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Special Report:

Managing Plastics in a Sustainable Way – A Global Necessity

The Ellen MacArthur Foundation

Editor's Note:

Plastic is everywhere, but insufficient thought is given to what happens after it is discarded. Most plastic is considered waste after its first, brief use. In the absence of an efficient recapture process, plastic "leaks" into the environment, most notably into the oceans, and creates damage far exceeding its original value. Plastic should be managed as a precious commodity because its cost skyrockets when allowed to occupy natural environments. Plastic in the environment is a big and complicated problem – the solution also is big and complicated.

The Ellen MacArthur Foundation, in partnership with the World Economic Forum and McKinsey & Company, proposed the implementation of a circular plastics economy to deal with these issues. Their roadmap to creating a sustainable lifecycle for plastic packaging is described in The New Plastics Economy: Rethinking the Future of Plastics.

This Renewable Natural Resources Foundation (RNRF) Special Report summarizes the key ideas and concepts of the New Plastics Economy.

I. Introduction

The New Plastics Economy detailed an approach for managing plastics through a circular economy. A circular economy is built on the concept of eliminating waste and pollution; keeping materials and products in use, rather than discarding them; and regenerating natural systems. Essentially, a circular approach deals with a product or material, in this case plastics, throughout its entire lifecycle. The New Plastics Economy emphasized the need to establish this circular economy to provide a future for plastic beyond its initial use.

Plastics are an integral part of modern society. Over the last 50 years plastics production has drastically surged, "from 15 million tonnes in 1964 to 311 million tonnes in 2014, and is expected to double again over the next 20 years, as plastics come to serve increasingly many applications."[1] Plastics provide unparalleled utility to our everyday lives but plastics also come with environmental and human health impacts that must be remedied. It is estimated that "at least 8 million tonnes of plastics leak into the ocean each year[2] – which is equivalent to dumping the contents of one garbage truck into the ocean per minute."[3] Much of the plastic that makes its way into the ocean breaks down into harmful microplastics that are ingested by marine animals. Plastics also significantly contribute to climate change through greenhouse gas emissions during production and are composed of substances that may contain substances harmful to human health and the environment.

II. New Approach Required to Implement the New Plastics Economy

The transition to the New Plastics Economy will need to be built on existing improvement initiatives and steered by the creation of an independent coordinating vehicle. This vehicle would aim to "stimulate development of a circular economy approach to plastics and plastic packaging as an integral part of the future economy. It would also aim for positive broader economic impacts and – directly

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[1] World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company, *The New Plastics Economy: Rethinking the future of plastics* at 17 (2016, https://www.ellenmacarthurfoundation.org/publications).

[2] J. R. Jambeck et al., Plastic waste inputs from land into the ocean (Science, 13 February 2015).

[3] World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company at 29.

or indirectly – to the protection and restoration of natural systems.”[4] Consumer goods companies, plastic producers and manufacturers, cities and businesses involved in after-use infrastructure, policymakers and NGOs all have a role to play in the New Plastics Economy. For example, policymakers could help to drive the transition through incentives and fostering secondary markets and innovation, while the NGO community could help to guarantee that social and environmental concerns are evaluated. Collaboration is essential to overcome the fragmentation within the plastics economy and bring about the New Plastics Economy.

III. The New Plastics Economy

The New Plastics Economy is built on the concept of a circular economy meaning, as the name connotes, a looped system that is designed to be restorative and regenerative. A key principle of the New Plastics Economy is that “products and materials are circulated at their highest value at all times.”[5] The three pillars of the New Plastics Economy include: (1) creating an effective after-use plastics economy through improved recycling, reuse and targeted compostable packaging, (2) drastically reduce plastic leakage into natural ecosystems (e.g. the ocean), (3) decouple plastics from fossil fuels through dematerialization and employing renewably-sourced plastics from biomass and/or captured greenhouse gases.

i. Creating an Effective After-Use Plastics Economy

The first priority of the New Plastics Economy is to establish an effective after-use plastics economy by improving the economics and uptake of recycling, reuse and targeted compostable packaging.

a. Recycling

To date, only 14% of plastic packaging is gathered for recycling. And of the plastic that is recycled, most is down-cycled into a lower value product that cannot be economically recycled again. It is estimated that “about 95% of plastic packaging material value, or US $80-120 billion annually, is lost to the economy after a short first-use

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[4] World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company at 39.

[5] World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company at 47.

cycle."[6] The New Plastics Economy sees this as an economic opportunity for industry to capitalize on by implementing five levers of change described below.

1. Establish a Cross-Value Chain Dialogue Mechanism

In order to remedy the disjointed plastics recycling process there must first be the ability to communicate among all parties involved, namely there must be a global cross-value chain dialogue mechanism. This mechanism would require actors from each step of the global value chain – from refining to reprocessing – to coordinate and communicate to overcome the fragmented processes and steer coordinated action. Coordination and communication are key to enacting largescale improvements to recycling worldwide.

2. Develop a Global Plastics Protocol to Set Direction on the Redesign and Convergence of Materials, Formats, and After-Use Systems

The current plastics economy is extremely fragmented due to a lack of unified standards and coordination across the value chain. As a result, there are inconsistent global plastic packaging designs as well as collection and sorting practices. The New Plastics Economy advocates for the creation of a protocol that would provide guidance on labeling, design, marketing, after-use infrastructure and secondary markets to bring uniformity to this process while allowing for innovation and regional differences.

The New Plastics Economy recommends that these plastic packaging design guidelines be industry-driven, global, flexible and coordinated with the development of after-use infrastructure. Global design guidelines could also provide a basis for policymakers to increase incentive measures. For example, in France "fees [that are] paid into the Extended Producer Responsibility compliance mechanism can reflect penalties for designs that are known to impede high-quality recycling (e.g. PET bottles with PVC or aluminum labels or caps)."[7] Using global design guidelines would create uniformity for producers and avoid the confusion of having to adhere to numerous regional regulations.

To start, design guidelines could be focused on replacing certain design and material elements that are harder to recycle. The idea would be to replace these problems materials/designs with existing alternatives that have a higher chance of recyclability without seriously impacting costs and performance of the product. An example of this is PVC, which can inhibit recycling, and already has existing alternativities for a majority of its packaging applications.

Design guidelines would need to be aligned with the global guidelines for after-use systems in order to be successful. This synergistic approach would enable innovation in sorting, labeling and other technologies to rapidly scale up and allow people to uniformly sort their plastics more easily. Cities and businesses involved in after-use infrastructure (e.g. collection and sorting) would also benefit from the economies of scale and could share best practices across the industry.

Collection and sorting guidelines need to be built on two basic principles: (1) source separation and, (2) comprehensive collection. Source separation simply means that biological cycle materials and technical cycle materials need to be dealt with differently – they must be separated. This separation can take place at the sources (i.e. household bins) or later in designated sorting facilities. Source separation improves the quality of recycling by avoiding contamination between biological and technical cycle materials during collection.

Currently, the collection systems of many countries are focused on collecting certain plastic packaging that have developed recycling markets, while the remaining plastic packaging becomes waste. This lack of comprehensive collection and sorting infrastructure creates an impasse to design improvements. There is no incentive to design recycle-focused products or develop reprocessing infrastructure when there is no way to effectively collect and

[6] World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company at 46.

[7] INSEAD, Extended Producer Responsibility: Stakeholder Concerns and Future Developments (2014); http://www.ecoemballages.fr/

sort the materials. The New Plastic Economy suggests that coordinated cross-value chain action could help overcome this impasse.

3. Focus on Key Innovation Opportunities That Have the Potential to Scale Up

Technological innovation is needed to achieve drastically better recycling rates, quality and economics. Collaboration and coordination from industry is integral to fulfilling this potential for improved recycling. Namely, there needs to be design innovation for improved recycling ability without comprised functionality such as investments in new or improved materials, sorting and reprocessing as well as improved mechanical and chemical recycling processes.

4. Enable Secondary Markets for Recycled Materials

The transition to the New Plastics Economy could be accelerated by creating a secondary market for recycled materials. In order to achieve his goal, there would need to be enhanced transparency to better match supply and demand as well as strengthening the "pull effect" on the demand side. The "pull" effect could be strengthened through a combination of industry commitments and policy decisions.

Transparency in material composition and specifications is extremely important and helps to better facilitate matchmaking between supply and demand. This better matchup could be achieved by introducing and scaling up matchmaking mechanisms. For example, an aggregator software or platform could be used to match recyclers and companies that sources recycled content.

The "pull" effect, meaning one that is intended to create demand for a product, could be strengthened for plastic packaging through voluntary industry measures or policy-driven. Creating demand for plastic packaging through the "pull" effect could expedite the transition to an after-use plastics economy. For example, manufacturers and/or companies could voluntary commit to using recycled material in their products, thereby generating a significant demand for recycled plastics. On the policy side, a law that imposes mandatory use of recycled materials could be implemented or incentives such as tax advantages or rebates on Extended Producer Responsibility contributions could be used. Extended Producer Responsibility refers to the approach where producers are required to take more responsibility, financially and/or physically, for the treatment or disposal of their products.

5. Explore the Enabling Role of Policy

Policymakers have the ability to play an integral role in allowing businesses and local governments to overcome the barriers to an effective recycling economy. In addition to the pull measures, discussed above, policymakers could also explore policy-focused measures. Potential measures include imposition of a carbon tax or bans on landfilling/incinerating as well as implementation of Extended Producer Responsibility schemes.

b. Reuse

Reuse has an integral role to play in the circular plastics economy. The New Plastics Economy asserts that reuse has value in both business-to-business (B2B) and business-to-consumer (B2C) applications. B2B applications could include individual company adoption of reuse systems as well as shared-asset systems such as the "physical internet." B2C applications involve user-centric models that focuses on the willingness of the consumer to be part of the reuse cycle.

Adopting reusable packaging in the B2B setting can provide significant material savings when compared to the disposable option and reduce a company's carbon footprint. If this system is effectively standardized across the board and shared among companies, reusable packaging could help to address waste in the logistics sector and create significant value beyond just material savings. B2B could take place on several different scales including through individual adoption (via a single retailer or brand), single-industry pooling (a reuse system that offers reusable packaging as a cost savings service to companies in a single industry) or multi-industry pooling (offering a reuse system on a larger scale across different industries). An advanced large-scale reuse system could take the form of the "physical internet."

The “physical internet” is a logistics system based on standardized, modularized, shared assets. The three pillars of this vision are (1) reuse – via standardized, modular, reusable, recyclable containers (2) share – via open networks with pooled assets and protocols, and (3) virtualize – employ IT infrastructure that allows real-time tracking. “Unlike the conventional approach of owning and optimizing assets, participants in the Physical Internet aim to optimize delivery of the product, using available assets regardless of ownership.”[8] The New Plastics Economy report states that a transition to the “physical internet” could “unlock significant economic value — estimated to be US $100 billion and a 33% reduction in CO_2 emissions annually in the United States alone.”[9]

B2C business models rely on the willingness of users to partake in reuse systems. This could include business models that take advantage of their user’s willingness to reuse in the home (e.g. using refillable cleaning products) and user-centric reusable packaging in stores (e.g. allowing and encouraging customers to bring in their own containers and use self-service weighing machines for certain goods). The application of the “physical internet” is more challenging in the B2C setting but could be employed for specific targets such as plastic bags.

c. Targeted Compostable Packaging

Most biological nutrients in plastic packaging are either sent to landfills or incinerated. In the United States, the largest element of municipal waste in landfills is uneaten food. Compostable plastic packaging for targeted applications could return this organic material to the soil, if deployed in conjunction with proper collection and recovery infrastructure. In order to make this happen compostable packaging must meet two criteria: (1) the packaging is prone to being mixed with organic content, and (2) compostable materials and recycle materials follow different after-use pathways. This second criterion is crucial because compostable packaging can interfere with the recycling process. Examples that meet both criteria include teabag packaging, coffee capsules and bags for organic waste. In order to execute this properly, requisite industrial composting and anaerobic digestion (the breakdown process that occurs in the absence of oxygen) infrastructure must be in place. Deploying compostable packaging could make a huge difference in reducing food waste worldwide.

ii. Drastically Reduce Plastic Leakage in Natural Ecosystems and Associated Negative Impacts

The New Plastics Economy aims to address plastic packaging issues by focusing on reducing plastic leakage and highlighting issues with certain substances in the composition of plastics.

a. Leakage

It is estimated that over 30% of plastics leak out of the collection system worldwide. Approximately 8 million tonnes of this leaked plastic, the majority of which is plastic packaging, leaks into the ocean every year. These plastics do not breakdown quickly but remain for hundreds of years causing harm to natural ecosystems as well as economic costs that range into the billions.

The New Plastics Economy offers a solution to this leakage by drastically improving after-use infrastructure in high-leakage countries. This improvement alone, however, is not enough. The economic attractiveness of keeping plastics within the system needs to be increased. Meaning, the effort it takes to collect and recycle plastics should be made worth the trouble. This can be achieved by creating an effective after-use plastics economy through recycling, reuse and targeted composting (as described above), which would get to the root cause of leakage.

Additionally, innovation needs to be steered towards bio-benign materials that reduce the negative environmental impacts of plastic packaging pollution. “Today’s plastic packaging offers great functional benefits, but has an inherent design failure: its intended useful life is typically less than one year; however, the material

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[8] World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company at 65.

[9] R. Meller et al., From Horizontal Collaboration to the Physical Internet: Quantifying the Effects on Sustainability and Profits When Shifting to Interconnected Logistics Systems, Final Research Report of the CELDi Physical Internet Project, Phase I (2012).

persists for centuries and can be damaging if it leaks outside collection systems."[10] While plastic leakage into the environment could be greatly reduced it is unlikely that leakage will be eliminated entirely. "Even in the case that leakage of plastic packaging could be reduced globally from 32% to 1%, about 1 million tonnes of plastic packaging would still escape collection systems and accumulate in natural systems each year."[11] Development of bio-benign plastics is greatly needed but faces innovation challenges because this product must also be cost-effective and the ability to scale up to be a viable alternative.

b. Substances of Concern

Plastics are made up numerous substances, some of which are reason for concern. There is uncertainty regarding the long-term impacts of exposure to this material on human health and the environment, namely the ocean. The New Plastics Economy suggested that further research and development of safe alternatives is warranted to capture value by using materials that are safe in all product phases.

iii. Decouple Plastics from Fossil Fuel Feedstocks

The New Plastics Economy advocates for a decoupling of plastics from fossil fuels through the use of dematerialization and renewably sourced plastics.

a. Dematerialization: Doing More with Less Plastic

Dematerialization is "the act of reducing or even eliminating the need for packaging, while maintaining utility."[12] The New Plastics Economy deploys three levers to utilize dematerialization of plastic packaging. These three levers include: (1) light-weighting – the process of reducing the mass of the packaging, (2) rethinking packaging design, and (3) virtualization – the act of delivering utility virtually.

The light-weighting process, while advantageous from a material savings standpoint, has an undesirable side effect for recycling. Reducing the material used through light-weighting may actually lead to more leakage because the product is now less valuable for recycling purposes.

Rethinking packaging design can capture economic value while reducing plastic packaging volume. Moreover, modern consumers are increasingly aware of over-packaging and prefer to buy concentrated products to avoid the excess plastic packaging. Companies could take advantage of this trend to their economic benefit.

Virtualization could drastically reduce the need for plastic packaging. Virtualization examples include those "in which utility is (partly) delivered virtually include the widespread use of digital music, movies and books, as well as emerging additive manufacturing technologies, commonly known as 3D printing, all of which change the requirements and necessity of packaging."[13]

b. Renewably-Sourced Plastics: Decoupling Plastics Production from Fossil Feedstocks

Plastics need to be decoupled from finite resources (i.e. fossil feedstocks) by sourcing plastics from renewable sources. Renewably-sourced plastics could be produced from captured greenhouse gases (i.e. methane and carbon dioxide) or biomass (bio-based). Methane and carbon dioxide can be captured from numerous sources. Methane can be recovered from anaerobic digesters, landfills or coal mines while carbon dioxide can be recovered as a by-product of industrial and chemical processes (e.g. petrochemical production or oil and gas processing). In addition to reducing the use of finite resources, using renewably-sourced plastics could greatly reduce carbon emissions and potentially act as a carbon sink throughout their life cycle.

While bio-based plastic presents an exciting opportunity, it is not currently cost-competitive with fossil-based

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[10] World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company at 77.

[11] World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company at 77.

[12] World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company at 88.

[13] World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company at 90.

plastics. Likewise, GHG-based plastics viability at scale has yet to be seen. Research and innovation in these areas are needed to make renewably-sourced plastics a reality.

IV. Conclusion

Overall, the New Plastics Economy provides a roadmap for a fundamental rethinking of how we deal with plastics. While many elements of this proposal will be difficult to implement, the report aims to be the spark that spurs change. One day this transformation could take place, ushering in the New Plastics Economy.

Read more about *The New Plastics Economy: Rethinking the Future of Plastics*: here.

Particulate Matter Pollution Remains a Human Health Threat

Environmental Law Institute

Editor's Note –

Particulate matter (PM) pollution remains a serious threat to human health. It causes disease in the lungs, heart and cardiovascular system, and also has neurological impacts. Recently, there has been a reversal of decades of progress in reducing PM pollution. The following is an excerpt from the Environmental Law Institute's 2020 report, Reducing Indoor Exposure to Particulate Pollution from Outdoor Sources: Policies and Programs for Improving Air Quality in Homes. *The excerpt is reprinted with permission, and the Environmental Law Institute reserves all rights.*

Industries, households, cars and trucks emit complex mixtures of air pollutants, many of which are harmful to health. Of all of these pollutants, fine particulate matter has the greatest effect on human health.

–World Health Organization[1]

Particulate matter (PM), also referred to as particles or particle pollution, is a complex mixture of small, solid particles and liquid droplets found in air. Particles may be emitted from a source directly, though most form in the atmosphere as a result of complex reactions of other chemicals emitted into the air. Thus, particulate matter may be composed of many different individual substances, including acids (e.g., nitrates and sulfates), organic chemicals, metals, soil or dust particles, and allergens (e.g., mold spores or pollen).[2]

Particulate matter is formed by both human activities and natural processes. While some PM emissions are highly visible and dramatic, others are less obvious. Outdoors, particulate matter is a constituent of wildfire smoke that can drift hundreds of miles, as well as smoke wafting through neighborhoods from backyard fires and fireplaces. It is a result of pollutant emissions from the stacks of industrial and power plants and from the tailpipes of cars and trucks. Particulate matter is also generated indoors, primarily by combustion activities such as smoking, cooking, burning wood, and lighting candles, and by reactions of chemicals.[3]

Regardless of the source, most of our exposure to particle pollution happens when we are *indoors*. A recent study estimated that 90 percent of total exposure to fine particulate matter in the U.S. occurs inside buildings.[4] This is not surprising in light of an earlier study showing that people spend 87 percent of their time in buildings, on average.[5]

While we are exposed to many different pollutants

[1] World Health Organization (WHO), Ambient Air Pollution, https://www.who.int/gho/phe/outdoor_air_pollution/en/(accessed 12/18/19).

[2] U.S. Environmental Protection Agency (EPA), Particle Pollution and Your Health (2003), https://www3.epa.gov/airnow/particle/pm-color.pdf. When outdoor particles move indoors, "the chemical content can change substantially, acquiring substances such as phthalates, organophosphates, and perfluorinated surfactants from the indoor air. Natl. Acad. of Sciences, Health Risks of Indoor Exposure to Particulate Matter: Workshop Summary at 34-37 (2016), available at http://nationalacademies.org/hmd/Activities/PublicHealth/Health-Risks-Indoor-Exposure-ParticulateMatter/2016-FEB-10.aspx (summarizing remarks of Charles Weschler).

[3] U.S. EPA, Indoor Particulate Matter, https://www.epa.gov/indoor-air-quality-iaq/indoor-particulate-matter; Cal. Air Resources Board, Reduce your Exposure to Particle Pollutants, https://ww2.arb.ca.gov/resources/fact-sheets/reduce-your-exposure-particle-pollution.

[4] P. Azimi & B. Stephens, A Framework for Estimating the U.S. Mortality Burden of Fine Particulate Matter Exposure Attributable to Indoor and Outdoor Microenvironments, *J. Expo. Sci. Environ. Epidemiol.* at Table 2 (12/05/18), https://www.nature.com/articles/s41370-018-0103-4 [hereinafter "Azimi & Stephens"](estimating the mean fraction of total PM2.5 exposure).

indoors, particulate matter is one of the most significant in terms of health risks. Indeed, a study by scientists at Lawrence Berkeley National Laboratory modeled the health impacts of non-biological air pollutants in U.S. homes and found that fine particulate matter was responsible for the largest number of lost years of productive life.[6] Responding to heightened attention to indoor PM exposure over the last several years, the National Academies of Sciences, Engineering and Medicine convened a workshop of scientific experts in 2016 to review the health risks and possible intervention strategies and to identify key research questions.[7]

Governments at all levels have an important role to play in changing how we construct, operate, and maintain buildings to protect people from being exposed to particle pollution. The ELI report discusses some of the ways that states, tribes, and local governments can improve public health and save lives by developing policies and programs to reduce indoor exposure to *particulate matter generated outdoors* (referred to here as "outdoor PM"), which enters buildings and comprises a large portion of indoor PM exposure.[8] Indoor activities and products also contribute significantly to PM exposures inside the home, and policies aimed specifically at reducing exposure to key indoor PM sources will be addressed in future ELI reports.

Health Effects of Particulate Matter

A great deal is known about the health effects of breathing particulate matter, thanks to a large body of scientific research conducted over decades. Breathing particles not only causes respiratory and other illnesses, but shortens lives as well.[9] Globally, these health effects "occur at levels of exposure currently being experienced by many people both in urban and rural areas and in developed and developing countries – although exposures in many fast-developing cities today are often far higher than in developed cities of comparable size."[10] In the United States, where great strides have been made to improve ambient air quality, exposure to particulate matter remains a serious public health problem. Recent estimates of premature deaths associated with particulate matter range from tens to hundreds of thousands each year.[11]

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[5] N. Klepeis, The National Human Activity Pattern Survey (NHAPS): A Resource for Assessing Exposure to Environmental Pollutants (2001), https://indoor.lbl.gov/sites/all/files/lbnl-47713.pdf.

[6] J. Logue, et al., A Method to Estimate the Chronic Health Impact of Air Pollutants in U.S. Residences, *Envtl. Health Persp.*, v. 120, no. 2 at 216 (2012), https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3279453/.

[7] *See* Natl. Acad. of Sciences, Health Risks of Indoor Exposure to Particulate Matter: Workshop Summary (2016), available at http://nationalacademies.org/hmd/Activities/PublicHealth/Health-Risks-Indoor-Exposure-ParticulateMatter/2016-FEB-10.aspx.

[8] *See* Azimi & Stephens, supra, at 1 (noting that "indoor exposure to [fine particulate matter] of outdoor origin is typically the largest total exposure, accounting for ~40-60% of total mortality"); R. Allen, Indoor Particulate Matter Pollution and Cardiovascular Health (presentation at the Workshop on the Health Risks of Indoor Exposure to Particulate Matter) (2/11/16), available at: http://nationalacademies.org/hmd/Activities/PublicHealth/Health-Risks-Indoor-Exposure-ParticulateMatter/2016-FEB-10.aspx (discussing study finding that outdoor PM2.5 accounted for 80% of indoor PM2.5 in non-smoking U.S. homes).

[9] *See generally,* WHO, Air Pollution, https://bit.ly/2pxYITb ("There is a close, quantitative relationship between exposure to high concentrations of [PM] and increased mortality or morbidity, both daily and over time.").

[10] WHO, Air Pollution, https://bit.ly/2pxYITb (noting also that in 2016, around 90% of the world's urban population living in cities was exposed to particulate matter in concentrations exceeding the WHO air quality guidelines).

[11] *See, e.g.,* A. Goodkind, et al., Fine-Scale Damage Estimates of Particulate Matter Air Pollution Reveal Opportunities for Location-Specific Mitigation of Emissions, *Proceedings of the Natl. Acad. of Sciences,* 116 (18) 8775-8780 (2019), https://www.pnas.org/content/116/18/8775 (estimating that in the U.S. "anthropogenic PM2.5 was responsible for 107,000 premature deaths in 2011, at a cost to society of $886 billion"); Azimi & Stephens, supra, at 1 (2019 study estimating 230,000-300,000 total deaths associated with PM2.5 exposure in 2012, including both outdoor and indoor sources); A. Cohen, et al., Estimates and 25-year Trends of the Global Burden of Disease Attributable to Ambient Air Pollution: An Analysis of Data from the Global Burden of Disease Study: 2015, *The Lancet,* v. 389, no. 10082 1907-1918 (5/13/17) (estimating over 88,000 deaths in the U.S. attributable to ambient PM pollution in 2015); N. Fann, et al., Estimating the National Public Health Burden Associated with Exposure to Ambient PM2.5 and Ozone, *Risk Anal.* V32(1):81-95 (2012), available at https://www.ncbi.nlm.nih.gov/pubmed/21627672 (estimating 130,000 PM2.5-related deaths in 2005).

Most research in this area has focused on the *size* of particles as an important factor in how they affect health.[12] Particle size (mass median aerodynamic diameter) is measured in microns; one micron (µm) equals one millionth of a meter. Particles under 10 µm are of special concern and are broken down into three categories:

- PM10 – "coarse" particles equal to or less than 10 µm;
- PM2.5 – "fine" particles equal to or less than 2.5 µm; and
- Ultrafine particles, or UFP – particles less than 0.1µm, or 100 nanometers.

These particles are a health concern because when inhaled, they can pass the nasal defenses and penetrate deep into the lungs, and some can even enter the bloodstream. We know the most about the risks of inhaling particles less than 2.5 µm (30 times smaller than the diameter of the average human hair), which have been the focus of much of the public health research.[13]

Although many people think of respiratory problems as the main health effects from air pollution, there is broad consensus that exposure to particle pollution affects not only the respiratory system, but the cardiovascular system as well.[14] In fact, the "global public health burden of PM is primarily due to its cardiovascular effects."[15] A decade ago, EPA's 2009 Integrated Science Assessment of Particulate Matter found that the scientific evidence was sufficient to conclude that a causal relationship exists between short-term and long-term exposure to PM2.5 and cardiovascular effects as well as overall mortality, and that a causal relationship likely exists with respiratory effects.[16]

In 2019, the American Lung Association summarized the scientific literature that linked exposure to particulate matter with a variety of health effects, including:

- Short-term exposure: premature death from respiratory and cardiovascular causes, including strokes; increased hospitalization for cardiovascular and respiratory problems; increased emergency room visits for asthma and increased severity of asthma attacks among children; increased asthma symptoms; inflammation of lung tissue in young, healthy adults; and

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[12] Particles vary considerably in their composition, however the public health research generally addresses the effects of PM as a general class of pollutant. *See* R. Allen, Indoor Particulate Matter Pollution and Cardiovascular Health (presentation at the NAS Workshop on the Health Risks of Indoor Exposure to Particulate Matter) (2/11/16), available at: http://nationalacademies.org/hmd/Activities/PublicHealth/Health-Risks-Indoor-Exposure-ParticulateMatter/2016-FEB-10.aspx (noting that one research gap is the relative toxicity of PM generated indoors versus outdoors); M. Bell and K. Ebisu, Environmental Inequality in Exposures to Airborne Particulate Matter Components in the United States at 1 (2012), *Envtl. Health Persp.,* v. 120, no. 12, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3546368/ (noting toxicity of different parts of the PM mixture as a critical research need).

[13] *See generally* U.S. EPA, Particulate Matter Basics, https://www.epa.gov/pm-pollution/particulate-matter-pm-basics; Centers for Disease Control and Prevention (CDC), Particle Pollution, https://www.cdc.gov/air/particulate_matter.html. The Clean Air Act requires a national network of monitors to measure PM2.5, but not ultrafine particles. See U.S. EPA, Ambient Monitoring Technology Information Center, https://www.epa.gov/amtic/amtic-ambient-air-monitoring-networks. A recent EPA draft report highlighted the need for more research on the health effects of ultrafine particles, including "the potential for translocation of ultrafine particles from the respiratory tract into other compartments...and organs..." U.S. EPA, Policy Assessment for the Review of the National Ambient Air Quality Standards for Particulate Matter, External Review Draft at 3-114 (Sept. 2019), https://www.epa.gov/sites/production/files/2019-09/documents/draft_policy_assessment_for_pm_naaqs_09-05-2019.pdf

[14] *See generally,* CDC, Health Impacts of Fine Particles in Air, https://ephtracking.cdc.gov/showAirHIA.action; Cal. Air Resources Board, Reduce Your Exposure to Particle Pollution, https://ww2.arb.ca.gov/resources/fact-sheets/reduce-your-exposure-particle-pollution; U.S. EPA, Indoor Particulate Matter, https://www.epa.gov/indoor-air-quality-iaq/indoor-particulate-matter.

[15] R. Allen, Indoor Particulate Matter Pollution and Cardiovascular Health (presentation at the Workshop on the Health Risks of Indoor Exposure to Particulate Matter) (2/11/16), available at: http://nationalacademies.org/hmd/Activities/PublicHealth/Health-Risks-Indoor-Exposure-ParticulateMatter/2016-FEB-10.aspx.

[16] U.S. EPA, Integrated Science Assessment for Particulate Matter (2009), available at: https://www.epa.gov/isa/integrated-science-assessment-isa-particulate-matter. The agency's more recent Assessment affirmed this finding. U.S. EPA, Integrated Science Assessment for Particulate Matter (2019), available at: https://cfpub.epa.gov/ncea/isa/recorddisplay.cfm?deid=347534.

- Long-term exposure: increased risk of death from cardiovascular disease; increased risk of lung cancer; slowed lung function growth in children and teenagers; development of asthma in children; significant damage to the small airways of the lungs; and increased risk of lower birth weight and infant mortality.[17]

In 2013, the International Agency for Research on Cancer concluded that outdoor particle pollution causes lung cancer.[18] Studies have also examined the impacts of particulate matter on neurological and psychiatric disorders, finding evidence linking PM2.5 and UFP exposure to, e.g., dementia, Parkinson's disease, and Alzheimer's disease.[19] In its 2019 *Integrated Science Assessment for Particulate Matter*, EPA concluded that the evidence supports a "likely to be causal relationship" between long-term PM2.5 exposure and both cancer and nervous system effects.[20]

Many people in the U.S. are at higher risk of suffering the adverse health consequences of PM exposure. Vulnerable individuals include children, older adults, and people with heart or lung diseases.[21] People of color and low-income children and adults "bear a disproportionate burden of asthma and other respiratory diseases and therefore they may be at increased risk of health effects due to exposure to particle pollution."[22] Socio-economic status, which encompasses a variety of community-level indicators such as education and income, may also increase exposure to particulate matter and the mortality risk from PM exposure.[23]

Ambient Particulate Matter in the United States

Thanks in large part to the implementation of a nationwide regulatory framework for reducing air pollutant emissions, ambient particulate matter in the U.S. has decreased substantially over the past several decades. Nonetheless, many communities throughout the country still experience levels of particle pollution that pose health risks.

Progress under the Clean Air Act. The federal Clean Air Act establishes the nation's principal legal framework for protecting air quality. Among other things, the Act requires the U.S. Environmental Protection Agency (EPA) to set primary (public health) and secondary (public welfare) national ambient air quality

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[17] Amer. Lung Assoc., Particle Pollution (citations omitted) (updated 4/18/19), https://www.lung.org/our-initiatives/healthy-air/outdoor/air-pollution/particle-pollution.html. *See also* U.S. EPA, Wildfire Smoke: A Guide for Public Health Officials at 1 (rev. 2019), https://www3.epa.gov/airnow/wildfire-smoke/wildfire-smoke-guide-revised-2019.pdf [hereinafter EPA Wildfire Smoke Guide] (describing health effects ranging from "eye and respiratory tract irritation to more serious effects, including reduced lung function, pulmonary inflammation, bronchitis, exacerbation of asthma and other lung diseases, exacerbation of cardiovascular diseases, such as heart failure, and even premature death").

[18] *See* D. Loomis, et al., The International Agency for Research on Cancer (IARC) Evaluation of the Carcinogenicity of Outdoor Air Pollution: Focus on China (2014), available at https://www.ncbi.nlm.nih.gov/pubmed/24694836; WHO., Air Pollution, https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health ("A 2013 assessment by WHO's International Agency for Research on Cancer... concluded that outdoor air pollution is carcinogenic to humans, with... particulate matter... most closely associated with increased cancer incidence, especially lung cancer.").

[19] Natl. Acad. of Sciences, Health Risks of Indoor Exposure to Particulate Matter: Workshop Summary at 87 (2016), available at http://nationalacademies.org/hmd/Activities/PublicHealth/Health-Risks-Indoor-Exposure-ParticulateMatter/2016-FEB-10.aspx (summarizing remarks of Marc Weisskopf); Amer. Lung Assoc., Particle Pollution (citations omitted) (updated 4/18/19), https://www.lung.org/our-initiatives/healthy-air/outdoor/air-pollution/particle-pollution.html.

[20] U.S. EPA, Integrated Science Assessment for Particulate Matter at ES-15 (2019), available at: https://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=347534.

[21] CDC, Outdoor Air: Particulate Matter, https://ephtracking.cdc.gov/showAirHealth.action#ParticulateMatter; U.S. EPA, Indoor Particulate Matter, https://www.epa.gov/indoor-air-quality-iaq/indoor-particulate-matter.

[22] EPA Wildfire Smoke Guide, supra, at 9.

[23] Id. at 9. *See also* CDC, Outdoor Air: Health Impacts of Fine Particles in Air, https://ephtracking.cdc.gov/showAirHIA.

[24] 42 U.S.C. §7409. EPA has set NAAQS for PM2.5 and PM10, along with five other "criteria" pollutants (carbon monoxide, nitrogen dioxide, lead, ozone, and sulfur dioxide) that cause adverse health effects.

standards (NAAQS).[24] The primary standards must be set at levels which, "allowing an adequate margin of safety, are requisite to protect the public health."[25] The current 24-hour primary standard for PM2.5 is 35 μg/m³ and the annual standard is 12 μg/m³; the 24-hour standard for PM10 is 150 μg/m³.[26] The NAAQS apply to geographic units known as air quality control regions, which are designated by EPA.[27]

The Clean Air Act is implemented jointly by the federal government and the states. States have "primary responsibility for assuring air quality within the entire geographic area," and they must submit to EPA a State Implementation Plan that specifies "the manner in which national primary and secondary ambient air quality standards will be achieved and maintained within each air quality control region" in the state.[28] The Act requires ambient air monitoring for NAAQS pollutants, and EPA designates air districts as having either attainment or nonattainment status for a pollutant, depending on whether the district meets the federal standard.[29]

The Clean Air Act has been one of the country's most notable environmental success stories. In 2019, EPA reported that emissions of criteria pollutants had fallen by 74 percent since 1970, alongside significant population and economic growth. Since 1990, PM10 levels have fallen 26 percent, and since 2000, PM2.5 levels have fallen 39 percent (annual standard) and 34 percent (24-hour standard).[30] The American Lung Association's *State of the Air 2019* report found that many cities with the highest PM levels have experienced decreases in recent years.[31] These reductions in PM levels have brought corresponding public health benefits.[32]

But there remains work to be done in reducing outdoor PM levels. The *State of the Air 2019* report found that PM levels had increased in many cities, and that more cities had days of elevated short-term PM levels during the period 2015-2017 than they had during 2014-2016.[33] A recent analysis of EPA monitoring data determined that, while overall levels of fine particulate matter decreased by 24 percent between 2009 and 2016, PM2.5 levels increased 5.5 percent between 2016 and 2018.[34]

Ambient Particle Pollution is a Problem that Affects Many States. Many of the areas with the highest PM levels are located in California, but the problem extends beyond one state. *The State of the Air 2019* report, which ranks cities based on PM2.5 monitoring data from 2015-2017, noted that while California continued to dominate the list of the 25 most polluted cities, other states and regions also showed elevated levels:

- For Year-round PM2.5 levels, California had six cities on the list, while Pennsylvania had five. Ohio and Texas each had two cities on the list, and 10 other states were represented. The list reflects cities in all regions of the country.

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[25] 42 U.S.C. § 7409(b).

[26] *See* U.S. EPA, NAAQS Table, https://www.epa.gov/criteria-air-pollutants/naaqs-table.

[27] 42 U.S.C. § 7407

[28] 42 U.S.C. § 7407 (a).

[29] *See* 40 C.F.R. Pt. 58; 42 U.S.C. § 7407(c),(d). EPA also designates some area as "maintenance" – those that previously were in nonattainment, but now meet the standard and must continue steps to meet the standard. A district may also be designated as unclassifiable for a particular criteria pollutant if it lacks the information needed to determine attainment status.

[30] U.S. EPA, Our Nation's Air, https://gispub.epa.gov/air/trendsreport/2019/#introduction.

[31] Amer. Lung Assoc., Year-Round Particle Pollution, https://www.lung.org/our-initiatives/healthy-air/sota/key-findings/year-round-particle-pollution.html

[32] U.S. EPA, Clean Air Act Overview: Progress Cleaning the Air and Improving People's Health, https://www.epa.gov/clean-air-act-overview/progress-cleaning-air-and-improving-peoples-health#pollution.

[33] Amer. Lung Assoc., State of the Air 2019: Key Findings, https://www.lung.org/our-initiatives/healthy-air/sota/key-findings/.

[34] C. Klay & N. Muller, Recent Increases in Air Pollution: Evidence and Implications for Mortality (2019), available at: https://www.nber.org/papers/w26381 (reflecting increases in the West and Midwest regions, while levels in other regions remained mainly flat).

- For 24-hour PM2.5 levels, there was less geographic diversity. California had nine cities on the list, while Oregon and Washington had four and three respectively. Of the nine other states represented, only Pennsylvania and North Dakota are east of the Rocky Mountains.[35]

Areas in Attainment with Federal Standards May Nonetheless Have PM Levels that Pose Health Risks. At the close of 2019, six areas of the country (representing 16 counties over three states) were in nonattainment with federal PM2.5 standards.[36] While the small number of nonattainment areas represents important progress in meeting the goals of the Clean Air Act, these areas are home to approximately 21 million people.

Moreover, exposure to particulate matter at levels *below* current NAAQS standards may also be harmful to health, and research has not identified a threshold value below which PM2.5 does not affect health.[37] The Clean Air Act requires EPA to reevaluate the NAAQS every five years, and EPA began its current review of the PM NAAQS in December 2014.[38] Current World Health Organization (WHO) guideline levels for PM2.5 are lower than U.S. levels, and WHO is currently considering further revisions to the guideline with an expected publication date in 2020.[39]

PM Monitoring Does Not Tell the Local Story. Air quality monitoring under the Clean Air Act provides continuous (hourly) PM data from over 1,200 PM2.5 monitors and 500 PM10 monitors.[40] Because many communities lack monitors, the existing network may not reflect pollution hotspots created by local PM sources, such as high-volume roads. Moreover, the ultrafine particles that are a key component of vehicle exhaust are not subject to federal monitoring or regulation.

Some Communities are Disproportionately Affected by Ambient PM. While there are elevated PM areas throughout the U.S., racial/ethnic disparities in pollution exposure are well documented. According to a 2011 Centers for Disease Control (CDC) analysis: "Minority groups, including Asians and Hispanics, were more likely to reside in [nonattainment] counties in comparison with non-Hispanic whites."[41] Moreover, numerous studies dating back decades have shown that communities of color and lower-income communities are disproportionately located near and affected by pollution from local sources such as hazardous waste sites, landfills, and other polluting facilities.[42] As discussed in Chapter Two of the ELI report, particle pollution from high-volume roads affects many people in many parts of the country, but lower-income communities and communities of color are more likely to live near busy roadways.[43]

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[36] U.S. EPA, PM-2.5 (2012) Designated Area/State Information (accessed 1/8/20), https://www3.epa.gov/airquality/greenbook/kbtc.html

[37] *See. e.g.,* U.S. EPA, Integrated Science Assessment for Particulate Matter at ES-23 (2019), available at: https://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=347534; F. Dominici, et al., (Health Effects Inst.), Assessing Adverse Health Effects of Long-Term Exposure to Low Levels of Ambient Air Pollution: Phase 1 at 24 (Nov. 2019), https://www.healtheffects.org/system/files/dominici-rr-200-report.pdf; U.S. EPA, Policy Assessment for the Review of the National Ambient Air Quality Standards for Particulate Matter, External Review Draft at 3-96, 98 (Sept. 2019), https://www.epa.gov/sites/production/files/2019-09/documents/draft_policy_assessment_for_pm_naaqs_09-05-2019.pdf; WHO, Air Pollution, https://bit.ly/2pxYITb; Natl. Acad. of Sciences, Health Risks of Indoor Exposure to Particulate Matter: Workshop Summary at 78 (2016), available at http://nationalacademies.org/hmd/Activities/PublicHealth/Health-Risks-Indoor-Exposure-ParticulateMatter/2016-FEB-10.aspx (summarizing remarks of Ryan Allen); Amer. Lung Assoc., Year-Round Particle Pollution, https://www.lung.org/our-initiatives/healthy-air/sota/key-findings/year-round-particle-pollution.html.

[38] 42 U.S.C. § 7409(d)(l); U.S. EPA, Particulate Matter (PM) Air Quality Standard, https://www.epa.gov/naaqs/particulate-matter-pm-air-quality-standards.

[39] WHO, WHO Air Quality Guidelines – Global Update 2005, https://www.who.int/airpollution/publications/aqg2005/en/ (PM2.5 standards of 10 µg/m3 [annual] and 25 µg/m3 [daily], compared to 12 µg/m3 and 35 µg/m3, respectively, in the U.S.) ;WHO, Ambient (Outdoor) Air Pollution, https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health.

[40] EPA Wildfire Smoke Guide, supra, at 33.

[41] CDC, Fact Sheet: Health Disparities in Unhealthy Air Quality (2011), https://www.cdc.gov/minorityhealth/chdir/2011/factsheets/AirQuality.pdf.

Reducing Indoor Exposure to Particulate Matter from Outdoor Sources

Source reduction is a crucial strategy for limiting exposure to indoor air pollutants. For pollutants that are prevalent mainly *indoors*, such as radon, lead, and tobacco smoke, source reduction can be achieved by remediating the building or changing personal behavior. For air pollutants generated outdoors, significant source reduction requires broader societal action to speed the transition to cleaner vehicles, industries, and power generation. Reducing PM and other pollutant emissions from these sources of ambient pollution will yield the twin benefits of improving public health and mitigating the impacts of climate change.[44]

Even with accelerated action to reduce outdoor emissions of particulate matter and other pollutants, millions of people across the U.S. will continue to be exposed to particle pollution in the coming decades, and many will become sick or die prematurely as a result. It is important to take steps now to protect people where they are most exposed – in their own homes.[45]

Buildings can provide good protection from outdoor air pollution. In practice, though, existing homes vary widely in the level of protection provided from the fine particles that are strongly associated with health impacts.[46] In general, buildings with envelopes and mechanical systems that are leaky or poorly maintained will provide less protection from outdoor particulate matter. Fortunately, building science provides technical solutions that can be integrated into policy and practice. These solutions include not only reducing infiltration of outdoor air through the building envelope, but also ensuring adequate ventilation and filtering the air inside the building.[47]

Integrating these technical solutions into policies and programs poses a number of challenges. Perhaps the most important challenge is ensuring that the benefits of public policies reach those who are most susceptible to the impacts of air pollution and who cannot afford the cost of implementing recommended measures to reduce their exposure. In developing financial assistance programs to help underserved communities that are heavily impacted by pollution, jurisdictions often must allocate limited funding among a wide array of housing and social service needs. In addition, while considering stronger building and housing standards to protect occupants,

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[42] *See, e.g.,* United Church of Christ, Toxic Wastes and Race in the United States (1987), http://d3n8a8pro7vhmx.cloudfront.net/unitedchurchofchrist/legacy_url/13567/toxwrace87.pdf?1418439935; U.S. EPA, Environmental Equity: Reducing Risk for All Communities (1992). See also C. Tessum et al., Inequity in Consumption of Goods and Services Adds to Racial–Ethnic Disparities in Air Pollution Exposure, Proc Natl. Acad. Sci. USA, 116(13):6001–6 (2019), https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6442600/ (study finding that Blacks are exposed to 21% more PM2.5, and Hispanics 12% more, than the overall population average exposure in the U.S.); M. Miranda, et al., Making the Environmental Justice Grade: The Relative Burden of Air Pollution Exposure in the United States (2011), Intl. J. Environ. Res. Public Health, 8(6): 1755–177 (2011), https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3137995/ (study suggesting that "among areas where monitoring data are available, low income and minority communities tend to experience higher ambient pollution levels").

[43] *See generally* T. Boehmer et al., "Residential Proximity to Major Highways – United States 2010," CDC Morbidity and Mortality Weekly Report Supplement, Vol. 62, No. 3 at 46-47 (2013) (citations omitted), available at: https://www.cdc.gov/mmwr/pdf/other/su6203.pdf.

[44] *See generally* U.S. Global Change Research Program, Fourth National Climate Assessment, Ch. 13 (Air Quality) (2018), https://nca2018.globalchange.gov/chapter/13/; Intergovernmental Panel on Climate Change, Global Warming of 1.5°C (2019), https://www.ipcc.ch/sr15/.

[45] *See* Azimi & Stephens, supra, at Table 2 (estimating that around 70% (mean fraction) of total PM2.5 exposure in the U.S. occurs inside homes and that the majority of this exposure is due to PM2.5 of outdoor origin). On average, 69% of our time is spent in our homes. N. Klepeis, et al., The National Human Activity Pattern Survey (NHAPS): A Resource for Assessing Exposure to Environmental Pollutants (2001), https://indoor.lbl.gov/sites/all/files/lbnl-47713.pdf.

[46] *See* Natl. Acad. of Sciences, Health Risks of Indoor Exposure to Particulate Matter: Workshop Summary at 73 (2016), available at http://nationalacademies.org/hmd/Activities/PublicHealth/Health-Risks-Indoor-Exposure-ParticulateMatter/2016-FEB-10.aspx.

[47] Measures for reducing exposure to PM inside a building may not be as effective in reducing exposure to other air pollutants generated by outdoor sources. See Cal. Air Resources Board., Technical Advisory: Strategies to Reduce Air Pollution Exposure near High-Volume Roadways at 36, https://ww3.arb.ca.gov/ch/rd_technical_advisory_final.pdf [hereinafter CARB 2017 Technical Advisory]; U.S. EPA, Residential Air Cleaners, A Technical Summary (3d ed.) at 7 (2018), https://www.epa.gov/sites/production/files/2018-07/documents/residential_air_cleaners_-_a_technical_summary_3rd_edition.pdf [hereinafter EPA Residential Air Cleaners Technical Summary].

policymakers must also work to preserve and expand the availability of affordable housing units. These multiple, related goals underscore the importance of consulting with affected communities in developing strategies for reducing indoor PM exposure.

The full report, “Reducing Indoor Exposure to Particulate Pollution from Outdoor Sources: Policies and Programs for Improving Air Quality in Homes,” can be found here.

News and Announcements

Renewable Natural Resources Foundation

Remembering John S. Dickey Jr.

(l-r) RNRF Chairman David Moody (AWRA), Maryland Governor Parris Glendening, and John Dickey, chair of RNRF 2002 Congress Program Committee, at the congress in Baltimore.

Scientist, author, and poet, died of cancer at his home in Puerto Rico on October 8, 2019. Born in Washington, D.C., he grew up in Hanover, New Hampshire and graduated from Phillips Exeter Academy, Dartmouth College (AB in geology), the University of Otago (MS in geology on a Fulbright Scholarship), and Princeton University (PhD in geological and geophysical sciences). A member of the Smithsonian research team that first examined the moon rocks from Apollo 11, John's career included positions at M.I.T. (Assistant Professor), NSF (Program Director), Syracuse University (Chair of Geology), Trinity University in San Antonio (Dean of Science, Math, and Engineering), and the American Geophysical Union (Director of Outreach and Research Support).

While at AGU, John served as an alternate RNRF board member from 1998 through 2002. He served on the program committee for RNRF Congresses on Human Population Growth: Impacts on Sustaining Renewable Natural Resources (1998), and Promoting Sustainability in the 21st Century (2000). He chaired the program committee of the Congress on Control of Nonpoint Source Water Pollution in 2002. In that same year, he received the RNRF Chairman’s Award for Professional Service to the Foundation.

John returned to the RNRF Board as a principal director in 2013, serving as a Public Interest Member. He served on program committees for congresses on Coastal Resiliency and Risk (2013), and Adapting Food Production to a Changing Climate (2014). He resigned from the board in 2015.

Call for 2020 Awards Nominations

Deadline: June 1, 2020

RNRF has three annual awards to recognize outstanding achievements in the renewable natural resources fields. Two of the awards, established in 1992, were the first to honor interdisciplinary achievements with an emphasis on the application of sound scientific practices in managing and conserving renewable natural resources.

The Sustained Achievement Award recognizes a long-term contribution and commitment to the protection and conservation of natural resources by an individual.

The Outstanding Achievement Award recognizes a project, publication, piece of legislation, or similar concrete accomplishment that occurred during the three years prior to nomination for the award. Visual media such as films or videos, audio media such as podcasts, and technical publications such as reference books and proceedings are eligible for this award. An individual cannot receive this award.

The Excellence in Journalism Award honors and encourages excellence in print journalism about natural resources. The award recognizes work by an individual, group, or organization for both print and digital media such as an online report, or article/feature in a newspaper, magazine, journal, or newsletter. General interest books and online videos, documentaries, and podcasts are not eligible.

Please visit our website for nomination guidelines. Nominations are due at close-of-business on June 1, 2020.

For more information on our awards, and to see past awards winners, please visit our awards page here, call (301) 770-9101, or email stephen.yaeger@rnrf.org.

We look forward to receiving your nominations!

American Geophysical Union

The Future Needs Science. The U.S. Elections Need You

AGU recently launched the Science Votes the Future campaign to increase science in the U.S. 2020 election cycle. The initiative aims to promote candidates to speak up about science and encourage scientists to vote in upcoming elections. The campaign toolbox includes talking points on key science issues such as climate change, health, natural hazards and STEM education as well as a 2020 Vote Pledge.

The campaign's goal is to make sharing scientific information with candidates easier and to facilitate engagement between candidates and their local communities. AGU believes it is essential for candidates at every level of government to include science as an integral part of their platforms.

With this effort, AGU hopes to increase the voter turnout of scientists and STEM students to vote in the 2020 elections.

For more information, click here.

American Meteorological Society

American Meteorological Society Workforce Report: New Minds for New Science

During January, AMS published a study entitled, "New Minds for New Science: The Forecast for Work in the Weather, Water, and Climate Enterprise." This study is largely based on an AMS Policy Program workshop conducted in April 2019, which discussed how rapid technological and societal changes are impacting the weather, water, and climate workforce. The workshop brought together individuals from the public, private, and academic sector as well as the NGO community to examine issues and identify opportunities for workforce advancement.

Based on workshop discussions and additional examinations, AMS identified numerous opportunities and needs for workforce advancement.

1. Build adaptiveness: to recognize and harness opportunities, and build resilience to face the challenges embedded in social change and technological advances, ranging from new media, to more flexible computing, and the internet of things.
2. Promote holistic approaches to Big Data and artificial intelligence (AI) that simultaneously consider issues of data quality, sharing, privacy, access, and bias.
3. Develop a diverse and inclusive culture; one that welcomes people from all backgrounds, empowers individual contributions, and encourages all to share their talents fully.
4. Enhance purpose-driven science that provides societal benefit. This will advance public wellbeing and create fulfilling career pathways for prospective members of the workforce.
5. Enable and promote phased retirement and succession planning.
6. Strengthen adaptive and evidence-based approaches to teaching and worker training.
7. Encourage development of high-value but nontraditional skills including collaboration and communication.
8. Facilitate collaboration across sectors, particularly in the education of students and workforce training.

In closing, the study emphasized that progress in this community is dependent on individual choices, community efforts, and societal decisions.

The study can be obtained here.

American Society of Civil Engineers

2019 Past President Robin A. Kemper Gives Keynote Address to Mississippi River Mayors

On March 4, 2020, 2019 ASCE President Robin A. Kemper, P.E., LEED AP, F.SEI, F.ASCE gave keynote remarks regarding resilience at the Mississippi River Cities and Towns Initiative's (MRCTI) 2020 Capitol Hill Meeting. "Since 2012, the MRCTI has been promoting economic and environmental security and stability along the Mississippi River. The MRCTI builds the capacity of member mayors, empowering them with tools and support to undertake effective local initiatives which attract green jobs, move towards sustainable economies, and achieve local environmental protection goals." Ms. Kemper's remarks focused on ASCE serving as a lead advocate for sustainable and resilient infrastructure and how investments in resilient, nature-based, and/or green infrastructure systems provide cost-competitive solutions for many of the challenges facing communities along the Mississippi River.

Coupled with the challenge of aging infrastructure is the occurrence of increasingly frequent and severe weather events, including flooding, which many Mississippi River cities face. Last June, the Mississippi River climbed to its second highest crest since records began in the 1700s, and disasters are becoming deadlier and costing communities across the country millions of dollars in damages, forcing families to move, and hurting businesses and farmers. However, an ounce of prevention is worth a pound of cure. For example, according to the National Institute of Building Sciences, every dollar spent on pre-disaster mitigation and preparedness saves six dollars in rebuilding costs after a storm.

To read more, click here.

American Society of Landscape Architects Fund

ASLA Publishes Guides to Highlight Successful Cross-Disciplinary Collaborations for Healthy, Equitable Communities

ASLA recently published ten guides as a part of the Joint Call to Action for Healthy Communities Coalition, a coalition of practitioners who are committed to creating healthy communities. These guides showcase ten case studies of successful cross-disciplinary collaboration for healthy, equitable communities. The case studies are taken from cities around the country and survey the successes and challenges presented in each case.

The guides build on the core values outlined in the 2018 Joint Call to Action for Healthy Communities, which provided a framework for effective local, state, and regional collaboration across fields. Those values include:

- Creating and fostering partnerships that advance health;
- Building an understanding of health data and establishing measurable health objectives for plans and projects;
- Advancing policies, programs, and systems that promote community health, well-being and equity; and
- Communicating the importance of health.

The Joint Call to Action includes American Society of Landscape Architects, American Planning Association, American Public Health Association, American Society of Civil Engineers, American Institute of Architects, National Recreation and Park Association, U.S. Green Building Council, Urban Land Institute.

For more information, click here.

American Water Resources Association

AWRA's Integrated Water Resources Management (IWRM) Award Open for Applications

The IWRM award recognizes outstanding IWRM teamwork on a complex water resources effort. The project chosen for this award will be conducted by a team representing multiple disciplines such as engineering, biophysical science, economics, social science, law, planning, political science, etc. The project team will have developed a common project mission with defined responsibilities, and collaborated to achieve a water resources management objective organized around IWRM principles.

Nominations are due Friday, May 8, 2020 and announcements for all awards and scholarship will take place in May 2020.

For more information on the IWRM award, click here.

For information on other AWRA awards, click here.

Geological Society of America

The Future for Geoscience in the Context of Emerging Climate Disruption

In his 2019 presidential address, GSA President Donald Siegel focused on climate change and the future for geoscience in the resulting climate change disruption. Siegel compared our climate change reality to the tragedy of commons, whereby humanity has continuously added greenhouse gases to the collective atmosphere without regard to the greater impacts. Siegel believes that most emitting nations will not make the necessary economic and political decisions to prevent at least a two-degree increase in the average global temperature. This stark reality will almost certainly bring significant climate disruption and greatly impact human life and natural ecosystems.

Siegel concluded that until climate disruption severely affects large swaths of “economically well-to-do populations” little change, on the scale needed, will be accomplished in order to make a positive global impact. He emphasized the need for change on a global scale, rather than smaller regional or village initiatives. According to Siegel, adapting to this environmental disruption could include developing new science and engineering technology designed to reduce floods and genetic advances designed to grow plants under stressful climatic conditions.

To read the full 2019 GSA presidential address, click here.

Society of Environmental Toxicology and Chemistry

Integrated Environmental Assessment and Management (IEAM) Calls for Papers Addressing UN Sustainable Development Goals

Integrating Science in UN Sustainable Development Goals

The 2020s will be a transformative decade for human interaction with the earth’s environment, largely inspired by the United Nations’ call for global action through 17 Sustainable Development Goals (SDGs). Scientific research and environmental management practices can lead the way to sustainability in all sectors of our society. Several SDGs, in particular, aim to reduce our environmental footprint on the planet and preserve, protect and restore the planet’s ecological well-being, notably:

- SDG #2 - Progress towards sustainable food production
- SDG #6 - Sustainable management of water
- SDG #11 - Nature-based solutions in the built environment
- SDG #13 - Strategies responsive to climate change
- SDG #14 - Focus on oceans, seas, and marine resources for sustainable development

- SDG #15 - Actions to protect and restore biodiversity

These six SDGs are the focus of IEAM's call for papers. To promote understanding of the science–policy nexus and enhance global awareness of the value of sustainable use of the planet's resources, IEAM is inviting papers describing cutting-edge environmental research and policy solutions relevant to promoting sustainability. Scientists and professionals are invited to present their work from the perspective of how the science community contributes to SDG implementation through new technologies, assessment and monitoring methods, management best practices and scientific research. Papers may describe case studies, regulatory policies, business strategies and science-to-policy assessments aimed at sustainability in various economic and social sectors around the world. Papers may focus on different aspects of issues concerning the conservation and sustainable use of land, air or water resources at the global, regional and national levels.

Successful submissions will benefit from international visibility through publication as examples of thought leadership. Online publication anticipated for late 2020.

For more information, click here.

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