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PM 2.5 and Impacts of Air Pollution on Ecosystem: Buddhist Perspective

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Abstract

The pollution of air with PM 2.5 has raised concerns about the negative impact of air quality on several health conditions, including respiratory illness, heart health, and allergic symptoms affecting the eyes and nasal passages. It is a growing concern for the general public in Thailand. Increasing levels of PM 2.5 in Thailand, it has impacted on the health and wellbeing of citizens, especially children. Exposure to high pollution levels affects children in irreversible ways. Children breathe faster than adults, which means that they are breathing in more polluted air than grownups. The younger they are, the more breaths per minute they take. In addition, their organs are still in a development stage, making them more vulnerable to immediate and life-long negative impacts. From a Buddhist perspective, an expression of craving, the very thing the Buddha pinpointed as the root cause of suffering. As signatories to this statement of Buddhist principles, the traditional five precepts, we acknowledge the urgent challenge of climate change we accept our individual and collective responsibility to do whatever we can to meet this target, including the personal and social responses outlined above. At the root of the ecological problem is a sense of self that needs to be

deconstructed. We have a brief window of opportunity to take actions, to preserve humanity from imminent disaster and to assist the survival of the many diverse and beautiful forms of life on Earth.

Keywords: PM 2.5; Air Pollution; Ecosystem; Buddhist Ethics

Introduction

Air pollution consists of gas and particle contaminants that are present in the atmosphere. Gaseous pollutants include sulfur dioxide (SO2), oxides of nitrogen (NOx), ozone (O3), carbon monoxide (CO), volatile organic compounds (VOCs), certain toxic air pollutants and some gaseous forms of metals. Particle pollution (PM 2.5 and PM 10) includes a mixture of compounds that can be grouped into five major categories: sulfate, nitrate, elemental (black) carbon, organic carbon and crustal material. Some pollutants are released directly into the atmosphere while other pollutants are formed in the air from chemical reactions. Air pollution impacts human health and the environment through a variety of pathways. (WHO, 2019b)

Air pollution is no new phenomenon, Bangkok experienced a smog in January 2018 that caused the government to issue a health warning to at risk residents. Moreover, cities in Thailand experience worse air quality than usual, causing somewhat of a mass migration to other city centers in SE Asia during spring months. If living is a recipe for a respiratory disease and poor general health as a result of air pollution. Bangkok, one of the world's most popular tourist cities, with many residents complaining about smog and suffered the worst air pollution in its history between January 1 and February 21, 2018. (Reuters, 2018) The PM 2.5 level in central Bangkok was at 22.5 microgrammes per cubic metre, according to the AirVisual

smart-phone application. The pollution department measured PM 2.5 dust in Bangkok at 72-95 microgrammes per cubic meter. That compares with a World Health Organization (WHO) guideline of an annual average of no more than 10 micro-grammes. (Praiwan, 2019)

There has never been a more important time in history to bring the resources of Buddhism to bear on behalf of all living beings. The four noble truths provide a framework for diagnosing our current situation and formulating appropriate guidelines. When the earth becomes sick, human becomes sick, because human is part of the earth. It's hard to imagine what people can do to resolve a problem of air pollution. Solving this requires all people to work together and share Buddhist perspective for people's minds following the Buddha teaching. Buddhism has lot to offer with respect to environmental con-servation and sustainable de-velopment. From a Buddhist perspective, environmental pro-blems are caused by greed and endless desire of people. Therefore, any environmental protection ecosystem strategies must pay special attention to the psychological dimension of human nature. More generally, Buddhism can be with environ-mental education in terms of promoting harmonious living between all living creatures and the environment and fostering environmentally friendly attri-butes such as selflessness, thriftiness, loving-kindness, social responsibility, and compassion. (Loy, 2019)

Content

What is Air Pollution?

Air pollution is often not visible to the naked eye as the size of the pollutants are smaller than the human eye can detect. They can become visible in some situations for example in the form of sooty smoke from the open burning of crop residues or other waste, as well as from burning wood, coal,

petrol and diesel fuels for cooking and heating, transport or power production. The fact that you cannot see the air pollution does not mean that it does not exist. Outdoor air pollution is a major environmental health problem affecting everyone in low, middle, and high-income countries. Ambient (Outdoor) air pollution in both cities and rural areas was estimated to cause 4.2 million premature deaths worldwide per year in 2016, this mortality is due to exposure to small particulate matter of 2.5 microns or less in diameter (PM 2.5), which cause cardiovascular and respiratory disease, and cancers. (WHO, 2019a)

WHO estimates that in 2016, some 58% of outdoor air pollution-related premature deaths were due to is chronic heart disease and strokes, while 18% of deaths were due to chronic obstructive pulmonary disease and acute lower respiratory infections respectively, and 6% of deaths were due to lung cancer. (WHO, 2018) Some deaths may be attributed to more than one risk factor at the same time. For example, both smoking and ambient air pollution affect lung cancer. Some lung cancer deaths could have been averted by improving ambient air quality, or by reducing tobacco smoking.

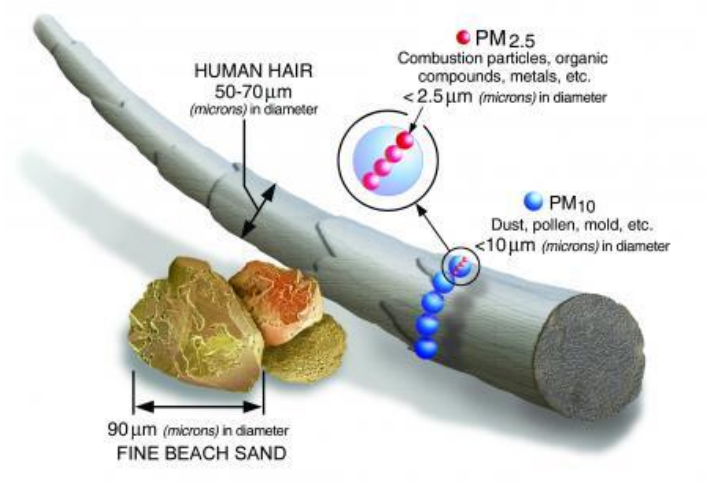

Figure 1 Size Comparisons for PM Particles
(Source: Environmental Protection Agency)

Definition and Principal Sources Particulate Matter (PM)

PM stands for particulate matter its the term for a mixture of solid particles and liquid droplets found in the air. Some particles, such as dust, dirt, soot, or smoke, are large or dark enough to be seen with the naked eye. Others are so small they can only be detected using an electron microscope. (EPA, 2018) PM is a mixture with physical and chemical characteristics varying by location. Common chemical constituents of PM include sulfates, nitrates, ammonium, other inorganic ions such as ions of sodium, potassium, calcium, magnesium and chloride, organic and elemental carbon, crustal material, particle-bound water, metals (including cadmium, copper, nickel, vanadium and zinc) and polycyclic aromatic hydrocarbons (PAH). In addition, biological components such as allergens and microbial compounds are found in PM. (WHO, 2013) PM 2.5, fine inhalable particles, with diameters that are generally 2.5 micrometers and smaller. (see figure 1) While particles with a diameter of 10

microns or less, (≤ PM 10) can penetrate and lodge deep inside the lungs, the even more health-damaging particles are those with a diameter of 2.5 microns or less, (≤ PM 2.5). (EPA, 2018)

Poor air quality and persistent haze is plaguing much of Thailand's north in the first quarter since last year, with the worst pollution in Lampang province, south of Chiang Mai in northern Thailand. Meanwhile, a bit further south, Bangkok residents had more of the fine-dust particles, aka. 2.5 microns, in eight of the city's districts. The Pollution Control Department in the north has reported unsafe levels of pollution in 11 of the 15 air quality measurement stations, (figure 2) including Mae Sai district in Chiang Rai; City area of Chiang Mai; City and Mae Mo districts of Lampang; City area of Lamphun; City area of Phrae; and City area of Phayao. (The Thaiger, 2020).

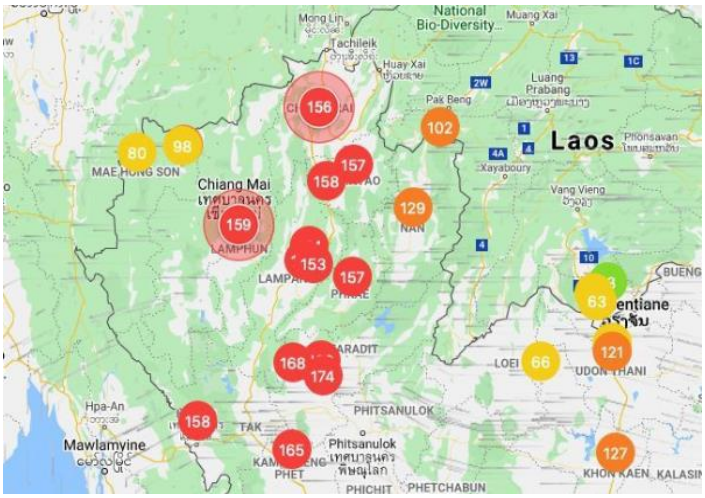

Figure 2 Unsafe Levels of Air Pollution Areas
(Source: S: AirQuality.com)

The United States Environmental Protection Agency (EPA) has developed an Air Quality Index (AQI) that is used to report air quality. This AQI is divided into six categories indicating increasing levels of health concern. An AQI value over 300 represents hazardous air quality and below 50 the air quality is good. Its air quality index values are typically grouped into ranges. Each range is assigned a descriptor, a color code, and a standardized public health advisory. (see figure 3) The AQI is based on the five "criteria" pollutants: ground-level ozone, particulate matter, carbon monoxide, sulfur dioxide, and nitrogen dioxide. The EPA has established National Ambient Air Quality Standards (NAAQS) for each of these pollutants in order to protect public health. An AQI value of 100 generally corresponds to the level of the NAAQS for the pollutant. (EPA, 2018)

Air Quality Index (AQI) Values	Levels of Health Concern	Colors
0 to 50	Good	Green
51 to 100	Moderate	Yellow
101 to 150	Unhealthy for Sensitive Groups	Orange
151 to 200	Unhealthy	Red
201 to 300	Very Unhealthy	Purple
301 to 500	Hazardous	Maroon

Figure 3 Air Quality Index
(Source: The United States Environmental Protection Agency)

Particles can either be directly emitted into the air (primary PM) or be formed in the atmosphere from gaseous pre-

cursors such as sulfur dioxide, oxides of nitrogen, ammonia and non-methane volatile organic compounds (secondary particles). Primary PM and the precursor gases can have both man-made (anthropogenic) and natural (non-anthropogenic) sources. Anthropogenic sources include combustion engines (both diesel and petrol), solid-fuel (coal, lignite, heavy oil, and biomass) combustion for energy pro-duction in households and industry, other industrial activities (building, mining, manufacture of cement, ceramic and bricks, and smelting), and erosion of the pavement by road traffic and abrasion of brakes and tires. Agriculture is the main source of ammonium. Secondary particles are formed in the air through chemical reactions of gaseous pollutants. They are products of atmospheric transformation of nitrogen oxides (mainly emitted by traffic and some industrial processes) and sulfur dioxide resulting from the combustion of sulfur-containing fuels. Secondary particles are mostly found in fine PM. Soil and dust re-suspension is also a contributing source of PM, particularly in arid areas or during episodes of long-range transport of dust. (WHO, 2013)

The effects of PM on health 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. There are serious risks to health not only from exposure to PM, but also from exposure to ozone (O_3), nitrogen dioxide (NO_2) and sulfur dioxide (SO_2). As with PM, concentrations are often highest largely in the urban areas of low- and middle-income countries. Ozone is a major factor in asthma morbidity and mortality, while nitrogen dioxide and sulfur dioxide also can play a role in

asthma, bronchial symptoms, lung inflammation and reduced lung function. (WHO, 2006)

At present, at the population level, there is not enough evidence to identify differences in the effects of particles with different chemical compositions or emanating from various sources. (Stanek, 2011) It should be noted, however, that the evidence for the hazardous nature of combustion-related PM (from both mobile and stationary sources) is more consistent than that for PM from other sources. (WHO, 2007) The black carbon part of PM 2.5, which results from incomplete combustion, has attracted the attention of the air quality community owing to the evidence for its contribution to detrimental effects on health as well as on climate. Many components of PM attached to black carbon are currently seen as responsible for health effects, for instance organics such as PAHs that are known carcinogens and directly toxic to the cells, as well as metals and inorganic salts. (WHO, 2013)

Preventing the Harmful Effects of PM 2.5 Air Pollution

The Air Quality Index (AQI) is a very useful application which reports the level of air quality. Before going outside, checking the pollution levels from this application for monitoring plan and activity outdoor wherever to go. Outdoor activities should be avoided or limited as less as possible. Stay indoors with the filtered air. Also, when staying inside the building, try not to open the window or do any activities that cause more smoke such as smoking and burning. Moreover, choose the mask which has the label of N95 because it has the ability to filter out the PM larger than 0.3 microns at least 95%. For the most effective protection, the mask should be used and worn properly to fit your face. Wearing the mask every time when going outdoors can basically reduce the risks of

inhaling PM 2.5 to your body. However, it is necessary to pay attention to symptoms carefully. The signs of being affected by the PM 2.5 may have sudden symptoms such as irritation and allergy of the eyes, nose, and throat; cough; phlegm; chest tightness; and shortness of breath. (Stanek, 2011)

The health and economic impacts of inaction should be assessed. Particulate air pollution can be reduced using current technologies. Interventions resulting in a reduction in the health effects of air pollution range from regulatory measures (stricter air quality standards, limits for emissions from various sources), structural changes (such as reducing energy consumption, especially that based on combustion sources, changing modes of transport, land use planning) as well as behavioral changes by individuals by, for example, using cleaner modes of transport or household energy sources. There are important potential co-benefits of integrating climate change and air pollution management strategies, as evidenced by the importance of the PM indicator and climate change contributor black carbon. (WHO, 2013)

The reduction of outdoor air pollutants and PM in particular requires concerted action by public authorities, industry and individuals at national, regional and even international levels. Responsible authorities with a vested interest in air pollution management include the environment, transport, land planning, public health, housing and energy sectors. Since the burden of air pollution on health is significant at even relatively low concentrations, the effective management of air quality is necessary to reduce health risks to a minimum. The development and exchange of information on policies, strategies and technical measures to reduce emissions are part of the fundamental principles of the Convention on

Long-range Transboundary Air Pollution. There are co-benefits to addressing particulate air pollution that go beyond just the positive impact on health. For example, reductions in black carbon emissions from the strategic mitigation of combustion sources will also simultaneously reduce global warming. (Schindell, et al., 2012) Finally, integrated policies on urban planning and transport can encourage the use of cleaner modes of transport and lead to changes in individual behaviour by promoting walking, cycling and increased commuting by public transport. These policies contribute to cleaner air while promoting physical activity and largely benefiting public health. (Schindell, 2012)

Buddhist Perspectives

The ecological crisis, and the larger civilizational predicament of which it is a symptom, is just as much a crisis for the Buddhist tradition, which needs to clarify its essential message in order to fulfill its liberated potential in the modern world. As Buddhist organizing for social and economic justice has floundered, the mindfulness movement has seen incredible success. Mindfulness offers an individualistic practice that can fit nicely into a consumer corporate culture focused on efficiency and productivity. Although such practices can be very beneficial, they can also discourage critical reflection on the institutional causes of collective suffering, or social dukkha. (Loy, 2017)

There is another way to understand the Buddhist path: that it is about deconstructing and reconstructing the self, the relationship between one's sense of self and the world. Reconstruction involves transforming our motivations, which is the key to understanding the Buddha's innovative teaching on karma. In it he emphasized motivation and intention because problems naturally result

when we act out of greed, ill will, and delusion. Transforming motivations alone is not sufficiency. At the root of the ecological problem is a sense of self that needs to be deconstructed. Because the self is a psychological and social construct, a cluster of impermanent processes, it is inherently insecure and anxious insofar as it feels separate from the rest of the world. This insecurity as a sense of lack, which nothing external can ever satisfy. Buddhist meditative practices can help resolve this feeling by revealing the interconnectedness with the world. As begin to awaken and realize not separate from each other or from the earth and begin to see that the ways people live together and relate to the environment, social, political, and economic institutions, need to be reconstructed in order to become more sustainable and socially just. (Loy, 2017)

The traditional five precepts or "training rules" of the Pali Canon are to abstain from killing living beings (sometimes understood as not harming living beings), taking what is not given, sexual misconduct, improper speech, and intoxicating substances that dull the mind (such as alcohol or recreational drugs). It's important to understand that these are not "thou shalt not" commandments. According to these principles is harmful to our-selves as well as to others, including the biosphere. Thich Nhat Hanh calls them "mindfulness trainings," replacing the usual "I undertake the precept to abstain from killing living beings," and so on, with "I undertake the course of training to abstain..." (Loy, 2017)

People need to wake up and realize that the Earth is our mother, when the earth becomes sick, people become sick, because people are part of the earth. At this time, economic and technological relationships with the rest of the biosphere are unsustainable. To survive the rough transitions ahead, our

lifestyles and expectations must change. This involves new habits as well as new values. The Buddhist teaching that the overall health of the individual and society depends upon inner well-being.

From a Buddhist perspective, a sane and sustainable economy would be governed by the principle of sufficiency: the key to happiness is contentment rather than an ever-increasing abundance of goods. The compulsion to consume more and more is an expression of craving, the very thing the Buddha pinpointed as the root cause of suffering. As signatories to this statement of Buddhist principles, we acknowledge the urgent challenge of climate change. We join with the Dalai Lama in endorsing the 350 ppm target. In accordance with Buddhist teach-ings, we accept our individual and collective responsibility to do whatever we can to meet this target, including (but not limited to) the personal and social responses outlined above. We have a brief window of opportunity to take action, to preserve humanity from imminent disaster and to assist the survival of the many diverse and beautiful forms of life on Earth. Future generations, and the other species that share the biosphere with us, have no voice to ask for our compassion, wisdom, and leadership. We must listen to their silence. We must be their voice, too, and act on their behalf. (Loy, 2019)

PM 2.5 needs to be improved in to assess population exposure and to assist local authorities in establishing plans for improving air quality. There is evidence that decreased levels of particulate air pollution following a sustained intervention result in health benefits for the population assessed. These benefits can be seen with almost any decrease in level of PM. The health and economic impacts of inaction should be assessed. Particulate air pollution can be reduced using current technologies along with

Buddhist concepts. Interventions resulting in a reduction in the health effects of air pollution range from regulatory measures, structural changes such as reducing energy consumption, especially that based on combustion sources, changing modes of transport, land use planning, as well as behavioral changes by individuals.

Conclusion

There is a real need for a greater sense of global responsibility based on a sense of the oneness of humanity. If Thailand wanted to manage its PM 2.5 for its citizens, surely it would do so in the worst areas of Bangkok. The Air Quality Control Program has pledged to implement emission standards for used and new vehicles, inspection and maintenance programs for cars, and roadside inspections and traffic management. Majority of cars, trucks and motorbikes in Thailand meet the national standards for acceptable pollution levels, though AQIs in Thai cities remain far too high. There is also a phase out of lead in gasoline, ongoing improvements in vehicle emission standards and better control of power plant based sulfur dioxide emissions. Regardless, hazardous pollution levels are rising faster than initiatives are taking hold, leaving far more to do to counter the country's continued and largely unrestrained industrial pollution problem. (NCCIE, 2020).

Thus, the Government of Thailand had issued an official statement regarding the quality of air in the metropolis area of Bangkok, along with five surroundding provinces, followed by a city-wide action plan to mitigate the situation. The air quality situation led to a demand that exceeded supply on N-95 protective face masks, while the number of hospitals visits due to respiratory illness significantly increased. The major concern about these tiny particles is its ability to travel through the respiratory tract and

deep into the lungs. PM 2.5 may not cause immediate harm to health; however, cumulative exposure over time can lead to various health disorders. One of the dangers related to PM 2.5 may be the role it plays in carrying other harmful environmental pollutants into the body through the adhesive properties of its outer layer, e.g. carcinogens, heavy metals, etc. The presence and continuously increasing levels of these tiny particles has been a worsening issue in Thailand over the past few years, with regular cycles of safe to unsafe levels. (Reuters, 2018).

Buddhists ethics tend to focus on personal lifestyle changes such as driving electric cars, installing solar panels on roofs, and eating less meat. While these are important, they are not sufficient responses to our increasingly urgent situation. If 10 or even 15 % of us do everything we can to reduce our own carbon footprint, the trajectory of our horror remains about the same. If even 10 % of us also work to change the system, it will be more than enough. By individual consumerism in Buddhism, particularly, we deny these, even though Buddhist teachings urge us to face our suffering rather than try to evade it. PM 2.5 problems are not an easy solution as long as we continue to consume energy without consideration of consequences to the planet. With everyone's cooperation and contribution to reduce air pollution, the quality of air will be brought back to safe levels and subsequently improving the quality of life and wellbeing for all.

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