

Are climate change and mental health correlated?

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ABSTRACT

Climate change is one of the biggest challenges of our time and is likely to affect human beings in substantial ways. Recently, researchers started paying more attention to the changes in climate and their subsequent impact on the social, environmental and economic determinants of health, and the role they play in causing or exacerbating mental health problems. The effects of climate change-related events on mental well-being could be classified into direct and indirect effects. The direct effects of climate change mostly occur after acute weather events and include post-traumatic stress disorder, anxiety, substance abuse disorder, depression and even suicidal ideation. The indirect effects include economic losses, displacement and forced migration, competition over scarce resources and collective violence. The risk factors for developing those mental health issues include young age, female gender, low socioeconomic status, loss or injury of a loved one, being a member of immigrant groups or indigenous people, pre-existing mental illness and inadequate social support. However, in some individuals, especially those undisturbed by any directly observable effects of climate change, abstract awareness and acknowledgement of the ongoing climate crisis can induce negative emotions that can be intense enough to cause mental health illness. Coping strategies should be provided to the affected communities to protect their mental health from collapse in the face of climate disasters. Awareness of the mental health impacts of climate change should be raised, especially in the high-risk groups. Social and global attention to the climate crisis and its detrimental effects on mental health are crucial.

This paper was written with the aim of trying to understand the currently, scientifically proven impact of climate change-related disasters on mental health and understanding the different methods of solving the problem at the corporate level, by trying to decrease greenhouse gas emissions to zero, and at the individual level by learning how to cope with the impacts of those disasters.

INTRODUCTION

The World Health Organization (WHO) has recognised climate change as a significant global challenge, with major threats to life, health and well-being.¹ In fact, it is one of the most important challenges facing future generations. The changes that climate can cause are in the form of acute weather events or natural disasters lasting for days, such as hurricanes, wildfires, floods and

short-duration heat waves; subacute events lasting for months or a few years, such as droughts; and long-lasting changes that may persist until the end of this century, such as higher temperatures, widespread melting of glaciers, rising sea level and potentially uninhabitable physical environments due to permanent alterations.

Climate change can affect different systems in the human body, including the respiratory, the cardiovascular and the central nervous system. The physical impact of climate change that can affect mental health includes injuries and fatalities with their impact on mental health; respiratory diseases like asthma and allergies due to an increase in allergens and air pollution with potential for depression and anxiety; changes in vector-borne diseases (as increased temperatures can shorten the time between blood meals of mosquitos and accelerate the development of protozoa or viruses within the insect, also it can change patterns of breeding and length of seasons, for example, mosquitos hibernate over winter),² which will lead to adverse mental health outcomes caused by vector-borne infections. Other impacts include decreased quality of water and food causing physical and mental health issues related to cholera, cryptosporidiosis, leptospirosis, diarrhoeal diseases and malnutrition.³

Higher temperatures can also have major adverse impacts on health. Heat exhaustion can lead to a significant surge in respiratory, cardiovascular, renal and mental diseases.⁴ Even mortality rates are reported to be affected by temperatures. Authors reported that nearly 30% of the world's population has been already exposed to temperatures that can increase mortality, and the percentage will likely increase to 74% by 2100 if greenhouse gas emissions grow.⁵ It is also reported that 1 day at 35°C causes an increase in the all-age mortality rate of around 0.4 deaths per 100 000 compared with 1 day at 20°C.⁶

The relation between climate change and mental health is not clear. However, there is robust evidence for it. Mental health can be affected directly especially after acute climate



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events in the form of higher rates of anxiety, post-traumatic stress disorder (PTSD), depression, substance abuse and domestic violence after the events.⁷ These acute events can also have indirect effects on mental health caused by disrupting educational and medical services, economic losses in the form of property damage, loss of income and employment opportunities, reduced economic productivity especially in agricultural societies, population displacement and forced migration, and increased conflict and violence, all of which significantly impact mental health.⁸ One of the major challenges of studying mental health in different contexts is the diversity of cultural and social norms, values and beliefs, which determines how mental health manifests and is perceived.⁹

Most of the recent work on the correlation between mental health and climate change has been conducted only in developed countries. This limits the generality of these studies, especially for the marginalised populations who are likely to be more vulnerable to climate change.¹⁰ In addition, there is a term known as climate injustice, highlighting the fact that the countries that contribute the least to greenhouse gas emissions are affected the most by the impact of climate change.¹¹ In this article, we provide an overview of the psychological consequences of climate change and current strategies to prevent or reduce those effects.

CONCRETE FACTS ABOUT CLIMATE CHANGE

There is no doubt in the fact that climate change composes an existential threat to humans and other living organisms. This crisis has been constantly on the rise since the beginning of time, but it has intensified even more since humans initiated what we now call the 'Industrial Revolution'. Since the start of the Industrial Revolution in the year 1760, humans have managed to use fossil fuels, like coal, oil and natural gas, in different kinds of industries to produce some 365 billion metric tons of carbon into the atmosphere. Deforestation has added some 180 billion tons. Annually, humans emit some 9 billion tons, and this amount has been increasing by a factor of 6% each year. As a result, the CO₂ concentration is currently higher than its concentration in the last 800 000 years, and some scientists even claim higher than its concentration in the last several million years. If CO₂ continues along that trend, the average global temperature is expected to rise by about 2°C to 4°C in the next two decades.¹²

The current human emission amount of greenhouse gases, such as CO₂, methane and nitric oxide, into the atmosphere is about 51 billion tons. Figure 1 shows how those 51 billion tons are distributed according to human usage.¹³

Not doing the necessary actions needed to stop greenhouse gas emissions means that within the next few decades, the global temperature may rise up to 2°C or even 4°C. A 2°C increase means the ice sheets in the North Pole will collapse and approximately 400 million people will suffer from water scarcity, major world cities will become uninhabitable and heat waves will kill thousands of people every summer season.¹⁴

51 billion tons of greenhouse gases

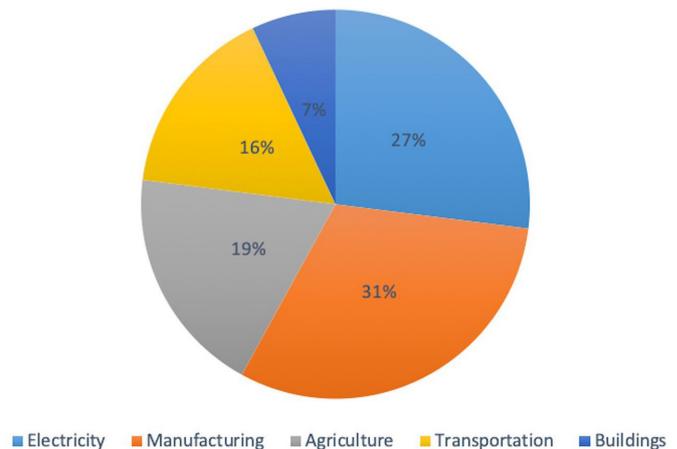


Figure 1 The current human emission amount of greenhouse gases per year is about 51 billion tons distributed among different sectors.

A 4°C increase means that the number of people suffering from dengue fever will increase by a factor of 8 million each year in Latin America alone and there could even be an annual global food crisis. Because of the climate disaster that may follow this increase, the global economic damages may reach 600 trillion dollars, a number that is more than twice the world's total wealth.¹⁴

DIRECT EFFECTS OF CLIMATE CHANGE ON MENTAL HEALTH

Mental health issues associated with climate change include higher rates of anxiety and PTSD, sleep disorders, increased addiction, depression and suicidal ideation.^{15 16} The symptoms can persist from months to years.¹⁷ The risk factors for developing these issues include the magnitude of the climate disaster, female gender, younger age, low socioeconomic status, less education, loss or injury of a loved one, minority or ethnic status, immigrant groups, indigenous people, family instability, pre-existing mental health problems and inadequate social support.^{15 16 18-20} Populations of low/middle-income countries are affected more due to their increased exposure to acute weather events and lack of access to health and support services.^{17 21}

One of the most vulnerable groups to climate change are children because of their immature thermoregulatory functions, biological sensitivity, limited adaptive responses, existential concerns about the future and the fact that they will be faced by the climate dilemma for many years to come, and dependence on stressed adults.^{22 23}

Extreme heat events and longer periods of increased temperature are linked to higher rates of aggressiveness and criminal behaviour, causing higher rates of physical assault and crimes,²⁴ as well as increased rates of anxiety, mood disorders and suicide.^{25 26} Heat can also suppress thyroid function, leading to functional hypothyroidism, causing lethargy, mood disorder and cognitive impairment.²⁷ Higher temperatures can also lead to dehydration

which cause a decrease in cognitive function.²⁸ One group of the global population that are especially vulnerable to heat stress are individuals taking psychotropic medications due to decreased heat regulatory functions and impairment of fluid haemostasis.²⁹

Floods, which are the most common cause of climate disasters worldwide, have been associated with higher rates of long-term anxiety, PTSD, aggression, depression and suicide.³⁰ Also, high humidity has been linked to higher fatigue and poor concentration.³¹

Air pollution which usually accompanies climate change has been linked to adverse mental effects. Some studies have linked long-term exposure to higher concentrations of particulate matter 10 (PM10), nitric dioxide, carbon monoxide, ozone and sulfur dioxide to poor quality of life and higher rates of stress, depression and suicidal ideation.^{32–35} Also, an association was reported between pollution and schizophrenia.³⁶ Even urban birth and city living were described as risk factors for the onset of psychosis.³⁷

Several studies have suggested that pollution can be linked to the pathophysiology of certain neurodevelopmental and behavioural disorders in children such as attention/deficit hyperactivity disorder and autism spectrum disorders.^{38,39} However, recent studies reported that this association is weak.^{40,41} Also, higher levels of neuroinflammatory markers were found in brains of children exposed to higher levels of pollution.⁴²

In addition, pollution was linked to increased expression of neurodegenerative markers such as beta-amyloid and alpha-synuclein and was suggested to be associated with the pathophysiology of Alzheimer's disease and Parkinson's disease.⁴³ Also, another study about structural changes in elderly brains exposed to air pollutants, especially PM2.5, reported that air pollution was associated with gradual effects on structural brain ageing even in patients without dementia or stroke.⁴⁴ In another study on elderly women, not only the brain volume decreased, but also the white matter volume was reduced.⁴⁵ In fact, air pollution was considered a potential risk factor for cognitive impairment by the Lancet Commission for the prevention and treatment of dementia.⁴⁶ However, inconclusive data were reported.⁴⁷

For some individuals, the negative emotions caused by abstract awareness and acknowledgement of the ongoing climate change, even in those who are well insulated from any directly observable effects, can be intense enough to contribute to mental illness.¹⁸ These negative emotional responses include guilt, pain, anxiety and demoralisation. The most vulnerable subjects are those who are already stressed and younger adults, including those living in high-income countries.^{22,48} Abstract climate change stressors are also affected by ideologies and values of the receiving audience to the circulating messages of climate change.⁴⁹

New terms were described to define some of the newly reported mental disorders caused by climate change. The term 'solastalgia' describes the chronic distress and grief experienced by individuals in response to negative

environmental changes, particularly when it affects the local environmental area.⁵⁰ The term 'ecoanxiety' describes the stress and anxiety experienced as a result of climate change on a global level, while 'ecoparalysis' is the inability to act on environmental changes due to the activation of certain psychological defence mechanisms (eg, denial) or a perception that they are intractable. 'Econostalgia' describes a perception that a local environment was better in the past.⁵¹

Recent research reported that climate change is an important source of worry around the world. Twenty percent to forty percent of Europeans, from multiple countries, described themselves as 'very worried' in a study in 2016.⁵² Another study reported that at least 69% of Americans are 'somewhat worried' about global warming, 29% are 'very worried' and 49% reported that they think they will be directly harmed by global warming.⁵³ An Australian study reported that when participants were asked the open-ended question 'what do you think will be the most serious problem facing the world in the future if nothing is done to stop it?', 39% of the answers were falling into the category of climate change and environment.⁵⁴

In addition to understanding the relation between climate anxiety and mental health, it is extremely important to understand its relation to behaviours. Climate anxiety may serve as a motivational source leading to better adaptive actions. On the other hand, it could serve as a source of severe anxiety that inhibits any form of effective action. In a recent study, it was reported that climate anxiety was neither positively nor negatively correlated with behaviour; in fact, the correlation was very close to zero.⁵⁵

INDIRECT EFFECTS OF CLIMATE CHANGE ON MENTAL HEALTH

Unlike extreme climate events, the effect of gradual climate change on mental health, such as increase in temperatures and sea level, is still unclear and more difficult to study, as it is less evident and indirect.⁵⁶ Climate change can affect mental health indirectly by economic losses, particularly affecting rural farming and fishing populations, due to their high dependency on the environment as a source of livelihood. Long periods of drought can lead to forced migration, which is known to be a relevant stressor that can potentially affect both physical and mental health. Also, in areas at higher risk of drought, higher rates of anxiety and depression were found.⁵⁷ Even suicidal rates among farmers living in these areas were higher.⁵⁸ One study described the relation between economic loss, forced migration and altered community structure, leading to shame, uncertainty and depression.⁵⁹ Another review stated that 150 million people may be displaced by climate change, which may result in depression from losing home and social networks.⁵⁶ In fact, displacement and relocation are considered risk factors for the onset of depression.⁶⁰

In addition, the destruction of the local environment and the extinction of different plant and animal species

in the long term can cause dissociative and identity disorders and personality changes.^{61 62}

Impacts of climate change on community well-being can occur through economic losses related to loss of employment opportunities, loss of income, property damage-associated loss of productivity, forced displacement and loss of attachment to the local natural environment.⁶³ Even disputes over resources and collective violence can result from economic losses, leading to higher rates of depression and anxiety disorders.⁶⁴ Also, the rates of intimate partner violence and child abuse increase in families affected by natural disasters. The reasons for this increase include increased stress and feeling of powerlessness due to bereavement and loss of livelihood, destruction of social networks and breakdown of law enforcement.⁶⁵

Low-income countries will be affected the most due to their greater exposure to the effects of climate change, dependence on agriculture and other climate-impacted industrial sectors, and limited access to medical services and resources.^{65 66}

While there is no direct evidence that climate change is affecting the spread of COVID-19, climate change can increase the likelihood of emerging infectious diseases. For example, one of the causes of climate change is deforestation, which leads to loss of natural habitat and forced animal migration, causing increased contact between humans and animals, which may result in spillover of organisms from animals to humans.⁶⁷ In fact, genetic and molecular analyses support that SARS-CoV-2 could be originated from bats, highlighting the strong zoonotic potential of coronaviruses.⁶⁸

WITNESSED MENTAL HEALTH IMPACTS OF CLIMATE CHANGE

Since the 1980s, average global temperatures have been progressively increasing. That progressive increase has directly and indirectly led to extreme weather events

especially during the summer and winter in different cities around the world. These extreme events include hurricanes, floods, wildfires, short-duration and long-duration heatwaves. Those events have had significant negative mental health impacts on the populations affected. The most commonly affected regions by those events are the rural and indigenous ones. In figure 2, we get a glimpse of how the average global temperature in some of the continents has significantly increased from the 1950s up until 2020.⁶⁹

In October 2017, Hurricane Maria, considered one of the worst climate-related disasters in recorded history, attacked the islands of the northern Caribbean. Regions like Puerto Rico, the Dominican islands, Haiti and the Bahamas have been drastically affected. In Puerto Rico specifically, before the onset of Hurricane Maria, Puerto Ricans were dealing with a 10-year recession that caused many individuals to lose their jobs and go bankrupt. This has led to a significant surge in the local cases of mental health problems. With Hurricane Maria, the rate of mental health problems increased even more. One study conducted post-disaster reported a 16% increase in the suicide rate in the span of only 1 year from 2016 and a 26% of the overall rate of suicides over the same period following Maria.⁷⁰

Another study conducted found that the rate of PTSD was higher in the Puerto Ricans displaced to Florida than those living in Puerto Rico, probably because of losing their homes and forced migration. In both Florida and Puerto Rico, the populations affected the most were those living in rural and suburban areas. In fact, a cross-sectional study conducted on 74 Puerto Rican households over the period of 6 months following the disaster concluded that 54.1% of the study participants scored as clinically significant for major depressive disorder, 48.6% for generalised anxiety disorder and 41.9% for PTSD.⁷¹

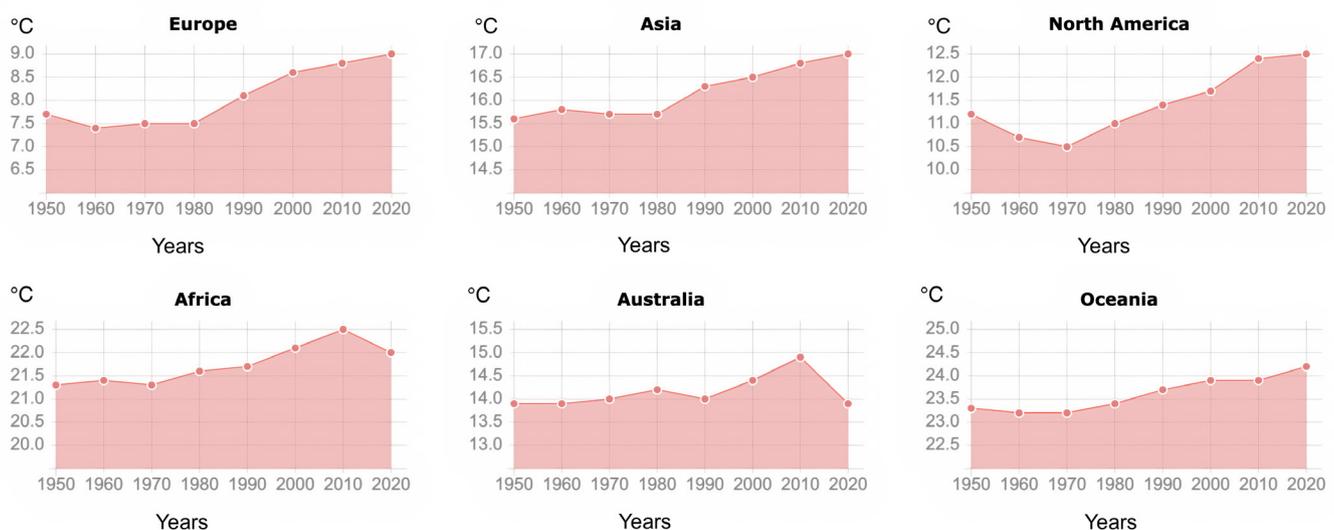


Figure 2 The average global temperatures of most of the world's continents have been progressively increasing since 1950s. This increase has led to many extreme climate-related events and led to mental health problems to the affected communities.

In August 2005, another major hurricane hit the USA, Hurricane Katrina. Katrina, which started at the end of August, led to a death toll of nearly 2000 individuals, caused the displacement of 650 000 individuals and cost a national record of 125 billion dollars in damages, making it the most economically drastic climate-related catastrophe in US history.⁷² Surely, as with most catastrophes, certain groups were more affected than others. Individuals with low income and the black community were broadly the most severely affected in the sight of forced migration, financial ruin and job losses.⁷³

Cases of mental health problems were significantly elevated, in the short and long term, following the disaster. Based on assessments for the general psychological distress using the Kessler-6 scale, conducted 5–7 months following the hurricane, 49% of those affected were liable to suffer moderate to severe mental illness,⁷⁴ and 30.3% were suffering from PTSD following the disaster.

In a study conducted on black, low-income, young mothers to children under the age of 18 years, three follow-up surveys were made in order to measure the mental health impact of Katrina. The first follow-up was conducted 11 months afterwards, the second 46 months and the third 12 years following the hurricane. Among those involved, four out of five (80.8%) suffered moderate to severe damages to their homes. One out of every three individuals had a relative or friend die because of the hurricane. As expected, the rate of mental health disturbance was highest during the first follow-up, which was conducted in 2006 and 2007, then the second in 2009 and 2010, and the third in 2016 and 2018. The percentage of those suffering from post-traumatic stress symptoms was 43.8% during the first follow-up, decreasing to 32% during the second and 16.7% during the third. The proportion of those having PTSD following the trauma significantly decreased in the 10-year period between the first and third surveys from 35.2% to 28.5%. On the other hand, the prevalence of serious mental illness increased from the baseline of 6.1% before the survey to 11.6% during the first follow-up. It even remained elevated during the third follow-up at 10.7%.⁷⁵

From May to July 2013, central and eastern Europe were hit by unusually frequent episodes of heavy rainfall, which eventually led to severe drought. Those storms were the cause for one of the most severe floods ever recorded in German history. It led to the forced evacuation of 100 000 individuals and economic losses that mounted to a grand total of €6.7 billion. A study was then conducted following the floods to measure the health-related consequences on individuals who directly experienced this trauma-causing disaster. This study included 1023 individuals who were given self-report questionnaires 12, 18 and 24 months and a control group 24 months following the flood. Those questionnaires were studied in three waves: 12, 18 and 24 months, respectively, in addition to the control group. A positive screening for depression or anxiety disorder was showed 50.7% to 20.5% from follow-up waves 1 to 3, respectively. Positive diagnosis of PTSD was shown to also

be declining in rate from 20.4% to 10.8% for waves 1 to 3.⁷⁶

For the past several decades, water insecurity has been a life-threatening issue for vulnerable populations in sub-Saharan Africa and Southeast Asia. Essentially, one of the reasons for the start of the 2011 Syrian revolution were multi-year droughts that severely affected the vulnerable rural Syrian areas resulting in loss of farming outputs, loss of livestock and water insecurity. Those climate-related events, among other political reasons, consequently resulted in the Syrian civil war that led to the forced evacuation of many civilians from their homes seeking refuge.

Northern Ghana is one of the most affected regions by such climate-related events as poor rainfall, wildfires, soil infertility and droughts. The farming community especially is at great risk from those losses. Without a doubt, those losses have already had a negative impact on those farmers' emotional well-being and mental health and have led to many cases of anxiety and depression.⁷⁷

WHAT WE CAN DO

Strategies to limit the incidence of climate disasters

In order for the incidence of climate disasters to significantly decrease, an efficient plan needs to be used to limit the 51 billion tons of greenhouse gases emitted by humans every year and turn this number to zero by 2050. This plan involves two main categories that should go hand in hand. One involves increasing the flow of research ideas that get tested and the other involves increasing the demand by the different world governments for those ideas. Regarding the first part of the plan, different technologies need further research in order to get tested for their efficiency and they include:

- ▶ Hydrogen production without carbon emission.
- ▶ Long-standing grid-scale electricity storage.
- ▶ Electrofuels.
- ▶ Advanced biofuels.
- ▶ Zero carbon cement.
- ▶ Zero carbon steel.
- ▶ Plant and cell-based meat and dairy.
- ▶ Zero carbon fertiliser.
- ▶ Nuclear fission.
- ▶ Nuclear fusion.
- ▶ Carbon capture.

In order for these technologies and many others to get used, governments need to invest more than they currently do in climate research and development. The total global investment in climate research and clean energy is \$22 billion per year, which is just 0.2% of the global economy. The public need to be more aware of the seriousness of the problem and start doing actions on their own to help solve it. In addition, governments need to understand that the process of testing out those technologies does not have to work out right away and that trial and failure is part of the process. For example, consider the human genome project which started in 1990 as a global collaboration between the USA, the

UK, France, Germany, Japan and China with the aim to sequence and understand the entire human genome. This project has changed the essence of the public health sector in terms of understanding more about human immunological and hereditary diseases and it has taken about 13 years to complete and cost billions of dollars in the process. The same collaboration needs to take place between countries around the world in order to reach the goal of zero carbon emissions by 2050.¹³

What we need to do

Part of the problem that causes climate disasters is the public. The public need to limit the emissions of greenhouse gases that we unknowingly emit in our daily lives. Most of those emissions are related to our daily usage of electricity. The public also needs to be more involved in the political agendas of candidates who represent them and demand climate-related plans from them. We also need to be selective in our demands and try to choose to consume climate-friendly products in our lives.

In using this plan, we can at least guarantee that climate-related catastrophes that we witness especially during the summer will significantly decrease and we can save the lives of communities at risk.

What governments and healthcare professionals need to do

In September 2021, numerous countries were invited to gather at the United Nations General Assembly to discuss the different strategies required to solve the climate crisis. Those countries will meet again at the Biodiversity Summit in Kunming, China and the climate conference in Glasgow, UK. The main idea behind those summits is to try to implement strategies to limit the global temperature increase to below 1.5°C.⁷⁸

Certain steps are already taking place in the world that can make us optimistic. The costs of clean energy are dropping, several countries are working to protect at least 30% of the world's ecosystem by 2030. However, what is currently being implemented is not enough. In fact, if the world's wealthiest countries continue on the current trend of greenhouse gas emissions, the average global temperature might reach 2°C. As mentioned at the beginning of the manuscript, a 2°C increase would be catastrophic for the entire ecosystem and will cause the extinction of thousands of the world's species, an event that will eventually have undesirable consequences for humanity. Healthcare professionals are united with climate scientists and businesses in rejecting the fact that climate catastrophes are inevitable. Governments need to implement different greenhouse gas-reducing technologies. Those technologies should be implemented especially by the wealthiest countries, as they are responsible the most for the global temperature increase. Governments need to use clean energy to redesign the public transportation systems, the way cities use energy, production, food distribution and healthcare systems.⁷⁸

Governments of low/middle-income countries need to invest more in research concerning the correlation

between mental health and climate disasters. Most of the current climate research articles are only from researchers in high-income countries. The global inclusion of mental health researchers from low/middle-income countries will undoubtedly help them in recognising the exact mental health problems that citizens from their countries are suffering from and help find treatment for those cases. Not involving those researchers will result in researchers from high-income countries not being able to fully understand the scope of mental health problems that citizens from low/middle-income countries are suffering from.⁷⁹

Dealing with the psychological impact of climate change

The psychological impact of climate change-related events is evidently undeniable. Post-disaster relief organisations have always had a major role to play in trying to mitigate the mental health consequences of those affected by such events. Special care should be dedicated to the vulnerable communities as they are the ones who suffer the most. Local health facilities should enhance their post-disaster methods in order to help those affected. Educational facilities should be able to provide awareness about the harmful impacts of climate-related disasters. Coping strategies should be provided to the affected communities to protect their general mental health from collapse in face of the climate disaster. Coping strategies could be labelled as emotional, behavioural and cognitive. To show how much those techniques could be effective, a study was conducted on children and adolescents in order to identify the coping strategies they used, following a climate disaster, and their effectiveness towards mental well-being. It was found out that children who used the problem-focused model, that is, informed themselves about the problem and talked to others about it, showed high levels of social and behavioural engagement. Those who used emotion-focused coping showed lower levels of behavioural engagement. Meaning-focused coping, which dealt with values and personal beliefs, was effective in reducing the detrimental effects of those negative emotions.^{80 81}

CONCLUSION

There is no doubt that climate change has now become an existential crisis that threatens human and animals' survival and might, if not stopped, cause a sixth extinction. What gives us hope is that research concerning the subject matter is on the rise and the global population has become more aware of the existence of the crisis. In the summer season of 2020, we all witnessed two of the most horrific climate-related catastrophes in the wildfires that hit the Amazon rainforest. The Amazon rainforest in Brazil alone composes some 60% of the global percentage of the rainforests which are essential in absorbing the atmospheric CO₂, which has a major impact on raising temperatures. According to Monitoring of the Andean Amazon Project, in the summer of 2020, an estimated total of 5.4million acres of those forests were burned. The burning of those horrendously gigantic areas led to the death of many plants and animals, causing a huge

disturbance in the ecosystem. Between the years 2019 and 2020, Australian wildfires have also taken place on a huge scale, burning more than 10 million hectares of land, killing dozens of people and burning a record number of over a billion animals, pushing numerous species to extinction. In the summer of 2021, the wildfires have extended to even more localities. Countries like Algeria, Tunisia, Turkey, Greece and states like California are currently dealing with major wildfires and suffering their consequences. Heat waves have been more frequent in 2021 than most other previous years and have been thought to be a major causation of wildfires and droughts in different areas. As mentioned in this article, climate-related catastrophes have major impacts on the mental well-being of the populations involved, causing surges in cases of depression, anxiety and PTSD primarily. In order for the incidence of those events to decline, the least thing that needs to be done is for each country to comply with the 2016 Paris Climate Agreement. The Paris Agreement aims to limit global warming to below 2°C, preferably to 1.5°C, compared with pre-industrial levels. Complying with the agreement can help, over the long term, in limiting global greenhouse gas emissions, which, if not limited, can lead to more climate catastrophes. At the individual level, dealing with a disaster-caused mental trauma should be done at two levels: pre-trauma and post-trauma. The pre-trauma level should be implemented by raising awareness about the mental health impacts of climate-related disasters, methods of how to mentally and emotionally deal with them and preparing healthcare facilities for dealing with individuals following a trauma. The post-trauma level is mostly concerned with coping strategies, the suitability of which differs from one person to another, and are categorized as emotional, behavioural and cognitive coping.

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REFERENCES

- World Health Organization. COP24 special report: health and climate change, 2018. Available: <https://apps.who.int/iris/bitstream/handle/10665/276405/9786057496713-tur.pdf>
- Craig MH, Kleinschmidt I, Nawn JB, et al. Exploring 30 years of malaria case data in KwaZulu-Natal, South Africa: Part I. The impact of climatic factors. *Trop Med Int Health* 2004;9:1247–57.
- Centers for Disease Control and Prevention. Climate effects on health. Available: <https://www.cdc.gov/climateandhealth/effects/default.htm> [Accessed 16 Aug 2021].
- Varghese GM, John G, Thomas K, et al. Predictors of multi-organ dysfunction in heatstroke. *Emerg Med J* 2005;22:185–7.
- Mora C, Dousset B, Caldwell IR, et al. Global risk of deadly heat. *Nat Clim Chang* 2017;7:501–6.
- Carleton TA, Jina A, Delgado MT. *Valuing the global mortality consequences of climate change accounting for adaptation costs and benefits*. National Bureau of Economic Research, 2020.
- Morganstein JC, Ursano RJ. Ecological disasters and mental health: causes, consequences, and interventions. *Front Psychiatry* 2020;11:1.
- Costello A, Abbas M, Allen A, et al. Managing the health effects of climate change. *The Lancet* 2009;373:1693–733.
- White RG. Mental wellbeing in the Anthropocene: socio-ecological approaches to capability enhancement. *Transcult Psychiatry* 2020;57:44–56.
- Cooper SJ, Wheeler T. Rural household vulnerability to climate risk in Uganda. *Regional Environmental Change* 2017;17:649–63.
- Nicholas PK, Breakey S. Climate change, climate justice, and environmental health: implications for the nursing profession. *J Nurs Scholarsh* 2017;49:606–16.
- Kolbert E. *The sixth extinction: an unnatural history*. New York: Henry Holt and Company, 2014.
- Gates B. *How to avoid a climate disaster: the solutions we have and the breakthroughs we need*. New York: Alfred A. Knopf, a division of Penguin Random House LLC, 2021.
- Wallace-Wells D. *The Uninhabitable earth: a story of the future*. Harlow, England: Penguin Random House, 2019.
- Bourque F, Willox AC, Cunsolo Willox A. Climate change: the next challenge for public mental health? *Int Rev Psychiatry* 2014;26:415–22.
- Palinkas LA, Wong M. Global climate change and mental health. *Curr Opin Psychol* 2020;32:12–16.
- Schwartz RM, Gillezeau CN, Liu B, et al. Longitudinal impact of Hurricane sandy exposure on mental health symptoms. *Int J Environ Res Public Health* 2017;14:957.
- Hayes K, Blashki G, Wiseman J, et al. Climate change and mental health: risks, impacts and priority actions. *Int J Ment Health Syst* 2018;12:1–12.
- Trombley J, Chalupka S, Anderko L. Climate change and mental health. *Am J Nurs* 2017;117:44–52.
- Gamble JL, Balbus J, Berger M, Ch. 9: Populations of concern. In: *Us global change research program*. Washington, DC, 2016.
- Rataj E, Kunzweiler K, Garthus-Niegel S. Extreme weather events in developing countries and related injuries and mental health disorders - a systematic review. *BMC Public Health* 2016;16:1–12.
- Burke SEL, Sanson AV, Van Hoorn J. The psychological effects of climate change on children. *Curr Psychiatry Rep* 2018;20:1–8.
- Hrabok M, Delorme A, Agyapong VIO. Threats to mental health and well-being associated with climate change. *J Anxiety Disord* 2020;76:102295.
- Stevens HR, Beggs PJ, Graham PL, et al. Hot and bothered? associations between temperature and crime in Australia. *Int J Biometeorol* 2019;63:747–62.
- Gao J, Cheng Q, Duan J, et al. Ambient temperature, sunlight duration, and suicide: a systematic review and meta-analysis. *Sci Total Environ* 2019;646:1021–9.
- Hansen A, Bi P, Nitschke M, et al. The effect of heat waves on mental health in a temperate Australian City. *Environ Health Perspect* 2008;116:1369–75.
- Norloei S, Jafari MJ, Omidi L, et al. The effects of heat stress on a number of hematological parameters and levels of thyroid hormones in foundry workers. *Int J Occup Saf Ergon* 2017;23:481–90.
- Piil JF, Lundbye-Jensen J, Christiansen L, et al. High prevalence of hypohydration in occupations with heat stress-Perspectives for performance in combined cognitive and motor tasks. *PLoS One* 2018;13:e0205321.
- Martin-Latry K, Goumy M-P, Latry P, et al. Psychotropic drugs use and risk of heat-related hospitalisation. *Eur Psychiatry* 2007;22:335–8.
- Ahern M, Kovats RS, Wilkinson P, et al. Global health impacts of floods: epidemiologic evidence. *Epidemiol Rev* 2005;27:36–46.
- Howarth E, Hoffman MS. A multidimensional approach to the relationship between mood and weather. *Br J Psychol* 1984;75 (Pt 1):15–23.
- Shin J, Park JY, Choi J. Long-Term exposure to ambient air pollutants and mental health status: a nationwide population-based cross-sectional study. *PLoS One* 2018;13:e0195607.

- 33 Bernardini F, Attademo L, Trezzi R, et al. Air pollutants and daily number of admissions to psychiatric emergency services: evidence for detrimental mental health effects of ozone. *Epidemiol Psychiatr Sci* 2020;29.
- 34 Kioumourtzoglou M-A, Power MC, Hart JE, et al. The association between air pollution and onset of depression among middle-aged and older women. *Am J Epidemiol* 2017;185:801–9.
- 35 Lim Y-H, Kim H, Kim JH, et al. Air pollution and symptoms of depression in elderly adults. *Environ Health Perspect* 2012;120:1023–8.
- 36 Attademo L, Bernardini F, Garinella R, et al. Environmental pollution and risk of psychotic disorders: a review of the science to date. *Schizophr Res* 2017;181:55–9.
- 37 Radua J, Ramella-Cravaro V, Ioannidis JPA, et al. What causes psychosis? an umbrella review of risk and protective factors. *World Psychiatry* 2018;17:49–66.
- 38 Saez M, Barceló MA, Farrerons M, et al. The association between exposure to environmental factors and the occurrence of attention-deficit/hyperactivity disorder (ADHD). A population-based retrospective cohort study. *Environ Res* 2018;166:205–14.
- 39 Volk HE, Lurmann F, Penfold B, et al. Traffic-Related air pollution, particulate matter, and autism. *JAMA Psychiatry* 2013;70:71–7.
- 40 Donzelli G, Llopis-Gonzalez A, Llopis-Morales A, et al. Particulate matter exposure and attention-deficit/hyperactivity disorder in children: a systematic review of epidemiological studies. *Int J Environ Res Public Health* 2020;17:67.
- 41 Yousefian F, Mahvi AH, Yunesian M, et al. Long-Term exposure to ambient air pollution and autism spectrum disorder in children: a case-control study in Tehran, Iran. *Sci Total Environ* 2018;643:1216–22.
- 42 Calderón-Garcidueñas L, Cross JV, Franco-Lira M, et al. Brain immune interactions and air pollution: macrophage inhibitory factor (MIF), prion cellular protein (PrP(C)), Interleukin-6 (IL-6), interleukin 1 receptor antagonist (IL-1Ra), and interleukin-2 (IL-2) in cerebrospinal fluid and MIF in serum differentiate urban children exposed to severe vs. low air pollution. *Front Neurosci* 2013;7:183.
- 43 Costa LG, Cole TB, Dao K, et al. Effects of air pollution on the nervous system and its possible role in neurodevelopmental and neurodegenerative disorders. *Pharmacol Ther* 2020;210:107523.
- 44 Wilker EH, Preis SR, Beiser AS, et al. Long-Term exposure to fine particulate matter, residential proximity to major roads and measures of brain structure. *Stroke* 2015;46:1161–6.
- 45 Chen J-C, Wang X, Wellenius GA, et al. Ambient air pollution and neurotoxicity on brain structure: evidence from women's health Initiative memory study. *Ann Neurol* 2015;78:466–76.
- 46 Landrigan PJ, Fuller R, Acosta NJR, et al. The Lancet Commission on pollution and health. *Lancet* 2018;391:462–512.
- 47 Peters R, Ee N, Peters J, et al. Air pollution and dementia: a systematic review. *J Alzheimers Dis* 2019;70:S145–63.
- 48 Brugha TS, Cragg D. The list of threatening experiences: the reliability and validity of a brief life events questionnaire. *Acta Psychiatr Scand* 1990;82:77–81.
- 49 Leiserowitz AA. American risk perceptions: is climate change dangerous? *Risk Anal* 2005;25:1433–42.
- 50 Albercht G. "Solastalgia": a new concept in health and identity. *PAN: Philosophy Activism Nature* 2005;3:44–59.
- 51 Albercht G. Chronic Environmental Change: Emerging 'Psychoterratic' Syndromes. In: *Climate change and human well-being*. New York, NY: Springer, 2011: 43–56.
- 52 Steentjes K, Pidgeon N, Poortinga W, et al. European perceptions of climate change (EPCC): topline findings of a survey conducted in four European countries in 2016, 2017. Available: <https://www.preventionweb.net/publication/european-perceptions-climate-change-epcc-topline-findings-survey-conducted-four>
- 53 Leiserowitz A, Maibach E, Rosenthal S. *Climate change in the American mind: December 2018*. Yale university and George Mason university. New Haven, CT: Yale Program on Climate Change Communication, 2018.
- 54 Reser JP, Bradley GL, Glendon A. *Public risk perceptions, understandings and responses to climate change and natural disasters in Australia, 2010 and 2011*. Gold Coast: National Climate Change Adaptation Research Facility, 2012.
- 55 Clayton S, Karazsia BT. Development and validation of a measure of climate change anxiety. *J Environ Psychol* 2020;69:101434.
- 56 Berry HL, Bowen K, Kjellstrom T. Climate change and mental health: a causal pathways framework. *Int J Public Health* 2010;55:123–32.
- 57 Campbell T, Campbell A. Emerging disease burdens and the poor in cities of the developing world. *J Urban Health* 2007;84:54–64.
- 58 Kjellstrom T. Climate change, direct heat exposure, health and well-being in low and middle-income countries. *Glob Health Action* 2009;2:1958.
- 59 Vins H, Bell J, Saha S, et al. The mental health outcomes of drought: a systematic review and causal process diagram. *Int J Environ Res Public Health* 2015;12:13251–75.
- 60 Hogg D, Kingham S, Wilson TM, et al. The effects of relocation and level of affectedness on mood and anxiety symptom treatments after the 2011 Christchurch earthquake. *Soc Sci Med* 2016;152:18–26.
- 61 Woodbury Z. Climate trauma: toward a new taxonomy of trauma. *Ecopsychology* 2019;11:1–8.
- 62 Marazziti D, Cianconi P, Mucci F, et al. Climate change, environment pollution, COVID-19 pandemic and mental health. *Sci Total Environ* 2021;773:145182.
- 63 Levy BS, Sidel VW, Patz JA. Climate change and collective violence. *Annu Rev Public Health* 2017;38:241–57.
- 64 Palinkas LA, Wong M. Global climate change and mental health. *Curr Opin Psychol* 2020;32:12–16.
- 65 World Health Organization. Violence and disasters, 2005. Available: https://www.who.int/violence_injury_prevention/publications/violence/violence_disasters.pdf
- 66 Nahar N, Blomstedt Y, Wu B, et al. Increasing the provision of mental health care for vulnerable, disaster-affected people in Bangladesh. *BMC Public Health* 2014;14:708.
- 67 Nicholas PK, Breakey S, White BP, et al. Mental health impacts of climate change: perspectives for the ED clinician. *J Emerg Nurs* 2020;46:590–9.
- 68 Malik YS, Sircar S, Bhat S, et al. Emerging novel coronavirus (2019-nCoV)-current scenario, evolutionary perspective based on genome analysis and recent developments. *Vet Q* 2020;40:68–76.
- 69 World Data.info. Climate change and global warming, 2020. Available: <https://www.worlddata.info/global-warming.php> [Accessed 08 Aug 2021].
- 70 Ramphal L. Medical and psychosocial needs of the Puerto Rican people after Hurricane Maria. *Proc* 2018;31:294–6.
- 71 Ferré IM, Negrón S, Shultz JM, et al. Hurricane Maria's impact on Punta Santiago, Puerto Rico: community needs and mental health assessment six months postimpact. *Disaster Med Public Health Prep* 2019;13:18–23.
- 72 Knabb RD, Rhome JR, Brown DP. Tropical cyclone report, Hurricane Katrina, 23–30 August, 2005. PP. 43. retrieved from national Hurricane center website. Available: https://www.nhc.noaa.gov/data/tcr/AL122005_Katrina.pdf
- 73 Fussell E, Sastry N, Vanlandingham M. Race, socioeconomic status, and return migration to new Orleans after Hurricane Katrina. *Popul Environ* 2010;31:20–42.
- 74 Kessler RC, Barker PR, Colpe LJ, et al. Screening for serious mental illness in the general population. *Arch Gen Psychiatry* 2003;60:184–9.
- 75 Raker EJ, Lowe SR, Arcaya MC, et al. Twelve years later: the long-term mental health consequences of Hurricane Katrina. *Soc Sci Med* 2019;242:112610.
- 76 Apel D, Coenen M. Mental health and health-related quality of life in victims of the 2013 flood disaster in Germany—A longitudinal study of health-related flood consequences and evaluation of institutionalized low-threshold psycho-social support. *Int J Disast Risk Re* 2021;58.
- 77 Wossen T, Berger T. Climate variability, food security and poverty: Agent-based assessment of policy options for farm households in northern Ghana. *Environ Sci Policy* 2015;47:95–107.
- 78 Atwoli L, Baqui AH, Benfield T, et al. Call for emergency action to limit global temperature increases, restore biodiversity, and protect health. *BMJ* 2021;374:n1734.
- 79 Osborn TL, Wasil AR, Weisz JR, et al. Where is the global in global mental health? A call for inclusive multicultural collaboration. *Gen Psychiatr* 2020;33:e100351.
- 80 Ojala M. How do children cope with global climate change? coping strategies, engagement, and well-being. *J Environ Psychol* 2012;32:225–33.
- 81 Ojala M. Hope in the face of climate change: Associations with environmental engagement and student perceptions of teachers' emotion communication style and future orientation. *J Environ Educ* 2015;46:133–48.



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