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Our Environment: A Health Crisis - and what we must do to heal it

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Our environment has no shortage of enthusiastic defenders. Propositions for oil pipelines arouse thousands of demonstrators; an ad to save the polar bears will always strike at hearts; the appointment of a science-denier to a federal Cabinet position can bring out the full force of activists and non-profit advertising campaigns. Yet, this still is not enough if we are to actualize the large-scale change we so fervently advocate for in regards to mediating environmental change. The most basic reason, in simplest terms, is that we need everyone. We need every single person to care as passionately about saving our planet as the most inspired activist. This, of course, is impractical; at least under the current framing of this environmental crisis we care so much about. This is essentially because we frame the issue of climate change and environmental degradation as just that: an issue area. It is one of many to be tacked on to the political speeches of progressive candidates, or a specialization area for a legislative aide. It is limited in such a framework. This article will not go deep into the social aspects of how or why this is so; however, I hope to offer one perspective on why framing the crisis we face in such a manner is, literally, deadly.

We, as humans, exist as part of the natural world. As we grow, evolve, adapt, and change, so does our natural environment which surrounds us. When we misunderstand this reality, and choose to overlook the impact our actions can have on the natural environment, we risk danger not only to natural cycles, wildlife, and ecosystems, but also to ourselves. There are many ways in which human-induced changes to our environment can create detrimental health effects for us as people. First, a changing climate, thrown off balance by the rapidly increasing emission of greenhouse gases into our atmosphere, can cause harm directly in the form of pollution or extreme weather events. Anthropogenic degradation of our environment also can influence other factors which can harm human health, like the spread of disease and access to food and other resources.

Our neglect for our natural environment, manifested through increasing effects of climate change and the destruction of our ecosystems and atmosphere, has led to an unimaginable degree of both explicit and implicit health problems on human populations around the globe. While the connection between climate change and our health is often overlooked and not fully understood, the impacts are widespread and pose dangerous omens for our future. An unhealthy environment can mean anything from increased likelihood for malaria to skin cancer to depression. Nearly 23% of all deaths globally can be attributed to some kind of environmental factor (*Preventing Disease Through Healthy Environments*, 2006). This fact itself should inspire nothing less than an urgent call to action against the harmful effects of climate change and environmental destruction. The remainder of this article will examine a wide variety of health effects due to the environment, as well as offer a look at some ways in which we can reframe the crisis into successful action towards a sustainable future.

Section One: Health Effects of Climate Change and Environmental Degradation

In building the argument for radical action to combat climate change, one has to commit to getting creative in constructing narratives which will spur such action. That is precisely why former EPA Administrator, Gina McCarthy, made it a special priority to emphasize the health implications of climate change and environmental degradation during her time in the Agency. She visited health schools, encouraging medical students to consider joining the EPA rather than pursue a traditional medical career (Neuhauser, 2016). The goal was to transform the image of the Agency, and, effectively, the movement itself to be more than a "tree-hugger" cause and into an intersectional profession of social justice and medical necessity (Neuhauser, 2016). In her own words, "I've always thought of myself as a public health person, I still do" (Neuhauser, 2016). McCarthy believed that this mission of public health was in fact central to the Agency and was infused into every bit of its work, even if that tended to be lost on the general public. After all, the work of environmentalism, just as in public health, is to build up the quality of life for communities across the world. As we consider this reality, it is also important to understand that not every community is or will be affected equally any of these environmental changes. As deforestation rips across regions of South America, it is the people of those rural communities who suffer the consequences of disease spread and ecosystem change. At times, traditionally marginalized communities, like indigenous peoples, can become targets of projects of environmental damage. In the United States, the highly public fight over the Dakota Access Pipeline, designed to cut across traditional Sioux lands in Standing Rock, is a prime example of such a project which includes both environmental and social justice elements (Purdy, 2016).

The intersections of health and environmental change support these proposed inherent links, and our work to promote protection of the environment should internalize these critical connections. The following sections describe just how our environment influences various aspects of our health.

Climate Change and Weather - Direct Effects

Direct effects of climate change on human health include heat related effects, extreme weather events, and exposure to increased radiation. These impacts are unique because they can be felt as a direct result of a changing climate, even if they are often not attributed to such a cause. Many direct effects are not simple to attribute specifically to climate change. However, trends and changes in normal expectations help us to monitor approximately the degree of the effect that climate change is wreaking on human health.

First, there is the issue of heat related incidences. A study in Australia showed the ratio of summer to winter deaths in the country has steadily risen between 1968 and 2010 (Smith, et al., 2014). This figure certainly does not prove any type of causality, but it does begin to hint at a trend. Climate change can affect health through heat exhaustion (where the body temperature rises above 38°C) which can cause physical and cognitive impairment, or heat stroke (where the body temperature rises above 40.6°C) which can result in organ damage, unconsciousness, and even death (Purdy, 2016). Another factor in this is the vulnerability of certain populations. First of all, with milder winters, there is a general higher likelihood of being impacted by heat, as seen during the 2003 European heat wave, which was preceded by a markedly mild winter (Smith, et al., 2014). Urban populations are also under increased threat to heat-related incidences, as cities experience enhanced temperature rises. Finally, age, gender, and physical activity are also all characteristics which may exacerbate a heat wave's effects on health.

Another direct impact of climate change on human health comes in the form of natural disasters. For every one person killed in a natural disaster, an estimated additional one thousand are negatively affected (Whitmee, et al., 2015). Floods are the most common and deadly natural disaster, and are increasing in frequency due to the effects of climate change on our planet (Smith, et al., 2014). Floods cause not only drowning, but hypothermia and are often spread infectious diseases. These sorts of events not only impact immediate health and wellness, but can lead to long-term change. For example, floods often lead to contaminated drinking water due to overflowing sewage, fostering an environment for vector-borne diseases, and loss of livelihood and assets causing mental distress (Smith, et al., 2014).

As the ozone layer of our atmosphere is threatened by our growing emissions, direct effects from sun exposure have been found to increase. Radiation caused by this deterioration contributes to more cases of skin cancer and cataracts. In a US study, cases of squamous cell carcinoma rose 5.5% for 1°C of average temperature rise (Smith, et al., 2014). What this equates to is essentially an additional 2% dose of UV radiation for every single degree Celsius in average temperature rise (Smith, et al., 2014). Going outdoors in summertime has become more of a threat than in previous times as heat threats increase and the strength of UV radiation creates increasingly greater risks to health.

Pollution

Our human health can also be affected by pollution, whether it be directly from air pollution or indirectly from consequences of chemical pollutants. Pollution historically has been a major human-induced threat to environmental health; now, we are finding that not only has it been a detriment to our natural ecosystems, but it persists as a potent threat to human health in a variety of ways as well.

Air Pollution

Air pollution is an increasingly significant direct agent of danger to human health as we continue our pollutive habits and fall short in cleaning up our atmosphere. Pollution of our atmosphere damages both human and environmental health. Concerning human health, it can manifest itself in a few different ways. The first way is through indoor air pollution. This comes about as a result of incomplete combustion of solid fuels, most prominently in developing nations where coal, wood, and charcoal make up a greater percentage of energy sources (Whitmee, et al., 2015). The specific health effects resulting from indoor air pollution include respiratory infections, chronic obstructive pulmonary disorder, stroke, and heart disease (Smith, et al., 2014). Between 2.6 and 4.4 million people die per year from indoor air pollution, most of whom are women and children (Whitmee, et al., 2015). Over 2.8 billion are exposed. As a relatively under-appreciated subset of pollution effects, indoor air pollution continues to have dramatic impacts on human health. Once again, lack of understanding and connection between inefficient energy sourcing and regular causes of death or illness have proven an obstacle to confronting this issue.

Air pollution is also a danger when it is in the open atmosphere. Ground level ozone is one example: methane emissions can cause the photochemical reactions which produce ozone to occur in the troposphere, the lowest dimension of Earth's atmosphere (Smith, et al., 2014). This leads to cardiopulmonary mortality, along with crop reduction and decreased forest growth which can further affect health (Smith, et al., 2014; Whitmee, et al., 2015). It is suggested that nearly half of the

deaths from the historic 2003 heatwave in Europe could actually have been caused by ozone exposure, intensified by the increased temperature and sunlight, rather than directly heat-related causes (Purdy, 2016). Aeroallergens are another cause of human health effects under the umbrella of air pollution, specifically affecting individuals with asthma and exacerbating those conditions. These allergens, like fungal spores or plant pollen, increase with warmer weather and earlier flowering of some grasses (Smith, et al., 2014). Droughts in particular can exacerbate allergen effects by spreading dust and pollen or spores. This specifically can expand the reach of these allergens, as winds carry the agents to new populations.

China provides a useful, if tragic, example when examining health effects of air pollution. According to a study from the University of California-Berkeley, air pollution kills around four thousand people a day in China, in the form of heart, lung, stroke, or other complications (Rhode & Muller, 2015). One in six premature deaths in the country are due to air pollution, and approximately 38% of the population lives in conditions where the air is considered "unhealthy" by U.S. EPA standards (Rhode & Muller, 2015). The smog is visible and very evident for people concerned with China's pollution problem; the degree of the underlying health effects it is having on the Chinese people is much less obvious and much more critical to understand if urgency is going to be stressed in addressing the country's polluting problem.

When translating the disability-adjusted life years due to particle air pollution, this epidemic costs approximately $1.9 trillion a year, or 2.7% of the global economy (Smith, et al., 2014). It would make sense that the world should be willing to pay at least that, to prevent economic losses; however, we are still facing a growing threat from air pollution, one which has far-reaching effects on health across the globe.

Toxic Chemicals

Pollution does not just equate solely to air pollution, however. Exposure to toxic chemicals is another important health issue. This can become a problem through either inhaling, eating, or drinking polluted substances, especially as chemicals become bioaccumulated along a food chain. Chemicals such as pesticides from agricultural runoff, heavy metals used in cement, electronics recycling, pharmaceutical pollution, mercury and heavy metals in coal and oil combustion, and more all factor into a global crisis of exposure to dangerously unhealthy toxins as a result of careless waste. What this looks like across the world includes lead poisoning, especially in low-income countries, illness from pesticides due to exposure during agricultural work, and mercury poisoning from aquatic food sources. Some of the effects of these pollutants range from endocrine disruption to cancer risk, to neurobehavioral disorders (Whitmee, et al., 2015). Another component to this issue is, once again, the absence of certifiable information. Of 300 chemicals which are currently in produced in high quantities, only about half have sufficient info on toxicity and health impacts (Smith, et al., 2014). With this dire information lack, we cannot even know the full extent to which dangerous chemicals that have been carelessly disposed of in our natural environment are affecting our health. If we are to properly address the root cause of these health impacts, it is critical to have a deeper awareness of precisely what the most effective actions will be in future policy.

Food Security and Nutrition

Threats to adequate food access have been exacerbated under climate change and continued overuse of our natural resources. With land degradation and development for agriculture and soil erosion, we are left with a loss of pollinators and increased exposure to pesticides (Whitmee, et al., 2015). Soil itself is becoming unsuitable for crop growing as it is overused and the nutrients are depleted; this affects not only food production but increases likelihood of flooding, destroys biodiversity, and eliminates a critical carbon sink to offset emissions of greenhouse gases (Smith, et al., 2014). Crop yields are vulnerable to changing temperatures, especially temperature variability which we are seeing increasing cases of in various parts of the world (Whitmee, et al., 2015). The shift in rainfall patterns as a result of climate change has affected crop yield and changed in what regions certain crops can grow as well. This leads not only to overall scarcity from decreased yield but also to nutrient deficiencies as a result of lost crops. With this critical threat to crop yield and nutrition, human populations are facing a barrage of health effects. Lack of overall food availability implicates a range of further health consequences, as does lack of proper nutrient intake.

Diminishing freshwater availability is another factor to be considered. A combination of overdrawing from underground aquifers and climate change has led to massive losses in crops (Whitmee, et al., 2015). Persistent droughts have played a large role in this loss. Water usage is also highly dependent on which type of food source is being produced. For example, beef requires eleven times the irrigation water per calorie than does poultry, eggs, or pork (Whitmee, et al., 2015). Water scarcity in itself is a dire threat to communities as well; like food insecurity, it can mean subsequent health complications in addition to the threat from lack of water itself.

Besides crop yield, another issue surrounding food security is the threat to fisheries. Overfishing, warming waters, and acidification negatively affect marine life. Ocean acidification, which has risen substantially since the Industrial Revolution, causes shellfish like mussels and clams, and corals, to grow softer shells and skeletons which have greatly impacted their ability to survive (Whitmee, et al., 2015). This means less food, especially for the growing number of people who are living near coastlines and derive much of their food stock from the oceans.

A particular issue with negative environmental effects on food availability is the fact that demand is, in fact, increasing. Roughly 40% of the global population is projected to be living in river basin regions which are under severe stress (Smith, et al., 2014). Agriculture and the raising of livestock intensify this pressure, which can not only lead to food shortages but a lack in basic water availability and economic impacts as well. The situation now, therefore, is an intensifying threat from climate change and environmental destruction coupled with a growing stress on the global food stock in historically unprecedented levels (Whitmee, et al., 2015).

Disease

One of the major fields of impact on health from environmental change is that of proliferating various diseases. Per the World Health Organization, the attributable fraction of a risk factor is the percentage decline in disease or injury due to changing conditions for the risk (Neuhauser, 2016). The metric attempts to build correlation between a specific risk factor and a certain health problem, and quantify the proportional reduction in those health issues if that risk were to be reduced (Neuhauser, 2016). So, for example, the attributable fraction of the environment on malaria is 42%; meaning that 42% of cases of malaria could be prevented if the environmental conditions were changed in a way that reduced the risk (Neuhauser, 2016). Attributable fractions may add up to be

over 100% - meaning that there are multiple means of intervention to reduce a disease burden. It also should be noted that many forms of environmental change may not be so clearly distinguished as damaging or beneficial when it comes to the spread of disease. Because of the complexity of risk factors of disease, environmental change can often both help and hurt the spread of disease. Nevertheless, it is useful to understand just how sensitive the crises of disease spreading are to their environments and changes in those environments. The sheer degree to which the environment can statistically be shown to influence diseases such as malaria serves as a poignant snapshot into just how much overlap there is between the environment and infection; and these effects are, in fact, discriminatory: more developing countries, specifically in sub-Saharan Africa, are disproportionately affected due to environment-related disease (Neuhauser, 2016).

Water-related Diseases

The climate influences growth, expansion, survival, transmission, and virulence of various water-borne pathogens which lead to diseases such as diarrhea (Smith, et al., 2014). As temperatures become increasingly fluctuating, precipitation rates change, water salinity is altered from runoff, the disease's spatial and temporal range are affected; this means the possibility for increased exposure rates. Some other diseases that can be amplified by these factors are diarrhea, schistosomiasis, cholera, and salmonella (Smith, et al., 2014; Whitmee, et al., 2015).

The disease most profoundly affected by environmental factors is diarrhea. Diarrhea is a water-related illness, and therefore is sensitive to changes in water quality and sanitation (Whitmee, et al., 2015). This explains the degree of burden associated with environmental factors for this particular disease, as environmental destruction often affects the quality of water for the surrounding region. Additionally, rising temperatures and increased humidity, as well as invariability of rainfall contribute to the spread of diarrheal disease; these factors alone have been estimated to cause a possible 8-11% spike in cases globally (Whitmee, et al., 2015). A prime case study of this phenomenon can be seen in the Ganges River region, where hundreds of cities upriver are dumping raw sewage into a source of drinking water for over 400 million people farther down the river, endangering the drinkability of the water and greatly risking infection (Whitmee, et al., 2015).

Cholera is another water-borne disease that is not only attributed to poor sanitation, but also is to a number of changing environmental factors including weather patterns. Cholera has been around for two centuries, and has historically most directly affected the regions with poor sanitation (Shah, 2011). However, recent research conducted by Dr. Rita Colwell at the University of Maryland has proven that bacteria like the cholera disease can in fact exist and flourish even in the absence of human waste (Shah, 2011). In many of these cases, the determining factor can be the environment, and environmental change. One such case can be seen in the Bay of Bengal during El Niño events. The rise in sea surface temperature creates blooms of phytoplankton - which studies reveal correlate to a increase in the cases of cholera in Bangladesh (Shah, 2011). In fact, cholera risk increases two to four times in the six weeks following a nine degree Fahrenheit rise in ocean surface temperature (Shah, 2011). The areas of the world under the most threat from the potential of new cholera outbreaks are those with less advanced waste management systems; places like most-earthquake Haiti, which faced an outbreak just a few years ago.

Schistosomiasis affects hundreds of millions of people a year, and leads to malnutrition, stunting of growth, and subsequent loss of productivity in the workplace or at school (Whitmee, et al.,

2015). It can also lead to the spread of HIV/AIDS, when one is exposed to schistosomiasis and HIV is prevalent in the locality (Brodish & Singh, 2016). This disease is influenced by factors like the increase in freshwater snails resulting from river fragmentation and biodiversity loss, as well as eutrophication and overfishing, all resulting from human-induced changes to the environment (Whitmee, et al., 2015). The examples of both diarrhea and schistosomiasis speak to the multiplicity of ways that environmental change, whether it be from lack of safe drinking water or damage to biodiversity, can have substantial negative effects on health in quite potent ways.

Another situation of disease from water-related climate change effects stems from harmful algal blooms. Algal blooms are formed by an increase in algae or cyanobacteria in bodies of water, which often lead to a depletion of oxygen and decline in life in those bodies. They also pose a threat to human health. The cyanobacteria present from algal blooms can release toxins which cause liver, neurological, digestive, and skin disease (Whitmee, et al., 2015). Additionally, diatoms, a type of algae which contribute to this depletion of oxygen in marine environments, produce domoic acid, a potent neurotoxin which can bioaccumulate in shellfish and finfish, and later impact human health as these organisms are consumed (Smith, et al., 2014). In many examples, the growths are caused by human waste, usually a form of agricultural runoff. In 1997, the the Chesapeake Bay was struck with outbreaks of *Pfiesteria piscicida*, a toxic bacteria that was killing aquatic wildlife and harming the ecosystems of the Bay (Boesch, 2001). High nitrogen concentrations in the groundwater and phosphorous saturated soils were the result of a booming poultry industry in the region. Reports of human health issues in North Carolina were attributed to *Pfiesteria* outbreaks as well (Boesch, 2001). Algal blooms are proven to have an acute effect of environmental degradation, as increasing temperatures and pollution have disturbed the equilibrium in many marine ecosystems across the world.

Vector-borne Diseases

Another pathway for a changing environment to influence the spread of disease is through vector-borne disease. Vector-borne diseases are transmitted by some type of "vector" - often, but not always exclusively this vector can be a "blood-sucking arthropods," also known as mosquitoes and ticks. Diseases transmitted by vectors include malaria, ebola, dengue fever, and Chikungunya fever (Smith, et al., 2014). The risk for this type of disease is affected when the conditions for the vectors become more favorable, or interaction between human populations and vector populations are forced into closer proximity. This occurs with forest loss and loss of plant diversity, along with changes in temperature, humidity, and rainfall (Smith, et al., 2014). For example, outbreaks of ebola have been suggested to be linked to intense deforestation in Africa, which has destroyed the habitat for bats, the natural hosts of the disease. Because of this habitat destruction, the bats were forced to alter their migration patterns which put them in closer proximity with human populations, and increased likelihood of outbreaks (Smith, et al., 2014). Separately, mosquito populations can increase in areas which experience a period of drought followed by a period of rewetting; this affects the water table, vegetation, and aquatic predators. Therefore, the highest risk area for infection is where human population is high, there is ongoing ecological disruption such as changes in land use or agricultural practices, and where the human and mosquito populations overlap. As the climate changes, different areas will become more suitable for these vectors; for example, tick populations will likely be able to expand northward in North America (Whitmee, et al., 2015). The Intergovernmental Panel on Climate Change projects that 200 million more people will at risk for exposure to malaria with current expectations under climate change (Smith, et al., 2014).

As rainfall increases in various areas of the globe, and hotter and drier conditions afflict others, the potential for these types of diseases to spread and infect new populations from Chicago to Botswana increases in dangerous ways (Smith, et al., 2014). One of the chief actions which should be taken in the effort to prevent such a catastrophe would be to learn more about the relations between these diseases and effects of climate change or environmental destruction. Many of the studies currently suggest what are oftentimes nonlinear and only "likely" influences. A degree of this speaks to the complex ways in which environmental factors impact disease agents, but other reasons include a simple lack of research into the subject. The gap speaks to the absence of overlap between environment and health professional fields; research continues to be siloed. A better understanding of the causes would allow us to more intelligently combat their effects.

Mental Health

Mental health may be a particularly overlooked and underappreciated result of increasing impacts of a changing environment, but this perception is certainly not for lack of tangible effect. One of the most significant relations of environmental change and mental health is displacement and destruction of one's home. Leaving one's home and familiar surroundings, loss of possessions, breaking social ties, absence of mental health services, and the difficulty of resettlement are all additional factors which could negatively impact mental health for peoples displaced or otherwise affected by environmental disaster (Whitmee, et al., 2015). While the total degree of displacement due to climate change and related causes is unknown, the adverse mental health effects are more clear. Depression and post-traumatic stress disorder are common results of natural disaster and conflict related to environmental factors. Sexual violence is another tragic effect of conflict and disaster which can be attributed to climate in certain situations.

The distress associated with environmental impacts, from displacement to losing one's home, has been studied a bit further: solastalgia means specifically the distress resulting from environmental change (Whitmee, et al., 2015). It includes aspects like the loss of familiar environment as natural disasters destroy homes and people are forced to abandon their homes due to unlivable conditions. At the core of solastalgia is an undercurrent of powerlessness and lack of control frequently present in contemplation when considering the future for our world under the threat of climate change. This commonly results in increased cases of depression, anxiety, and even suicide (Whitmee, et al., 2015). Another aspect to this scenario is the question of empowerment to affect some degree of change. Engaging local communities in efforts to combat climate change and respond to natural disaster is one possibility in alleviating the negative mental health impacts of those changes.

Section Two: Building Resilience, Protection, and Adaptation with a Special Concern for Safeguarding Human Health

Understanding just how a changing environment impacts human health is a necessary first step if we are to combat the causes of those changes. Drawing on these understandings, we now may begin to explore a few possible theories for solutions.

First, there are some outstanding contradictions which must be reconciled. For instance, between the growing demand for food and the increasing threat to food security and environmental limits to production: it is crucial that we seek out sustainable intensification practices, such as drip-irrigation or genetically-modified organisms (GMOs) (Whitmee, et al., 2015). Achieving adequate

global food production for an increasing population will take advanced scientific application. In China, for example, an enhanced approach to soil-crop system management has been adopted which draws on knowledge of individual crop ecophysiology and soil biogeochemistry to maximize yields of rice, wheat, and maize, improving overall efficiency (Whitmee, et al., 2015). It is going to take creative solutions such as aquaponics, growing plants in a soil-free fashion; this practice utilizes aquariums of fish to supply plants with nutrients, which in return filter the water and keep the fish healthy (Neuhauser, 2016). To combat overfishing we must examine sustainable aquaculture options, where fish can be bred and "harvested" for the sole purpose of being supplied as a food source. Human lifestyles will also need to change as we socially internalize the dangerous health effects that a changing environment can have. This includes dramatically reducing food waste, and altering our diets to one that is lower-impact (Smith, et al., 2014). We must harmonize our health and environmental policies at all levels, and resist the urge to compartmentalize each of them into separate issue areas.

Throughout this next section of the article, we will examine some case studies and further detailed examples of options we have for transforming our lifestyles, our policies, and our relationship with the environment in a way that minimizes our contributions to destruction of the natural environment and, in turn, protects our collective human health from the dangerous effects of anthropogenic changes in our environment.

Regulation

One of the more popular attempts to combat climate change in the hope of minimizing its effects is through legislative regulation. Regulation can have positive impacts, but is often accompanied by dissension at the idea of government infiltration into private business practices. Nonetheless, it has historically played a significant role, and continues to do so today. To highlight this, we can look at an example of a proposed (but ultimately unsuccessful) piece of U.S. legislation aimed at reigning in pollutive practices and protecting the American people from harmful effects of climate change.

The Super Pollutants Act of 2015 was aimed at reducing short-lived climate pollutants, including black carbon, methane, and hydrofluorocarbons, all of which are significant contributors to both climate change and other more direct effects on human health; in fact, the reduction of these pollutants could result in an estimated prevention of two million premature deaths, according to the UN Environmental Program (Super Pollutants Act of 2015). The Act sought to effectively accomplish this mission through a variety of integrated measures. It called on a combination of federal agencies and global partnerships from the Arctic Council, to USAID, to the EPA, to the US Export and Import Bank to initiate practices and implement policies which were tailored to each agency's portfolio and touched on the wide reaching roots of the pollution problem (Super Pollutants Act of 2015). Through a multi-pronged approach which ranged from recommendations on conditional financing of sustainable energy projects to prioritizing international development projects which included provisions for black carbon mitigation, this bill had the potential to spur action across the necessary spectrum of factors which have a hand in contributing to the super pollutant emissions.

Sustainable Cities

Cities are often extra-vulnerable to environment related health effects. They also play a complex role in relation to climate change and pollution. On one hand, they offer opportunities for travel

methods which are more eco-friendly than single person cars; however, they also concentrate significant amounts of pollutants into one area and are warmer on average than suburban or rural areas which exacerbates heat-related events; both of the latter scenarios often lead to many health problems (Whitmee, et al., 2015). Despite these complicated realities, there is a high degree of potential for cities to become beacons of sustainable living. By incorporating green spaces into city life, air pollution and carbon emissions can be reduced and rising temperatures can be regulated. Not only does this assist in alleviating threats of heat or pollution related health ailments, but it contributes to improved mental health as well (Whitmee, et al., 2015). Overall, as population trends point to increasing populations in urban areas, cities small and large are going to be pressed to transform into sustainability centers. Thankfully, we have some existing models to build off of for inspiration.

The city of Burlington, capital of the state of Vermont, was the first U.S. city to transform its energy intake to 100% renewable energy (Woodard, et al., 2016). The city of 42,000 has been pointed to as a sustainability success story, mainly for its transition from a logging port on Lake Champlain to an international model for sustainable policy and livelihood. The city generates its energy from a combination of locally (and sustainably) harvested wood, a hydroelectric plant, a few wind turbines on a nearby hill, and an array of solar panels at its small airport (Woodard, et al., 2016). On top of this, they have not had to raise energy prices in nearly eight years; a feat accomplished in large part due to the investment in state-of-the-art scrubber technology which was implemented at the Burlington Electric station, allowing the city to earn the state's highest energy credits by selling their emission rights out of state (Super Pollutants Act of 2015). The city, though, offers a full picture of what a sustainable urban area can look like: in addition to Burlington's impressive energy generation statistics, the city gets its food from a non-profit owned plot of 300 acre reclaimed floodplain land. The non-profit got its startup funds from the municipal government as part of an effort to support local entrepreneurship under the mayorship of a certain contemporary name in sustainability policy, Bernie Sanders, in his earliest days of public service. The food is now harvested and sold as part of a member-owned cooperative market located in the downtown (Woodard, et al., 2016).

Although Burlington offers a glorious example of sustainable living, other efforts can easily fall short in ways that have detrimental effects on the natural environment. For example, a new development in southwest Florida is aiming to be the world's first solar-powered town (Woodard, et al., 2016). Those designing the town traveled across the globe in search of the best practices to shape their vision of what a futuristic municipality should look like in a world increasingly affected by climate change. Despite their successes in designing an impressive solar grid, integrated green space, and a locally sourced food system, the simple overlook of their local ecosystem could throw an ugly stain on the acclaimed development. The city's location threatens to cut off transit of one of the last remaining panther populations in the state (Woodard, et al., 2016). While the development itself poses no direct threats to the critically endangered species according to Fish and Wildlife Services, the proximity can cause enough damage on its own. The increased traffic, possibility of illegal hunting, and pollution all factor into the well-being of the panther population. The development is also in a possible projected area of expansion for the panther population (Helmore, 2016). This example demonstrates the crucial necessity of careful, integrated planning methods when designing sustainable cities; and the importance of a comprehensive solution where all aspects of the issue are solved in the most appropriate and efficient of manners.

Integrated Landscape Management

Solutions which include integrated land use techniques oftentimes can be optimal platforms for implementing policies and practices which will interrupt the causes of climate change and mediate its effects. Integrated landscape management (ILM) is more of a philosophy to approaching this broader issue than a specific policy platform. The idea behind it is to achieve multiple targets in sustainability in the most efficient, eco-friendly, and human-friendly way. Through the harmonization of planning, implementation, and monitoring, integrated landscape management offers an alternative to the siloed approach which plagues many of our national and international efforts in the fields of health, development, and sustainability. In an oversimplified word, it is all about "synergy" (Thaxton, et al., 2015). For example, it can look as simple as accomplishing the reduction of cases of Lyme disease by reducing transmitter agents through protecting habitats by residential zones. In protecting these ecosystems, we also prevent biodiversity loss and maintain a critical carbon sink, all while keeping to the original goal of reducing cases of Lyme disease. This is a prime example of how the health and environmental field of policy can and should be integrated, in order to maximize effectiveness of proposed solutions.

A particularly useful framework for illustrating this integration of the two fields can be found in the United Nations' Sustainable Development Goals (SDGs), which were adopted in 2015 as part of the 2030 Agenda ("SDGs: Sustainable Development Knowledge Platform"). These seventeen goals are broken down further into 169 specific targets. The philosophy behind these goals and targets was to design them in such a way so as to implicitly promote collaboration and integration of solutions. For instance, the Lyme disease example given above can easily be considered to incorporate aspects of Goal 3, "Good Health and Well-Being," Goal 13, "Climate Action," and Goal 17, "Life on Land" ("SDGs: Sustainable Development Knowledge Platform"). The very design of these types of projects gives hope and vision for what future approaches to a wide variety of global challenges can look like. ILM empowers local communities, promotes transboundary cooperation between industries, and reduces costs by making solutions efficient (Thaxton, et al., 2015).

To provide a real-world case study example, we will look to the Imarisha Naivasha Board in the Lake Naivasha Basin of Kenya. This Basin includes national parks, bird sanctuaries, is home to over 700,000 people, and is the epicenter of the country's lucrative flower export industry (Boesch, 2001). However, due to poor agricultural practices, over extraction of water, and uncoordinated resource management, the local environment became heavily strained. Not only were the natural ecosystems in the region under duress, but the floriculture, agriculture, and ecotourism industries were also placed in a direct line of threat by the environmental damage (Thaxton, et al., 2015). The solution to this environmental crisis incorporated the philosophy of integrated landscape management to gather the multiple stakeholders together and organize a unified plan to save the region's natural environment. In establishing the Imarisha Naivasha Board, a combination of local government, NGOs, small-scale farmers, community groups, commercial flower growers, and others developed the "Lake Naivasha Integrated Management Plan" to properly address the variety of threats to their environment, local economy, and ways of life (Thaxton, et al., 2015).

When the UN first came out with its seventeen new SDGs, many were frustrated at the evident vague language and ambitious breadth of the targets. Critics pointed to the SDGs as being too

aloof, lacking in the tangible community-level actionables which would ultimately need to come about if these grandiose Goals were to be anything close to accomplished. What ILM offers is landscape-scale solutions to a global agenda (Thaxton, et al., 2015). Although the Goals can be applied to varying degrees of unique issues facing communities in all corners of the globe, ILM dissects these Goals into meaningful actions to be undertaken at the most grassroots level all across the globe.

Political Coalition Building

One of our most poignant weapons in the fight to protect our natural environment is unity. In unifying the contemporary environmental movement with other causes for social justice, the voice of environmentalism is magnified greatly. An example where this coalition building has the opportunity to be successful is in the United States, where protests have occurred throughout the past year in opposition to the Dakota Access Pipeline. Construction of the pipeline is scheduled to cut through traditional Native American land (Purdy, 2016). At Standing Rock, activists have unified the voices of the environmental movement with those standing up for Native American and other minority community rights. Even other progressive activist organizations who did not have a direct stake in the conflict began to take part. The Black Lives Matter group has been an outspoken advocate for the Standing Rock community and has marched alongside environmental activists in Washington, D.C. to protest the White House's approval of the pipeline (Purdy, 2016).

This idea of coalition building is critical to elevating the agenda of environmental protection. It forms an identity of common values. In the political sense, it can grant access to higher levels of influence and attract greater levels of interest and attention from those with legislative power and the general public, who may otherwise not have taken note.

Conclusion

The changing environment we are experiencing today poses an unprecedented breadth of threats to our livelihoods, most poignantly to our human health. While causality between environmental causes and health effects is often difficult to prove because of lack of information and the fact that this is very much a new phenomenon, with conditions changing every day and throughout seasons, there is a substantial degree of studies which show wide-ranging areas of correlation which has meant travesty for the health of whole populations in every corner of the globe. We as inhabitants of this unique planet have failed to conscientiously self-regulate our waste, our emissions, and our destruction on the natural environment. For too many in our societies today, the insight into the crisis nature of this issue is dulled, or intentionally overlooked in favor of profit, the status quo, or fear of what acknowledging this intimidating reality means.

Ignoring the realities of climate change today must be understood to equate to risking hundreds of thousands of lives which have been shown to be at the mercy of a changing environment and its harmful effects. Anything less than this dims the brutality of the crisis and lulls us into apathy and inaction. It is dangerous, deadly, and unacceptable. Our response, therefore, must be bold and it must be comprehensive. As I have demonstrated above, when solutions are designed in an integrated fashion, incorporating a variety of stakeholders, and not overlooking any component of the broader environmental situation, we have seen success and hope for a sustainable future. It is through initiatives under this philosophy, and only in this resolute and meticulously premeditated fashion can we hope to alleviate the health burden of our human-induced environmental change.

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