



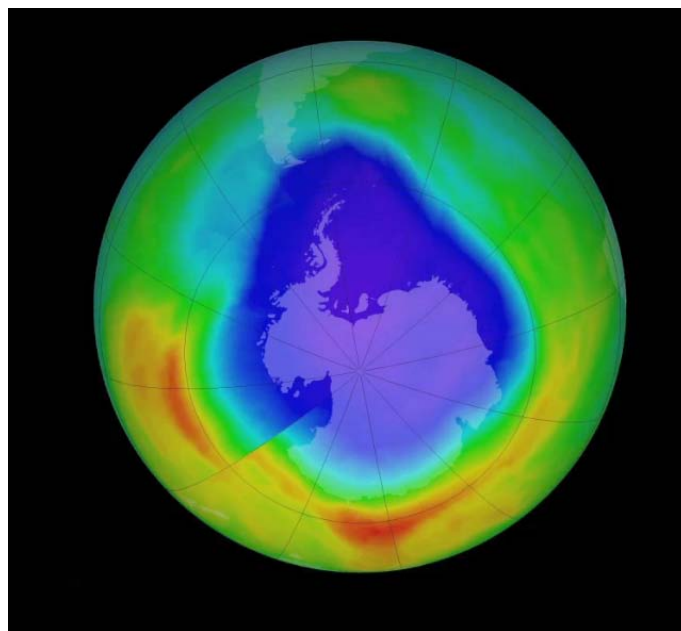
CYPRUS INTERNATIONAL INSTITUTE
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IN ASSOCIATION WITH
HARVARD SCHOOL OF PUBLIC HEALTH

Global Climate Change

“Ozone depletion: The interaction with climate change and
Health implications in European region”



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1. Introduction

Environment has been harmed adversely by human activities, especially during the last decades. The human effects resulted, between others, in global changes in atmosphere and stratosphere. The main suspects for these changes are considered the intensity of released greenhouse gases, as well as their trend to accumulate in the lower levels of the atmosphere. According to climatologists, climate change is a projection of the bigger picture of the problem (Kovats, et al., 2000). The onset of the bigger scale change originates from the depletion of the stratospheric ozone layer that has led to increased solar UV-B radiation (280–315 nm) at the surface of the Earth. Therefore, these two phenomena-the ozone depletion and the climate change-have attracted the attention of the scientific community during the last years, who investigates the potential relationship between them that seems to be rather complex (Norval, et al., 2011). On the other hand, these global consequences are likely to have an impact on human exposure to UV-B radiation with detrimental effects on health. The effects range from extreme cases of deaths, due to hit waves and skin cancer that are induced by the intense ultraviolet radiation, to milder like disturbances in physical and ecological processes, contributing in the development of infectious diseases, affecting water supplies and agricultural yield (Kovats, et al., 2000).

There are many regions globally that are affected by ozone depletion, facing enormous changes in their climate, including the rise of sea level and water stress, more frequent heat waves, higher average temperatures, heavier precipitations and snowfalls and winds of high intensity that were never before observed in these regions. The consequences of climate change are numerous and enormous, resulting in floods, damage of agricultural crops and buildings, diseases and deaths of humans and animals, as well as social, economic and demographic alterations. As mentioned earlier, the effects of climate change are obvious globally. Between all the continents, Europe, northern as well as southern, encounters big and sudden changes, which were first observed around 1990, when the Intergovernmental Panel of Climate Change, IPCC, conducting assessment of the status of global warming, reported that winter and springtime temperatures over northern Europe and Siberia were remarkably warm during the 1980s relative to the reference period 1951–1980 (Hartmann, et al., 2000).

The management of this environmental phenomenon is urgent and needs united effort and consistency. Greenhouse gases have to be reduced, meaning that any further failure to reduce the combustion of fossil fuels, which is their main source, will lead to exacerbation of the problem (Kovats, et al., 2000).

2. Ozone Depletion and Climate Change in Europe

Over the past three decades, scientists have recognized clearly a new but unexpected trend in global climate. The first official references, regarding these new climate trends, are appeared after 1980, when Northern Europe dealt with remarkably high temperatures, especially during winter and spring, raising the scientific concern. Initially, these temperature increases were considered to be an integral part of the greenhouse warming ‘‘fingerprint’’ predicted by climate models. However, it has since then become apparent that the warming of these regions is linked to the observed trend toward the ‘‘high index’’ polarity of the Northern Hemisphere annular mode (NAM) during this period (Hartmann, et al., 2000).

The vast majority of the environmental changes have common origins in the human activities, which since they are mostly profit-oriented, ignore the environmental impact. Some practical examples are the population growth, the spread of industrialization, the modern transport system and the increased consumerism, which are affecting the environment in a way that may not have been thought the years before. The ugly truth is that human economy and natural environment are inversely related (Kovats, et al., 2000).

More specifically, climate and weather are both thought to be products of the lower atmospheric layers, which is troposphere. However, stratosphere, which is located in the middle atmosphere, and particularly the stratospheric ozone, seem to interact with climate, inducing changes in it. Regarding stratospheric ozone, its origin is found billion years before, where solar-powered destructions and recombination of oxygen formed this layer that we now call ozone. There is a dynamic equilibrium that is supposed to keep stable the concentration of ozone, maintaining a balance between the production and destruction of it. The observed destruction of ozone layer may occur naturally and is catalyzed by trace amounts of hydrogen, nitrogen and halogen-free radicals like chlorine and bromine. The human activity, such as the industrial, however, favors the production of these radicals, which contribute to the further depletion of

ozone leading to serious consequences for human health. Stratospheric ozone depletion is the main suspect for climate changes, resulting from the accumulation of greenhouse gases in the lower atmosphere. Basic greenhouse gases in the atmosphere are water vapor (H₂O), ozone (O₃), carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O). Additionally, halocarbons (i.e., chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), and brominated chlorofluorocarbons (halons)) not only affect atmospheric chemistry, but are also significant greenhouse gases (WMO (World Meteorological Organization), 2011).

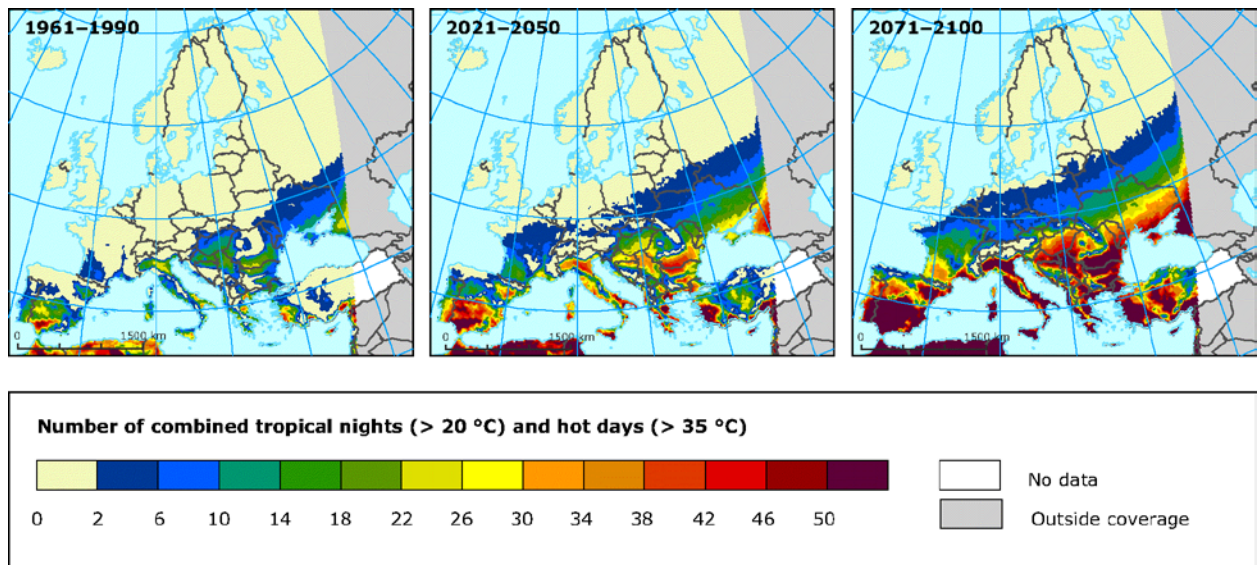
The primary influence is a cooling of the mid- to upper stratosphere due to increases in carbon dioxide (CO₂) via radiation to space, which is a well-understood process (WMO (World Meteorological Organization), 2011). Consequently, the cooling of stratosphere that is enhanced by the accompanied warming of troposphere, favors the respective destruction of stratospheric ozone layer. Climate change that is connected with the phenomenon delays the recovery of the aforementioned layer. The human's effects come from the impact of ozone depletion in atmosphere, which causes alterations in ground-level ultraviolet radiation that is primarily determined by the amount absorbed by stratosphere. The extend of ultraviolet absorption is affected negatively from the air pollution as well as the clouds, inducing higher surface temperatures and bigger personal exposure to harmful solar radiation (Kovats, et al., 2000).

In general the climate of a country is determined by its altitude and its proximity to the ocean or an inland sea. In Europe the temperature varies annually from 10° C in coastal regions of Ireland and United Kingdom to about 30° C in Finland and the Russian Federation. Regarding the precipitation rates, these range from 200mm per year in Greece and Southern Spain to over 2000mm per year in Norway and some regions in Alps. Despite the fact that the bigger part of Europe locates in northern latitudes, the climate in Europe, especially central and western, is normally quite moderate, with mild winter and summers. Mediterranean region is characterized by hot and dry climate, with most of the precipitations to occur during the winter period, whereas Northwestern Europe has mild winters and abundant rainfalls in Norway region and much colder winters with drier conditions in Finland and Sweden. In Eastern Europe the climate alternates from cold winters to hot summers (Beniston & Toll, 1998).

The last years a clear warming trend has been observed worldwide. Especially the mean temperature in the northern Hemisphere has been considerably increased. Over the last 100 years the average temperature in Europe is in average 0.8 ° C higher compared to the past years.

Additionally, there are some regions, such as Greece and other eastern regions that show a cooling trend. On the other hand, precipitation rates seem to be greater in northern part of Europe, with increase to ranges from 10-50%. Despite the fact that precipitation does not seem to follow a stable pattern, the down central Europe and the Mediterranean region experience droughts, with decreased annual rainfalls, up to 20% (Beniston & and Toll, 1998). Extreme weather events are by definition rare and are closely related with climate change. However, there are not enough data up to the moment that support a trend for extreme events in European regions during the last decades. The only quite clear observation is that UK has more “hot” days compared to the past (Kovats, et al., 2000). Below, in Figure 1, a projection of climate change in Europe is presented, providing information for the number of hot days and nights for three different time fractions, one in the past and two predictions for the future.

Figure 1: Map of projected climate change in Europe: Average number of simultaneous hot days and tropical nights (European Commission, 2013).



Stratospheric ozone depletion, either natural or anthropogenic induced, entails changes in the global climate. Despite that greenhouse gases are emitted from local sources found in all over the continent, due to their ability to be transferred through atmosphere, their impacts can spread in global scale. It is important to mention that ozone depletion appears some seasonality, being much more pronounced in winter and spring compared to summer, as well as some local preference, being more intense in Southern Hemisphere than Northern. Stratospheric ozone

provides natural protection to living earth organisms, since it absorbs the harmful UV radiation coming from the sun. Clouds, aerosols and tropospheric ozone also absorb or reflect part of the aforementioned UV radiation (Kovats, et al., 2000).

According to United Nations Environmental Program, biologically active radiation has been increased during the last years, ranging from 3.5-5% for different latitudes. There is increasing evidence that due to ozone depletion there will be a climate change, altering the global heat distribution, by increasing the cooling of the stratosphere. Additionally, there is great concern about the fact that even the cessation of chlorine and bromine fuels may not be enough to stop the ozone depletion, meaning that the cooling of stratosphere plays a more decisive role. This fact, along with the delay in the recovery of the layer poses great threat for the human health (WMO (World Meteorological Organization), 2011).

Other changes in the global climate that may contribute to ozone depletion, are effects on winds intensit, storms and precipitation, which are apparent both winter and summer. Additionally, ozone-hole, as the ozone depletion is also known, is responsible for changes in Antarctic Surface and sea ice. Looking at the big global picture, another serious effect that is closely related to ozone destruction is the effects on southern ocean temperature and circulation that are determinants of global climate and temperature levels (WMO (World Meteorological Organization), 2011).

3. Health Effects

The ozone depletion alone is in fact an indirect threat to human health, but the intense UV radiation, due to ozone depletion, to which humans are exposed is the main reason of damages in human health. The amount of UV radiation that may reach certain regions in a specific time frame is determined by a number of factors, including the latitude, season, time of day, altitude, local atmospheric conditions (e.g. fog), the variation of the thickness of ozone layer and the angle of the sun above the horizon. The attributed health effects to UV are damages in skin and eyes, as well as influences in the immune system. These effects may be acute or chronic depending on the duration and the intensity of the exposure.

The current background rate of skin cancer (melanoma) in Europe is about 2000 cases per million population per year. However other skin abnormalities, non-carcinogenic seem also to be

increased increasing the exposure to UV radiation. Regarding the eye problems, the most related to UV radiation condition is the corneal photokeratitis or “snow blindness”. Chronic exposure to UV is also associated with eye-conditions, such as pterygium. The cataract is not directly related to exposure to UV. Respectively, the effects in immune system are local and systemic immunosuppression. More specifically, the cellular immunity and the activity of natural killer cells seem to be affected by ultraviolet radiation. This may lead to lower resistance against different type of tumors, as well as diminished resistance to viruses and bacterial infections. Additionally, there is some indication that UV radiation may also induce changes in the immune system regarding its response against autoimmune diseases. It has been proved that the radiation may either aggregate or suppress the disease depending on the exposure. Lupus lesions and respiratory allergy seem to relate and affected by UV (Kovats, et al., 2000). Vitamin D seems to be weakly associated with exposure to UV radiation. Recent simple model computations, based on UK data for ambient UV radiation, indicate that sun exposures in the summer may indeed be inefficient in maintaining a sufficiently high vitamin D status in the winter (Norval, et al., 2011). However, there are other factors that contribute with UV and increase the risk for the aforementioned health effects, such as the personal behavior, the lifestyle, the age, the sex (Kovats, et al., 2000), (Urbach, 1991).

Speaking more general, ozone depletion and consequently climate change, both contribute to the development of a great number of diseases posing significant threat for human health. The direct health effects include the cases of heat stroke and dehydration or heat stress due to extreme cases of heat waves, along with other heat-induced illnesses. Direct effects are also considered all these effects that are attributed to the frequent and intensive extreme weather events, due to climate change. These are referred as injuries, deaths, mental disorders and the general damage of public health infrastructure (Kovats, et al., 2000). Some examples of indirect effects that are associated with climate changes are allergic effects; food-borne diseases, because of the rapid growth of bacteria due to warmer conditions; floods of sewage systems, due to heavy rainfalls; water-borne diseases that are caused from parasites like *Cryptosporidium* and *Giardia*, which development is also favored by floods and heavy rainfalls; and animal-borne diseases, such as Lyme disease and West Nile virus that are newly developed and depend strongly to environmental factors (EPA, 2013).

Humans are not the only who get affected by climate change and ozone depletion, but also animals and plants. Climate seems to be related with plant growth and distribution, as well as changes in animal's behavior and reproduction (Kovats, et al., 2000).

4. Conclusion

Human induced depletion of stratospheric ozone interacts with climate changes posing great threat not only for human health, but also for animals and plants. Unfortunately, despite the actions that could be taken in order to minimize the harmful destruction of ozone layer, it is unavoidable humans and other living organisms to be exposed to some climate change and increase UV radiation in the future. Any failure to reduce the use of fossil fuels will enhance the environmental damage increasing the incidence of diseases and mortality. In Europe climate change is likely to have serious implications in human health in many countries. Northern Europe seems to be more vulnerable to diseases like encephalitis, whereas southern in others like malaria (Kovats, et al., 2000).

Further actions should be taken to reduce the effects of ozone depletion and the respective climate change. These may include preventive measures, such as primordial prevention or mitigation that prevents the climate change itself, primary prevention that prevents the onset of diseases from environmental factors, secondary prevention that is taken in response of early evidence of health effects and tertiary prevention that is health care action which is taken to lessen the morbidity or mortality caused by a disease. The secondary and tertiary prevention are both less effective compared to the rest two and ethically undesirable when primordial or primary prevention can be applied. Additionally, adaptation strategies should be also developed in order to reduce the potential effects on health of climate change in Europe. The ultimate goal of these strategies is to reduce diseases, injuries, disabilities, suffering and death from climate change at the least feasible cost. Monitoring and surveillance policies could be also useful (Kovats, et al., 2000).

Briefly summarizing, in order to face this new threat for humanity, awareness for the problem, understanding of its causes, protective measures and defense mechanisms as well as political will need to be developed from European's and the rest world's governments and societies.

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