



ENVIRONMENTAL HYGIENE

The health of mankind and the health of the planet in a historical-ethical perspective: an inseparable relationship and a single destiny

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Summary

Recent years have seen increasingly severe natural disasters, the consequences of which have been catastrophic. Clearly, our global environment is undergoing major changes. The climate is becoming deranged and pollution on a global scale afflicts air, water, and land. We are faced with an unprecedented shortage of cultivable land and fresh water for drinking, irrigation, and livestock farming, while our marine systems are breaking down.

These environmental changes have a very high anthropogenic component; they are induced by human activities that are potentially dangerous for both the environment and human life. Moreover, not only do they have an enormous impact on the environments in which we live and on our way of life, they also have harmful effects on our health. Indeed, we must understand that our body – as Hippocrates explained long ago – is a system that constantly interacts with the surrounding environment.

Introduction

Every living organism is part of an ecosystem, which constitutes the condition sine qua non of its very existence, and “the relationship with the environment is one of the fundamental determinants of the state of health of the human population” [1]. “The health of humans, domestic and wild animals, plants, and the wider environment are closely linked and inter-dependent” [2]. At the same time, the environment is constantly modified by the set of actions and relationships implemented by the living beings that inhabit it. Therefore, it is essential to understand that human health is inseparable from the health of the Planet and from that of all other living beings. Human health is closely linked to the state of the natural systems on which it depends: and together they determine Planetary Health [3].

The effects of anthropization and climate change on human health

The scientific literature indicates that such important, and in part irreversible, changes that are affecting our planet because of anthropization can have both immediate and medium - and long-term effects on health. Indeed, back in 2006, the Italian National Federation of Orders of Physicians, Surgeons, and Dentists (FNOMCeO) introduced into its code of conduct a specific article regarding the “Promotion of health, the environment and global health”.

This article states that “Considering the living and working

environment and the levels of education and social equality to be fundamental determinants of individual and collective health, doctors will collaborate in the implementation of suitable educational and preventive measures and policies to combat health inequalities and will promote the adoption of healthy lifestyles by providing information on the main risk factors. Based on the available knowledge, they will foster communication on exposure and vulnerability to environmental risk factors and promote the appropriate use of natural resources, in order to create a well-balanced ecosystem in which both present and future generations can live” [4].

The doctor must therefore tackle any risks to human health, including those of an environmental nature, before their consequences arise.

An analysis updated to 2016 – the most up to date among those available – has shown that 24% of deaths worldwide (and 28% of deaths among children under 5 years of age) are due to modifiable environmental factors [5].

“Factors include air pollution, water and sanitation, increasing severe weather events, harmful exposure to chemicals and more” [6].

Furthermore, the climate crisis has increased the average global temperature and is leading to more frequent high-temperature extremes, such as heatwaves.

The last few years have been the hottest on average as long as records have existed, and more than 400 weather stations all around the World have beaten their heat records in 2021 (reaching up to 48.8°C in Italy on 20 July, 49.6°C in Canada on 29 June or even 54.4°C in the US on 9 July) [7].

Although full-year data is not yet available, 2023 is set to become the hottest year in history according to data from Copernicus, the European Commission's Earth observation programme coordinated and managed by the European Commission, dedicated to monitoring our planet and its environment. The news is reported by the most important news agencies and at the opening of Cop28, the United Nations Conference on Climate Change, held in Dubai from November 30 to December 13, 2023, the UN Secretary-General, Antonio Guterres, confirmed that 2023 is the hottest year ever, with record temperatures and Antarctic Sea ice at historic lows. "We are experiencing climate collapse in real time" Guterres said [8].

According to the WMO (World Meteorological Organization), in 2022 [9], the global mean temperature, which combines near-surface temperature measurements over land and ocean, was 1.15 [1.02-1.28] °C above the 1850–1900 pre-industrial average.

Shifts in climate can influence the structure and diversity of microbial communities [10].

Candida auris is considered the first "novel" pathogen to have evolved in response to climate change, although this remains speculative and awaits conclusive evidence [11]. The transformation of *Candida auris* from an environmental fungus to a human pathogen could be also due to thermal adaptation induced by climate change, enabling it to survive in human body temperatures. *Candida auris* may have originated as an environmental fungus in wetlands, and due to its adaptation to rising temperatures, it may have infected birds as an intermediary species before further adapting to the higher body temperatures of humans [12-14].

Changes in precipitation and temperature were also noted to affect human social gatherings and the transmissibility of viruses such as influenza and COVID-19 [15].

Emerging and re-emerging viral outbreaks are becoming more frequent due to increased international travel and global warming.

The emergence of the Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV) in 2002, followed by the H1N1 influenza outbreak in 2009 [16] and the most recent SARS-CoV-2 pandemic [17, 18] underscored the potential of viruses to swiftly disrupt global health and economies [19].

Liu [20] demonstrated that rapid weather variability (RWV) also played a significant role in changing the strength of the influenza epidemic in the past. In a warming climate, the RWV will intensify, and the influenza epidemic risk can increase by up to 50% in some northern mid-latitude regions.

The consequences of global warming and resulting climate change are expected to have effects on waterborne infections in the future. Longer seasonal warm periods due to hot summers or prolonged warm autumns lead significant increases in temperatures even in the polar areas [21] with a relative increase in the temperature of waters (marine and continental) at high latitudes.

These increased temperatures can favour the multiplication of waterborne pathogens like *Legionella*,

that causes various clinical manifestations, including the form of pneumonia commonly known as Legionnaires' pneumonia illness [22].

Given the rising average of global temperatures, also the base temperature of cold water will increase. Such an effect could lead to increased *Legionella* growth in cold water, which in turn could lead to increased *Legionella* concentrations in both cold and hot water [23].

Another serious drawback of global warming is the increase in antibiotic resistance. This is a major public health problem and a cause of substantial morbidity and mortality among hospitalized patients, especially in at-risk wards [24-27].

In a 30-country cross-sectional study conducted by Kaba et al. [28] the six-year prevalence of carbapenem-resistant *Pseudomonas aeruginosa* (CRPA), *Klebsiella pneumoniae* (CRKP), Multiresistant *Escherichia coli* (MREC), and Methicillin-resistant *Staphylococcus aureus* (MRSA) was determined based on > 900 k clinical isolates. Bi- and multivariate analysis were performed to identify associations with climatic variables using healthcare and socio-economic confounders. CRPA was significantly associated with the warm-season change in temperature. Moreover, they found significant associations of CRKP, MREC, and MRSA with the warm-season mean temperature, which had a higher contribution to MRSA variance explanation than outpatient antimicrobial drug use.

The link between climate change and cholera epidemics

To all this we must add environmental disasters due to climate change and the improper use of land. Malawi, for example, is currently experiencing the deadliest cholera epidemic in its history. "Between March 3 2022 and February 3 2023, a total of 36,943 cases, including 1,210 deaths, were reported from all 29 districts in Malawi (overall case-fatality rate (CFR) 3.3%) with active transmission ongoing in 27 of the 29 districts. There was a 143% increase in the number of cases in January (17,078) in comparison with December (7,017 cases)" [29]. And the situation in recent months tends to worsen further.

Cholera has been endemic in Malawi since 1998, with seasonal outbreaks reported during the rainy season (November to May). The conditions for the present severe outbreak were probably created by the tropical storms that hit the country just over a year ago. However, the fact that the current epidemic has extended throughout the dry season is a sign of a worsening situation, which is evidently linked both to problems concerning water and sanitary infrastructure and to the interruption of cholera prevention campaigns due to the COVID-19 pandemic. A peak of cholera cases – over 28,000 cases – was also recorded in mid-March 2023 in Mozambique, where the disease has been growing exponentially since December 2022.

Cyclone Freddy, the resulting flooding and heavy rains

in the first weeks of last February further worsened the situation. “Weak surveillance and late reporting, inadequate WASH conditions (lack of access to safe drinking water, poor sanitation and hygiene practices), a weak health system and the exhaustion of a workforce that has to respond to multiple emergencies threaten to favor the spread of the disease, as do the ongoing heavy seasonal rains” [30].

The situation also continues to be alarming in Pakistan, where, since last year’s floods, the risk of cholera remains high [31], and where polio outbreaks persist [32].

In 2022 there were 20 cases of WPV Polio in Pakistan and already 2 cases were recorded in 2023 [33].

But above all, polio has reappeared in the last year in various countries of Africa, after the World Health Organization declared the African continent polio-free on August 25, 2000 [34, 35].

The World Health Organization (WHO) has expressed concern over the risk of the potential spread of these diseases to other countries in the area, given the significant cross-border traffic between Pakistan and neighboring countries.

Returning to talk about cholera [36], which today is widespread in Africa [37] but also in Haiti, India, Pakistan, the Philippines and Syria [38], it should be remembered that in February 2023, the United Nations health agency pointed out that the greatest challenges in the fight against epidemic diseases, starting with cholera include climate change, which has led to droughts or floods in many parts of the world, resulting in increased population migrations and reduced access to safe water. Of particular interest in this regard are the studies that correspond climate variations with the ENSO phenomenon, El Niño Southern Oscillation.

Since the late 1970s, in fact, the warm periods originating from ENSO have become more and more intense and the increase in temperatures on a regional scale, due to climate change and ENSO, can facilitate the proliferation of bacteria that populate salty waters and thrive at high temperatures.

These results were reached by the working group coordinated by Xavier Rodó, an ICREA research professor and head of the Climate and Health program at the Barcelona Global Health Institute (ISGlobal), where he directs the climate and health research programme, studying the interplay between climate and health [39-42].

Wars and famines at the root of the resurgence of epidemic diseases

Moreover, in many areas, the disasters caused by climate change and environmental problems are compounded by war, famine, and the marginalization of entire ethnic groups. As a result, thousands of people are driven from their homes and are often forced to flee to refugee camps, where drinking water is scarce and toilets facilities inadequate owing to the frequent breakdown of aqueducts and sewage systems. Added to this is the

lack or limited availability of medical care, which can aggravate epidemics once they occur.

In this regard, the case of Syria is exemplary; for 12 years, the country has been racked by a bloody civil war, which to date has caused hundreds of thousands of deaths, mass displacements and the destruction of civil infrastructure. This difficult situation has led to the constant recurrence of a series of epidemics that are decimating the population: cholera, Wild polio virus, measles, leishmaniasis, diarrhea, scabies, lice, hepatitis A and leptospirosis, in addition to COVID -19. Against this backdrop of serious social and health difficulties, last February many disastrous earthquakes hit the north-western area of Syria, on the border with Turkey [43].

The destruction due to war and earthquakes, which have damaged water infrastructure and made access to clean water extremely limited, and access to water purification tools is made difficult by the restrictions imposed on the country, have caused the return of cholera to Syria thirteen years after its disappearance [44], as happened in Haiti, whose population in recent years has had to endure very strong storms and floods, earthquakes, hurricanes and famines, accompanied by epidemic diseases, with a return of cholera in October 2022 [45]. Such extreme situations are becoming increasingly frequent, above all when, as in Syria, a situation of poverty is aggravated by environmental disasters or earthquakes which deprive people of the means of sustenance and impair their physical and mental health. This is the case of Afghanistan - already hit by an earthquake in June 2022 - and of Pakistan, Chile, and Libya, which suffered earthquakes of magnitude greater than 6 on the Richter scale in March 2023 [46].

These situations immediately give rise to problems such as dehydration and dysentery, caused by the lack of drinking water and poor hygiene, which lead to the spread of epidemics [47]. A particularly worrying phenomenon is the rapid increase in measles infections among Afghan children, owing to low vaccination coverage, as well as among children who are experiencing the dramatic situation of the war in Ukraine [48, 49].

Measles damages children’s immune systems, making it more difficult to fight off complications such as respiratory infections and pneumonia. Moreover, without treatment, measles mortality can be as high as 20%.

In addition to measles, various vaccine-preventable diseases can strike in similar contexts, precisely because of the impossibility of carrying out vaccination campaigns.

In the periods following earthquakes or other disasters, the risk of respiratory diseases absolutely must not be underestimated. Indeed, the risk of outbreaks of infectious diseases caused by respiratory viruses is particularly high, especially in temporary reception camps, owing to both overcrowding and low seasonal temperatures.

Finally, one of the heaviest burdens borne by survivors of a natural disaster concerns the mental health problems caused by the severe trauma and the serious losses

suffered, in terms of both human lives and the loss of one's home and one's certainties [50, 51].

Conclusions

These few data highlight an incontrovertible fact: mankind cannot live in a ruined environment. We must rebuild that "bridge" imagined by Van Rensselaer Potter (1911-2001), the father of bioethics: a bridge between the present and the future, and, above all, between man and nature, between human health and that of the planet, between the future of mankind and that of the environment in which we live [52, 53].

Understanding this simple but fundamental reality should prompt us to adopt radically different lifestyles and models of consumption that are sustainable in terms of their environmental impact. It may also raise our awareness of the fragility of man and other living beings in the face of global change and extreme natural events. If so, scientists, governments and society may be able to implement appropriate and timely interventions, albeit in the knowledge that it is becoming increasingly difficult, if not impossible, to respond simultaneously to multiple epidemics, owing to the lack of resources, drugs, and medical and healthcare personnel.

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Conflict of interest statement

The authors declare no conflict of interest.

Authors' contributions

DO: designed the study; MM: conceived the study; DO, MM, MLC: drafted the manuscript; DO, MM, MLC and AMS, MS: critically revised the manuscript. DO, MM, AMS, MLC: performed a search of the literature; furthermore: MM, DO and MLC: methodology; MLC and AMS, MS: validation and data curation; MS: formal analysis; MM, MLC, DO: final editing.

All authors critically revised the manuscript. All authors have read and approved the latest version of the paper for publication.

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