the information derived from them. Current research is more molecular and cell-based, including the use of stem cells to evaluate effects of chemicals on the biological processes that govern very early embryonic development. For example, stem cells can be directed to develop into cardiomyocytes in vitro, and the results used to shed light on the development of the heart. New molecular methods are also being used to determine the extent to which environmental exposures and conditions may cause epigenetic modifications that influence the timing or normalcy of embryonic development and future health.

In terms of children’s health, we have learned much about environmental impacts on development from mother–child cohort studies, some of which have been ongoing since the late 1990s. While attention was at first directed at how certain chemicals and pharmaceuticals to which pregnant women were exposed could cause birth defects, more recent research, made possible by tracking children longitudinally from birth through adolescence, is showing that early-life exposures may contribute to chronic disease risk later in life. Such studies collectively address the concept of ‘Developmental Origins of Health and Disease’. From these and others, we have learned that children are often more vulnerable than adults in more than one way. Pound for pound, infants and children breathe more air, drink more water and consume more food than adults. So if there are contaminants in any medium (food, air, water) children are likely to be more exposed than adults. In addition, because their bodies are still developing, they may be more vulnerable than adults to effects of chemicals that interfere with growth and development, and the consequences are more likely to be permanent.

I would be remiss not to mention changes in risk-assessment approaches and risk-management strategies. Research is developing better methods to predict risk from complex exposures, and better ways to reduce exposures to multiple chemicals. With increasing interest on the part of the public, especially women who are pregnant or raising young children, new ways to get accurate information about how to avoid exposures, without unnecessarily alarming the public, are much needed. The information needs to be not only reliable but also presented in a way that is understandable by a non-technical public audience. This is where journals like EHP can play an important role.

NSR: As one of the major contributors to scientific research in the world, China is still facing big environmental challenges. What would you suggest for the Chinese environmental health research community, institutions and government to develop environmental health research and environmental protection?

Darney: I think China has certain unique problems, and the causes and nature of these problems needs to be understood better in order to take action. While I am familiar with regulatory controls in the US, I am far less familiar with how authorities in China are addressing environmental problems. During my recent visit to Beijing and Wuhan, it was clear that air pollution is a persistent and highly visible problem. Industrialization and improved economic conditions contribute to this problem by adding to emissions. Food safety is also a compelling need everywhere, but especially in large cities such as those in China where food must be packaged and handled to stay fresh during transit and distribution. The good news is that Chinese environmental scientists are being well funded to address these problems with modern facilities and tools. Because other countries in the world have similar or even worse environmental problems, China can lead the way in finding solutions that are transferable to other countries where research support and scientific capacity may be lower.

Chinese scientists, along with scientists around the globe, need access to the latest research results. I am proud that NIEHS has made it possible to provide EHP content, without cost or subscription, to anyone with an Internet connection. Motivated by requests from our Chinese partners for publishing some of our content in Chinese, particularly the news articles which
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address important contemporary issues, we launched the EHP Chinese Edition some years ago. The Chinese Edition publishes EHP news and other articles that are relevant to China in Chinese, and is particularly informative for decision-makers and the public who may be less fluent in English than Chinese scientists.

EHP now receives many submissions of research articles from Chinese scientists. These, along with all the papers in EHP, provide information that can be used by China to solve its environmental problems. As an important part of the international environmental health community, Chinese scientists are contributing new knowledge that can inform environmental policies not only in China, but across the globe.

NSR: Recent research suggests that human reproductive ability may be declining. What kind of role does environmental pollution play in this problem?

Darney: In the 1990s, several papers suggested that sperm counts in men were declining over time. In the US, the percentage of couples seeking medical help to have a baby seems to be increasing. These reports prompted concern about environmental contaminants that might be causing such effects and stimulated research, especially in Denmark and the US. Additional research indicated that the incidence of testicular cancer (the most common cancer in young men) was increasing in certain countries including Denmark. These findings stimulated a great deal of new research about male reproductive health and the environment, and led to improvements in study design, analysis and laboratory methods. Furthermore, because couples are having children at older ages in many parts of the world, and age is associated with declining reproductive success, contemporary studies include consideration of age and other demographic information, as well as the influence of life-style factors such as diet and consumption of alcohol and smoking. Again, taking a more systems-based approach that includes multiple determinants and outcome measures should help us resolve this interesting issue.

NSR: Environmental concerns impact everyone’s life. People receive tons of news regarding environment and health every day. How can they ‘filter’ the news and get authentic and useful information? What can scientists do to help the public get reliable and trustworthy information?

Darney: Clearly, environmental issues impact everyone’s life, and articles on this topic abound in newspapers, magazines, television news reports and on the Internet. Because some news may be biased or alarming, I believe strongly that we need to educate the public to be able to tell the difference between reliable information and so-called ‘junk science’. Young people, especially, need to learn not to believe everything you read on the Internet. Therefore, we need to educate young people so that they have enough background in science that they can read an article and question its conclusions. Each study is different, involving groups of people who are exposed to different chemicals, and are living in different environments. Therefore, no one study is definitive, and the whole body of knowledge needs to be synthesized.

Journals like EHP publish scholarly reviews that evaluate all the published evidence that has accumulated over time. Such ‘systematic reviews’ consider how strong that evidence is based on defined criteria such as the size of the study and the strength of the analysis. They are particularly useful for informing regulatory decisions.

I also believe all young people should be taught about the scientific method in school, and learn to read articles in the popular press more critically. In turn, this means we need to educate teachers as well. Everyone should understand how to find reliable information online. EHP has recently modernized its website to make our news content, written in less technical language for a more general audience, more discoverable and to provide links to additional reliable information on other websites such as those designed to inform women about how to have healthy babies.

In the US, many government agencies and non-governmental organizations have websites designed to inform the public about health issues, including environmental health. Many radio and television programs include segments on science. Environmental scientists interviewed for such programs need to be able to speak to the public in terms they can understand. In this way, environmental scientists, as well as journal and public media, can play a critical role in educating the public about environment and health.

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