

Negative Impact of Ground Level Ozone on Human Health and Environment

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At ground level, O₃, or tropospheric ozone, can be harmful to both humans and plants due to the fact that ozone has the ability to oxidize biological tissues (Bell et al. 2005). Tropospheric ozone is known to be a key component of photochemical smog (Ali 2006). Ozone is not released directly into the atmosphere but is formed by many chemical reactions that involve sunlight, oxides of nitrogen, oxides of hydrogen, and hydrocarbons (Seeley et al. 2005). The nature of tropospheric ozone production results in atmospheric concentrations and the generation of this oxidant prompts environmental fixations that are exceedingly subject to an assortment of components including time, temperature, stickiness, wind bearing, and topographical area (Seeley et al. 2005). The centralization of tropospheric ozone in the lower environment concentrations commonly extends from 10-120 ppb (by volume) which can be measured by an osmometer (Seeley et al. 2005). When tropospheric ozone is at elevated concentrations, it affects the respiratory system by exacerbating existing respiratory diseases/conditions, reducing quality of respiration, and causing a high mortality rate. Along these same lines, ground level ozone has similar effects on agriculture.

To avoid possible confusion, one must know the difference between the two kinds of ozone. There is ozone in troposphere, or ground level ozone (low altitude), which is harmful to the environment (a pollutant), and ozone in stratosphere (high altitude), which protects the earth from the sun's UV radiation. Tropospheric ozone is made from the burning of fossil fuels (mainly through automobile exhaust which contains nitrogen oxides, carbon monoxides and volatile organic compounds) reacting with sunlight exposure to produce a key component of smog, ground level ozone. Since ground level ozone is a harmful mixture of gasses and chemicals reacting with sunlight, it affects the vast majority of the living organisms on the

planet. In terms of humans however, it affects mainly the elderly, young, and those who are physically active, especially during the hot summer days (when there is a lot of traffic and during noon time because there are many sun rays radiated). Additionally, tropospheric ozone damage surprisingly can occur without any noticeable signs. According to United States Environmental Protection Agency, after exposure to tropospheric ozone, one could have a painful cough, feel an irritation in their throat, and/or experience an uncomfortable sensation in their chest which can last hours and lead to more major problems in the lungs or worsen already present lung disorders such as bronchitis, emphysema, and asthma. It also continues to cause lung damage even when the symptoms have disappeared. The best way to protect one's health is to find out when tropospheric ozone levels are elevated in the area and take simple precautions to minimize exposure even when obvious symptoms arise (United States Environmental Protection Agency).

The same chemicals (and their components) that permit excessive concentrations of ozone to react with organic substances outside the human body give it the potential to react with alike organic substances that make up the body, and are likely to cause damaging health consequences (Ali 2006). Interestingly, even low amounts of tropospheric ozone can cause coughing, throat irritation, chest pain, and shortness of breath. There is a high possibility of O₃ worsening chronic respiratory diseases such as asthma and endangering the capability of the body to fight infections, especially in the respiratory/cardiac region of the body (Rosenthal 2016). Additionally, according to the American Lung Association (ALA), tropospheric ozone is a “potent lung irritant and exposure to elevated levels is a contributor to the exacerbation of lung disease” and exposure to this dangerous chemical is similar to getting sunburn in the lungs . This is because according to the U.S. Environmental Protection Agency (US EPA), O₃ can damage

and inflame the cells that line the lungs. In no more than a few days of exposure, the lungs will replace the damaged cells and the old cells will be shed, similar to how the skin peels after getting sunburnt, and will make one more susceptible to lung cancer.

The main health concern of the human body when it is exposed to O₃ is its dangerous effects on the respiratory system, especially the functioning of the lungs (Pugliese *et al.* 2014). Several factors influence the dysfunctioning of the lungs when tropospheric ozone is inhaled, of which involve the the duration of exposure to O₃, the concentrations of tropospheric ozone in the area one is exposed to, and the average volume of air breathed per minute (Ali 2006). Exposure to significantly high concentrations of O₃ has also been proven to reduce physical performance, since a higher respiration rate during physical activity increases exposure to the chemicals present in the air that is being inhaled. Similarly, a study done by Oxford University found that tropospheric ozone can modify the extracellular lining of the lungs, and that further harm could arise with the interaction of O₃ with macrophage function, or the white blood cells in the human immune system, which could in turn reduce “the immune system’s ability to fight off bacterial infections in the respiratory system” (U.S. Environmental Protection Agency). Of the many health issues, the most common at the exposure of tropospheric ozone are difficulty breathing, shortness of breath and pain when taking deep breaths, lungs being more susceptible to infection, coughing and sore scratchy throat, and the possibility of permanent lung damage.

Associations between mortality and air quality have been extensively studied, specifically with respect to the levels of the pollutant chemicals in the air. One interesting example was a study conducted by Ohio Environmental Protection Agency (OEPA), which focused on the relationship between mortality and PM₁₀, a mixture of air pollutants. The scientists found that

the mortality has a striking 4-5 percent average increase than normal for each 50 $\mu\text{g}/\text{m}^3$ progressive increase of the PM10 on the same day. In addition, they conducted a similar study over a 5-day time period and found that the average mortality rate was around 6-8 percent higher than typically expected for each 50 $\mu\text{g}/\text{m}^3$ progressive increase. A famous Harvard University study showed similar supporting results as well. In this study, scientists monitored 6 cities and looked at the correlation between an increase in PM10, cause-specific mortality, and the size of the pollutant particles in the air (Geyh, Xue, Ozkaynak, & Spengler, 2001). The results of this Six City study portrayed the fact that there is a significant correlation between size of particulate matter and cause-specific mortality (Geyh, Xue, Ozkaynak, & Spengler, 2001). Most interestingly, a small increase of PM 2.5, significantly smaller pollutant molecules than the PM10, triggered an increase in ischemic disease (heart tissue slowly dying due to a sudden starvation of oxygen, and the buildup of dead tissue can cause a heart attack), mortality rates, COPD (progressive lung diseases), and pneumonia (Geyh, Xue, Ozkaynak, & Spengler, 2001). Additionally, this study emphasized the significance of ischemic heart disease mortality association and the PM by implying that PM-related mortality is a main element of death due to the ischemic disease. This Six City Study was repeated by other researchers that found similar results (Geyh, Xue, Ozkaynak, & Spengler, 2001).

Tropospheric ozone not only affects humans, but also has a negative on the environment. Ozone typically enters through the stomata of the plant when the plant is conducting regular gas exchanges. Due to the fact that tropospheric ozone is a strong oxidant, after the plant takes this toxin in, several types of symptoms including chlorosis (a disease where the chlorophyll in green parts of the plant is destroyed) and necrosis (plant disease where the tissues of the plant die) can

result. The symptoms of tropospheric ozone are typically presented between the veins on the upper leaf surface of middle-aged and older leaves, and sometimes on both leaf surfaces (for some species). The kind of injury and its severity depend on numerous factors including concentration of the tropospheric ozone exposure, the duration of the exposure, the plant's genetics and the weather conditions during that time period. Depending on the species of plant, one or even all of these symptoms can take place under certain conditions, and specific symptoms will differ from one species to another. With the continual use of harmful fuels and chemicals that lead to a majority of the world's plants getting unnatural daily exposure, classical symptoms such as reddening, flecking, and bronzing, will gradually lead to lethal diseases such as chlorosis and necrosis (United States Department of Agriculture). The destruction of plant species will not only lead to the endangerment of those plants, but will have a negative domino effect on the earth. The endangerment (or possibly extinction) of these plant species will lead to food and oxygen shortages and the endangerment of the animals who feed on those plant species which in turn could lead to certain species losing their habitats. These events would then lead to the destruction of ecosystems and food chains.

The general public's tremendous contribution to the hazards of tropospheric ozone are not only logically unethical but are also against the core beliefs of Islam. Allah (swt) says in surat Israa ayah number seventy, "We have honoured the sons of Adam; provided them with transport on land and sea; given them for sustenance things good and pure; and conferred on them special favours, above a great part of the creation" when talking about the blessing of having planet earth. Allah the almighty has surely awed mankind with the wealth and blessing he deposited in this world, exceeding a human's needs, in order for mankind to live worry free and

in comfort and has given mankind a body and mind which help with the utilization of these blessings. Mankind is well aware of these blessings, but with the introduction of new technologies and new industrial services and products, we have turned a huge blessing into a potentially harmful obstacle. The number of dangers due to environmental pollution have been skyrocketing, especially the penetration of destructive and harmful solar rays to the ozone layers (due to the chemicals in the air breaking down the protective barriers Allah (swt) has placed for us) which has led to the danger of cancer and the deformity in children. Although one takes the blessing of having a beautiful world to live in for granted, the people of the 20th and 21st centuries must learn to be especially thankful, as it is not only a core aspect of Islam but also due to the fact that in these two centuries mankind has done more harm to the earth than any other time period the earth has lived through and mankind has seen the effects of these harmful advancements.

Allah (swt) makes it clear to us in Surah Luqman verse ten that the creation and setup of this earth is a miracle and blessing in itself that is not possible for anyone to come near its expertise of set up when he says:

“He [Allah] created the heavens without pillars as you see them, and put mountains upon earth lest it might convulse with you, and he spread in it animals of every kind; and We sent down water from the cloud, then caused to grow therein (vegetation) of every noble kind” (pg.411).

Mankind must learn to look after the blessings Allah (swt) has given him since Allah (swt) tells mankind that he has given them the vegetation they see around themselves and the animals they eat (which they would not survive without both) and mankind is responsible for this earth's

growth as well as preventing vices and corruption in it. Furthermore, Allah (swt) promises a great reward for even the smallest contribution to take care of the environment. That being said, the messenger of Allah (PBUH) said "If a Muslim plants a tree or sows something, and then a bird, or a person, or an animal eats (something from sown or planted them), it will certainly be counted him as sadaqah" showing mankind just how important taking care of this earth is, and how such a small act to help the environment is greatly rewarded. Allah (SWT) has given mankind this earth as an amanah, or an important trust, and as muslims, it is their job to take good care of it.

Mankind also learns the importance of keeping the environment clean when Abu Musa (RA) was sent to Al-Basrah as the new governor and addressed the people saying: "I was sent to you by 'Umar ibn Al-Khattab (RA) in order to teach you the Book of your Lord [i.e. the Qur'an], the Sunnah [of your Prophet], and to clean your streets." Abu Hurairah reported that the Messenger of Allah (Peace Be Upon Him) forbade that a person relieve himself in a water source or on a path or in a place of shade or in the burrow of a living creature. These values emphasize Islam's stress on the importance of cleanliness as well as avoiding pollution of resources. If air pollution, due to new technological advancements, continues to be something that the general public supports instead of opposes, mankind will not only will be polluting the available natural resources (air, water, etc), but also their relationship with Allah as well.

Since tropospheric ozone can be harmful to both the human body and outside environment, and polluting the environment goes against Islamic teachings, there are many ways one can limit the negative effects of tropospheric ozone on their body, and lower tropospheric ozone levels in their environment. The most important step in making a change is to be educated

about tropospheric ozone, and to know the resources one can utilize in order to know when levels are especially high. One resource that can be used is the Air Quality Index (AQI), which posts the tropospheric ozone levels in the surrounding area everyday; this can usually be found on a morning weather forecast, the newspaper or on TV/ radio. If in color format (digital, newspaper, etc.) the AQI will provide a color- coded map which will help one easily determine whether air pollutants are reaching unhealthy levels in one's area. For example, the color red means that conditions are "unhealthy" for everyone (different levels of tropospheric ozone can be found online at www.airnow.gov). Also one can utilize the U.S. Environmental Protection Agency (EPA) guide for Tropospheric ozone-alert values (levels at which tropospheric ozone can hurt the human body, and is better to stay inside). In terms of steps that can be carried out daily in order to prevent tropospheric ozone exposure and limit tropospheric ozone emissions into the atmosphere, one can use environmentally safe paints and cleaning products whenever possible and carpool. Additionally, one can prepare for days when high tropospheric ozone levels are expected by combining errands, walking to errands when possible, reducing trips, and refuel your car in the evening when it is cooler.

In the long term, countries could also pitch in to make major contributions. One step that can be taken is ensuring that tropospheric ozone levels do not go over the guidelines established by the EPA. In the meantime, the government could adopt new air quality standards and set appropriate phase in periods during which townships and districts that do not meet the new standards will be assisted to attain these standards. The government could also work with cities to ensure that industrial areas should be established at a distance from residential, school, and recreational areas. Additionally, the development and employment of non-combustive sources of

energy, such as solar power, would not only prevent tropospheric ozone emissions, but provide an alternative for harmful means of energy.

To conclude, tropospheric ozone can be harmful to the human body because it affects the respiratory system by exacerbating existing respiratory diseases/conditions, reducing the quality of respiration, and causing a high mortality rate. Tropospheric ozone will also have similar effects on agriculture. In addition to tropospheric ozone harming the environment and the human respiratory system, it also ruins mankind's relationship with Allah (SWT), because Allah (SWT) tells mankind in the Quraan to preserve the earth because it is a blessing and he gave him more than he needed. Allah (SWT) established cleanliness as a key principle in being Muslim, and one way He does this is through an encounter a sahaba went through. There is still hope to improve the environment by taking many precautions such as carpooling, and limiting car use when possible by walking instead. Protecting our environment from tropospheric ozone will not only help us live on a healthy earth, but also improve our relationship with Allah (SWT).

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