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Climate Change: A Forced Choice Ethical Paradigm

Daniel Londyn Menkes

Abstract

Notwithstanding the political debates in the media, climate change presents a unique set of ethical challenges faced by all the planet's inhabitants. To understand the current challenges facing humanity, it is important to retrace the evolution of human society as this underlies the ethical foundations that internalize a group's beliefs and norms. Humans have modified the environment on a global scale that is unsustainable that has resulted in climate change-a disease process with dire implications. Understanding the root causes of a disease process is the best means of devising a treatment plan. Climate change solutions must be syntonetic with a bio-psychosocial model that addresses culture and belief systems. The six main ethical theories-utilitarianism, egoism, deontology, virtue, divine command, and relativism all have their inherent flaws. Beauchamp and Childress concatenated these constructs into the four main bioethical principles of autonomy, beneficence, non-maleficence, and justice. Of these, autonomy is least applicable to climate change as decisions made by a subgroup of one species will have an impact on all terrestrial lifeforms both present and future. Humanity must accept the reality of climate change and effect solutions based on these four principles. Failure to act will lead to catastrophic climate changes that may lead to the sixth mass extinction. Effective climate change solutions must embrace an integrative approach by supporting leaders who will embrace science and will advocate for universal human rights.

Keywords: climate change, global warming, ethics

1. Introduction

"Global warming" and "climate change" are not synonymous as global warming refers to an increase in the average atmospheric temperature whereas climate change describes the downstream impact of a global temperature increase [1]. Thus, the term climate change will be used preferentially in this manuscript. It should also be stated that weather and climate are not synonymous as weather refers to short term atmospheric fluctuations whereas climate refers to what can be expected over a longer-term period. In this context, an occasional 90 °F or 32 °C summer day in Fairbanks, Alaska would not be an unusual event for its weather whereas 30 consecutive days at this temperature in the autumn might portend climate change. Thus, climate change evolves slowly and is often only discernible in retrospect. A comprehensive understanding of this process requires an interdisciplinary knowledge of mathematics, biology, chemistry, and physics. One must understand the underlying issues to devise viable solutions.

Problem solving requires several steps including identification that a problem exists, discerning the facts, framing the problem, and then proposing solutions. Errors may occur in any step of this process. With respect to climate change, there is no universal agreement that a problem exists. Irrespective of the preponderance of scientific evidence, there continues to be debate on climate change's existence as well as its root causes. Anurag Shurie once remarked that "A half-truth is even more dangerous than a lie. A lie, you can detect at some stage, but a half truth is sure to mislead you for long" [2]. Scientifically speaking, there are no half-truths in that a statement is factually correct or it is not. Most "half-truths" are opinions that reflect a different interpretation of the available data. To paraphrase the late United States Senator Daniel Patrick Moynihan, everyone is entitled to their own opinions but not their own facts. Solutions may only be achieved when all stakeholders agree on the facts that frame the issue as well as the certainty to which these facts have been established. In the absence of such agreements, solutions are unlikely to be achieved. If climate change is to be addressed, then there must be a commitment to accepting reality while understanding that there will always be some level of uncertainty. The next step is to frame the problem such that potential solutions will become apparent. Ideally, the best decision is made based on a risk to benefit analysis with the understanding that the failure to act is also a decision. Given that most of humanity appears to be mired in the fact gathering stage, the author will address the current facts in evidence.

2. The salient facts of climate change

The intergovernmental panel on climate change stated that the scientific evidence for warming of the climate system is unequivocal [3]. The Potsdam Institute for Climate Impact Research stated that "business as usual" climate change trends portend a warming of 4 °C or 7.9 °F this century's end [4]. Notwithstanding the political debate, an overwhelming number of scientists concur that the current rise in global temperature is from human activity [5]. Those who have an opposing viewpoint correctly state that the earth has experienced numerous warming and cooling cycles. One previous warming event that occurred 252 million years ago, likely from volcanic activity, resulted in an average global temperature rise of 10 °C, which induced an extinction of 75% of terrestrial life and 95% of all marine life [6]. Dinosaurs arose to fill this void for the next 165 million years wherein being large bodied and cold-blooded was advantageous. This provides an example of Darwinian selection in which those organisms best suited to their natural environment survived to reproduce and dominate that niche, which Darwin termed "survival of the fittest" [7]. The age of the dinosaurs ended with an asteroid impact 65 million years ago that extinguished 75% of all lifeforms on earth including all land-based lifeforms weighing more than 25 kilograms or 55 pounds [8]. Mammals arose to fill this gap, some which were capable of altering their environments such as beavers, elephants, and humans. However, none of these mammals made a significant impact on the atmosphere until the Industrial Revolution, which consumed fossil fuels for energy. The current Anthropocene era has ushered in significant changes including global warming, habitat loss, changes in atmospheric composition and incipient mass extinctions. Prior history indicates that novel lifeforms will adapt to these changes. However, this is the first time in geological history that climate change did not occur from natural phenomena. Humanity has altered the biosphere, yet humanity also can avoid the most profound effects of self-induced climate change with a commitment to action.

Climate change induced by global warming may seem complex initially as it involves an understanding of chemistry and physics, specifically the laws of thermodynamics. The first law of thermodynamics states that energy may neither be created nor destroyed such that one can only change its form. For example, consider using a coal stove that combusts hydrocarbons with oxygen to create heat and light. Implicit in this law is that the conversion is imperfect such that some of the energy is lost as heat. Thus, burning hydrocarbons results in the net addition of heat to the atmosphere some of which cannot be radiated into space. Hydrocarbon combustion on a massive global scale will increase the amount of heat retained in earth's atmosphere thus raising the average global temperature. However, heat production itself is not the only issue as the covalent bonds holding the greenhouse gases (GG) together are capable of absorbing infrared radiation without breaking chemical bonds. The net result is that the excess GG radiate heat (infrared) energy back to earth at a later time much in the way that a glass container may be put in an oven, removed intact, and then cooled down to food serving temperature by releasing the excess heat into the environment [9]. The downstream effects of this additional heat production and heat trapping are explored in subsequent sections.

Another issue facing humanity is that of our current, unsustainable rate of resource consumption. Presently, humanity requires the annual equivalent of 1.6 Earths or 20 months to provide the resources we require and absorb our waste, which is the environmental equivalent of "deficit spending" [10]. This rate of resource consumption and waste generation is simply unsustainable. The United States Army Field Manual 21-76 states, "Remember that nature and the elements are neither your friend nor your enemy-they are actually disinterested. Instead, it is your determination to live and your ability to make nature work for you that are the deciding factors" [11]. The current willful disregard for nature portends the sixth mass extinction, the Anthropocene extinction, which will result from humans' alteration of the environment [12]. One prediction is that, unless drastic action is taken, the earth will experience catastrophic climatic and negative socioeconomic changes within the next 30 years [13]. This author further stated that a solution requires "political change producing policy change" [14]. If such changes are to be realized, then an understanding of the science underlying climate change must be understood within the framework of human evolution, the rise of political systems and the ethics that arose from these political developments.

3. The science of climate change

The tendency of CO₂ and other gases to trap heat is often summarized as the "greenhouse effect" in which solar radiation penetrates the earth's atmosphere but only 30 percent is reflected into space [15]. This acts as a warming blanket such that the earth's average temperature supports terrestrial life. Without naturally occurring GG, Earth's average temperature would be near 0 °F (or – 18 °C) instead of the much warmer 59 °F (15 °C) that currently exists [16]. The five main gases that have significant global warming potential [GWP] are CO₂, methane (CH₄), nitrous oxide (NO₂), fluorinated gases and water vapor [17]. These are potent trappers of infrared wavelength energy as the covalent chemical bonds between them are relatively weak such that the molecule remains intact despite adding energy. Nonetheless, these gases are not equivalent in their GWP as this is dependent on their concentration, their ability to trap infrared wavelengths, (i.e. heat), and their atmospheric functional lifespan. GWP uses CO₂ as a benchmark when calculating 100-year relative effects. For example, methane is 84-fold more effective in

trapping heat but it persists in the atmosphere for only slightly more than a decade reducing its 100 year impact to 28 times that of CO₂ [18]. Notably, CO₂ released today will persist in the atmosphere for 300–1000 years such that it will have a much greater overall temporal impact. In comparison, nitrous oxide persists in the atmosphere for more than a century such that its short term and long-term effects are identical at 28 fold the impact of CO₂ [19]. Fluorinated gases are even more potent as R-22, the most common refrigerant currently in use, has a 100-year GWP of 1,810, which is almost 2,000 times the potency of CO₂, such that one pound of R-22 is nearly as potent as a ton of CO₂ [20]. This same reference stated that releasing one 30-lb tank of R-22 into the atmosphere is nearly equivalent to the CO₂ emitted by driving 7 additional cars each year, (source data available at CARB's Cool California Calculator). Notwithstanding these effects, water vapor currently exerts the greatest greenhouse effect at this time given its higher concentration in the atmosphere. While the effects of water vapor are relatively short-lived, the amount of water vapor in the atmosphere will increase as warmer atmospheres correlate with greater degrees of humidity [21]. The positive feedback generated by adding additional water vapor into the atmosphere is such that a 1 °C temperature increase from excess CO₂ production has a net effect of increasing atmospheric warming by 2 °C [22]. Ice (solid water) also has an impact on climate change as snow and ice reflect a greater degree of incoming sunlight than does water known as the "albedo effect" [23]. Polar ice cap shrinkage leads to reduced reflectivity or reduced albedo. Conversion of polar ice in the Northern Hemisphere to liquid water leads to a relatively darker ocean surface, which facilitates the absorption of additional heat from the sun, thus melting large masses of ice in the ocean [24]. Melting ice will lead to a rise in sea levels coupled with more frequent storm surges leading to more frequent and intense flooding [25]. Sea level rise will result in less habitable land for terrestrial based life forms as was noted during the past interglacial period when the earth's average temperature was 1 to 2 °C warmer and sea levels were 4 to 6 meters or circa 13–20 feet higher [26]. Even with limiting global warming to 1–2 °C, many of our coastal cities will be submerged.

The most recent extreme period of relative warming in Earth's history was that of the Paleocene-Eocene Thermal Maximum (PETM) about 55–56 million years ago when the earth's mean temperature rose by 5–8 °C (9–14 °F) to an average temperature of 22.8 °C or 73 °F [27]. These authors further stated that concurrent paleoclimate data from fossilized phytoplankton and ocean sediments recorded a massive release of CO₂ into the atmosphere, at least doubling or possibly even quadrupling the background CO₂ concentrations. The net result was that crocodilians and palm trees thrived at the polar regions. Thus, the geological record is clear that failure to address climate change and permitting average temperatures to rise will lead to lands unsuitable for large scale agriculture and a drastic reduction in the biodiversity of the planet. Therefore, the moral imperative is to mitigate the probability of this result. The United Nations' International Panel on Climate Change (IPCC) reported that global temperatures will likely rise to 1.5 degrees Celsius above pre-industrial levels in the time interval of 2030 and 2052 if GG induced warming continues at the current rate [28]. The Paris Agreement, in which all countries agreed to cooperate in order to limit average global temperature increases to between 1.5 and 2 degrees Celsius above pre-industrial levels [29]. Even if this goal is reached, climate change will have a significant impact on global ecology. Restated, it is not debatable if climate change will occur but rather that of the rapidity and the severity of the ongoing climate change.

Climate change is already having impacts. A review article stated that there is a 97% consensus within published climate research that is robust and consistent with other surveys of climate scientists and peer-reviewed studies [30]. Global weather

patterns are changing such that there is less precipitation in the Western United States and greater precipitation in the Midwest [31]. Other climate change effects may be summarized as melting polar ice caps and glaciers leading to coastal flooding, loss of biodiversity, and a redistribution of species such that some are becoming extinct while others, (e.g. invasive pests and disease carrying vectors), are expanding their range [32]. All these data indicate that the earth is unwell and is suffering from the disease of global warming that has already induced permanent changes to the global environment and portends greater degrees of climate change.

4. Medical model of disease

One approach to understanding climate change is that of the medical model of disease. This model assesses how several risk factors and causative triggers interact to produce a “disease” characterized by specific pathology that presents with a combination of symptoms and signs that help establish a diagnosis and suggest potential treatments [33]. This has been greatly enhanced using technology such as laboratory testing, imaging studies and genetic analyses. Agusti opines that this approach is more applicable to acute disease rather than chronic disease as chronic diseases tend to induce secondary effects and produce additional comorbidities leading to ever increasing adverse impacts on the afflicted organism. The chronic disease model integrates more risk factors and triggers that interact, (e.g. aging and smoking), which induce damage to several organ systems concurrently, (e.g. cardiovascular and respiratory) [34]. Type two diabetes mellitus, a disease that results in elevated blood sugar, provides an example. This disease occurs from inadequate insulin production and/or insulin resistance that often leads to multiorgan dysfunction. These comorbidities include large vessel complications such as stroke and cardiovascular disease as well as microvascular complications such as nephropathy, retinopathy, and polyneuropathy. The net result is a significantly reduced quality of life, wherein the person survives but in a compromised state. To avoid these complications, the disease process must be identified, confirmed as a diagnosis, and treated as soon as practical. In the early stages of type two diabetes, the body can tolerate some excess glucose, but there is a threshold beyond which compensatory mechanisms fail and hyperglycemia begins to exert its deleterious effects. In this analogy, global temperature rise is equivalent to increasing blood sugar levels that must be identified and reduced before long-term complications arise. Restated, it is better to recognize and treat an asymptomatic person with an elevated blood sugar with oral medications than to begin aggressive high dose insulin when that person is admitted to an intensive care unit with a hyperglycemic coma. While an asymptomatic person may deny their disease’s existence despite laboratory testing, it is only a matter of time before the consequences are self-evident such that denial is no longer possible. However, a person’s willingness to accept a medical diagnosis, seek treatment and adhere to that treatment is highly variable between individuals and reflect cultural background, education, and acceptance of scientific principles.

George Engel MD described the biopsychosocial model of disease in which social and psychological factors have a significant impact on disease development and management [35]. For example, the Pima people in the Sonoran Desert region have one of the highest rates of diabetes on the planet [36]. Their ancestors had to adapt to an environment where nutrients were scarce such that evolution favored the survival of those individuals who could extract the most calories from limited food sources. Human evolutionary biology has prioritized calorie dense foods as their consumption favored survival and subsequent reproduction such that humans will consume these foods preferentially [37]. The Pima people, who did not live in an

area conducive to intense agriculture, consumed whatever calories were available to endure episodes of relative famine, especially calorie dense foods such as animal fat. This ancient adaptive strategy became maladaptive once these people adopted a Western diet high in processed sugar and saturated fat that induced an exponential increase in the incidence of diabetes mellitus. For the Pima people, education strategies designed to limit the consumption of high calorie foods is more likely to be successful than insisting that they return to their ancestral diet. In this analogy, the modern world is unlikely to be willing to return to a pre-industrial state. Few people would be willing to eschew modern conveniences such as electricity, indoor climate control, and internal combustion engine modes of transportation. Therefore, any viable solution to climate change must integrate the realities of the Western standard of living. Just as it would not be feasible for the Pima people to resume their Pre-Colombian lifestyle, it would not be feasible to return to a pre-industrial civilization.

5. Origins of human civilization

As humans evolved from primates, brain development eventually resulted in language and the ability for critical thinking. Our evolutionary history likely began as small bands or tribes of hunter-gatherers in which the individual was required to subordinate his or her immediate desires to that of the tribe's overall benefit. For example, a hunter who successfully killed an animal would benefit from its sole consumption, but that hunter's long-term survival would be threatened if the consequences were expulsion from that group. This struggle between critical thinking that resides in the cortex that accepts delayed gratification and emotional behavior residing in the limbic system favoring instant gratification has been traditionally viewed as the struggle between good and evil [38]. Therefore, it became important to define "good" or ethical behavior from "bad" or unethical behavior. Behaviors that enhanced tribal survival were more likely viewed as "good," "ethical" or "normative" thus necessitating the suppression of contrary behaviors. "Proper behavior" included deference to the tribe and the forces of nature, as natural phenomena were understood as the vicissitudes of arbitrary spirits or deities. Pre-agricultural societies such as the San people of the Kalahari Desert tended to have an egalitarian culture and a belief system that can be generally characterized as a struggle between good and evil. In such societies, subordination of the individual to the needs of the group was more likely to insure survival than individual efforts. Gender parity likely existed in which women performed the child rearing and gathering while men provided meat derived from hunting that was not invariably successful. This arrangement optimized child survival given the relatively prolonged time required for human development and dependency on others for survival. Given that such tribes were nomadic, few material possessions would be accumulated such that there were fewer disparities between the richest and poorest members of a tribe. However, this remains speculative as this occurred before recorded history.

The agricultural revolution altered this dynamic in that permanent city states arose in which food production was more reliable and a nomadic lifestyle was no longer required. Hierarchies arose in which there was a stricter division of labor, greater wealth accumulation and a need to defend the city state from neighboring tribes. This created a need for a warrior caste governed by a monarch and supported by a religious order designed to enforce the monarch's will and placate temperamental deities. This political, religious, and military aristocracy would value its members and its offspring over others. The subjugation of women likely followed

as it was important for an aristocratic male to ensure that his offspring were his own such that his offspring would inherit his accumulated wealth and social position. Thus, rigid rules regarding women's roles and their sexual behavior were strictly enforced. Since few labor-saving devices existed, the society's survival depended on manual labor. A shortfall in labor was likely met through indentured servants or slaves. Slavery has been widespread throughout recorded human history and did not start to diminish until after the start of the Industrial Revolution and the invention of labor-saving devices. Slaves were supplied by persons unable to pay their debts, birth into a slave family, child abandonment, war, or punishment for a crime [39]. The monarch's authority was absolute and bolstered by a religious order that would threaten divine retribution for failure to comply. In exchange, the subjects of the city-state would be protected against outsiders and the vicissitudes of temperamental deities. Expulsion from the city-state could lead to a reduced probability of survival or death at the hands of a hostile tribe. Given these alternatives and the pressure of adhere to societal norms, most subjects acquiesced to this reality. Adherence to authority, temporal and divine, was integrated into a belief system, expressed as morality, and codified into law. Although greater democratic participation has evolved, humanity still functions within a hierarchy ruled by some combination of politicians, religious leaders and the nobility.

The philosopher Thomas Hobbes articulated these concepts when he advocated for a strong centralized authority that would prevent the expression of baser instincts in which people would stop at nothing to further their own interests including theft and murder [40]. He famously opined that existence outside a society without a rigid authority would be "nasty, brutish and short." As the son of a clergyman, Hobbes was likely familiar with the Bible and its emphasis on obedience to higher authorities. One particular passage from Genesis 1:26 has been translated as follows, "Let us make mankind in our image, in our likeness, so that they may rule over the fish in the sea and the birds in the sky, over the livestock and all the wild animals, and over all the creatures that move along the ground" [41]. One interpretation of this passage is that humans are the "in group" and that nature is available for exploitation. A more sanguine interpretation is that humans were commanded to be stewards of the earth's resources. Nonetheless, with few exceptions, modern history has been one of nature's exploitation out of proportion to conservation. If the worst outcomes of climate change are to be avoided, then it will be necessary to develop a belief system or moral code that respects nature and embraces science while accepting the reality of the political and religious foundations of modern society.

6. Ethical constructs

The Merriam Webster dictionary defines ethics as "the principles of conduct governing an individual or a group" [42]. Thus, ethics may be viewed as behavioral guidelines designed to enhance the survival of the individual and the group to which that person belongs. Implicit in this definition is that there are those within the group and those that are external to the group. Thus, the size of the "group" may range from one individual to all life forms on the planet. It is how those external to the group are treated that sets the stage for conflict. While conflict is inherent in any instance of resource scarcity, it is how conflict is resolved that determines the outcome. Many leaders invoke morality to bolster their position in such conflicts. Nonetheless, conflict resolution can be achieved by five different methods: avoidance, competition, accommodation, collaboration, and compromise [43]. These potential solutions to climate change are discussed in the penultimate section of this chapter.

Four major ethical theories discussed in the literature may be summarized as utilitarianism, deontology, virtue, and relativism [44]. Utilitarianism attempts to maximize benefit and minimize harm to all stakeholders involved. In such a paradigm, decisions are made without consideration of the costs involved. Utilitarianism would advocate the same standard of living across the globe irrespective of the economic impact. Deontology focuses on rules that distinguish “right from wrong.” Deontology tends to be rather rigid in that it focuses on adhering to rules without appreciating nuance [45]. Immanuel Kant promulgated this approach in which people are morally obligated to act in accordance with a certain set of principles and rules independent of the outcome [46]. Although many religious leaders are deontologists as they promulgate adherence to divine authority, belief in a deity is not required. One variant of deontology, Natural Law, opines that there is an order to human behavior that can be deduced independent of religious or secular authorities [47]. The contrast between deontology and utilitarianism would be apparent in a situation in which a homeowner is harboring 30 refugees illegally and is confronted by the police. Utilitarianism would dictate that the owner should lie as this would protect 30 people whereas a deontologist would insist that the owner should follow the law of the land and tell the truth even if this adversely affected the refugees.

The other two major theories are virtue and relativism. Virtue is an ethical framework that evaluates a person’s overall character as opposed to their actions. When questionable behavior is observed, the virtue theory requires that the person’s past actions and temperament be taken into consideration when evaluating the act. For example, if a person is known as a mild mannered, temperate and a pillar of the community who embezzles money then the act needs to be evaluated in the context of prior behavior. Virtue based theory would recommend greater leniency for this person as opposed to someone who had a reputation as a scofflaw. Relativism opines that moral obligations and beliefs tend to be based on the environment and that acts need to be judged within that context. Thus, a relativist would not categorically condemn cannibalism as this may be an accepted practice in some cultures.

Beauchamp and Childress discuss a different framework in which they promulgate the four ethical pillars of autonomy, beneficence, non-maleficence, and justice [48]. They opine that these must be taken into consideration when faced with a moral dilemma. Autonomy expresses the concept that an affected individual has the right to make decisions that directly impact them. For example, autonomy dictates that a person should be able to act in accordance with their religious beliefs and refuse a blood transfusion even if this decision could result in death. Beneficence implies that a decision should always be based on achieving a good outcome whereas non-maleficence is a requirement to minimize harm as epitomized in the Latin expression *primum non nocere*. Justice implies that one is obligated to treat all stakeholders fairly. In health care ethics, this can be subdivided into three categories: fair distribution of scarce resources (distributive justice), respect for people’s rights (rights-based justice) and respect for morally acceptable laws (legal justice) [49]. Alperovitch et al. described an alternative view in which there are two elements of justice, namely equality and equity [50].

It should be evident from this brief discussion that each of these ethical theories have advantages and disadvantages such that no one theory is always superior when faced with a moral dilemma. While the four ethical pillars allow for autonomy, an apocryphal quote often attributed to United States Justice Oliver Wendell Holmes states, “Your right to swing a punch ends at the bridge of my nose.” The earth is a closed system such that an individual cannot act in isolation as one individual’s consumption of resources will have climate impacts. Moreover, the right to assert “climate denial” is untenable given the overwhelming scientific evidence of climate change. Nonetheless, autonomy should not be excluded altogether. One such approach is a

carbon tax in which a person or a corporation can use more than their fair share of fossil fuels but would pay a premium to do so [51]. A person would be able to make choices although some of these choices would be economically prohibitive.

7. Climate change solutions

Can humanity adapt its social norms and integrate science into a solution? The late cosmologist, Professor Stephen Hawking opined that, “There is a fundamental difference between religion, which is based on authority, [and] science, which is based on observation and reason. Science will win because it works” [52]. However, religion and a belief in supernatural phenomena predates recorded human history. It is unlikely that humans would reject millions of years of belief in supernatural phenomena and suddenly embrace science. Moreover, even humans who possess a high degree of scientific literacy do not make decisions solely on scientific principles as political and religious backgrounds factor into these decisions such that those persons with more hierarchical and individualistic worldviews rated climate risk significantly lower [53]. Therefore, it is important for scientists to align with religious and political leaders in order to meet the challenge of climate change. The challenge is to convince humans of diverse political backgrounds, cultures, and religions to overcome tribalism, accept that climate change is a crisis and act in accordance with scientific principles to address its most deleterious effects. From a scientific perspective the options are GG removal from the system, decreased production, and sequestration.

Returning to the diabetes analogy, excess blood sugar can be addressed by excreting it from the body, decreasing glucose production (e.g. consume fewer calories) and sequestration in which it is stored in an unusable form in the body. Indeed, a comprehensive treatment for Type II diabetes usually involves weight loss from decreased calorie consumption, medications to store glucose within the body and, in some cases, medicines designed to facilitate glucose excretion. In this analogy, the earth’s disease is a rising average temperature due to excess GG production, predominantly CO₂. As an overview, the main solutions are removal of atmospheric CO₂, (e.g. send it into outer space), sequestration, and reduced production of GG.

Removal involves sending greenhouses gases out of earth’s orbit never to return whereas sequestration involves converting atmospheric GG into a different form, (e.g. pumping underground or storing in a liquid or solid form). While theoretically possible, pumping GG out of the atmosphere would require building a pipe in the form of a space elevator up to 53,000 km, (circa 33,550 miles), an altitude wherein these GG would be at escape velocity [54]. Using rockets to remove GG is impractical given the economic costs and relatively limited payloads in addition to the possibility that rocket launches might actually result in a net addition of GG to the environment [55]. Thus, removal is not practical as it is cost prohibitive, technologically challenging and may be counterproductive.

CO₂ sequestration involves capturing and storing atmospheric carbon dioxide of which there are two main methods: geologic and biologic [56]. This government source states that, “Geologic carbon sequestration is the process of storing CO₂ in underground geologic formations. The CO₂ is usually pressurized until it becomes a liquid, and then it is injected into porous rock formations in geologic basins. This method of carbon storage is also sometimes a part of enhanced oil recovery, otherwise known as tertiary recovery, because it is typically used later in the life of a producing oil well. In enhanced oil recovery, the liquid CO₂ is injected into the oil-bearing formation in order to reduce the viscosity of the oil and allow it to flow more easily to the oil well” [57]. The United States Geological Survey estimated

that 2,400 to 3,700 metric gigatons of CO₂ could be stored by this method [58]. Nonetheless, this method has its limitations in that during calendar year 2017, the United States produced 5.1 metric giga tons of energy-related carbon dioxide, while the global emissions of energy-related carbon dioxide totaled 32.5 metric gigatons [59]. Using the lower estimate, the United States could store approximately 74 years of global CO₂ emissions at 2017 production levels. Objections to this method include the possibility of inducing seismic activity and contaminating drinking water although the United States' Environmental Protection Agency has proposed mitigation strategies [60]. There are other geologic CO₂ sequestration methods that may be used to sequester CO₂, but they are beyond the scope of this discussion. Nonetheless, such a strategy would only be temporary such that longer term strategies are required.

Biological carbon sequestration is the storage of CO₂ in vegetation such as grasslands or forests, as well as in soils and oceans [61]. Animals, including insects, also contribute to the planetary biomass. The oceans absorb 30% of annual CO₂ emissions, which has mitigated the full effect of GG emissions at the expense of acidifying the oceans from an historic pH of 8.2 to a current pH of 8.1 [62]. This increased ocean acidity impairs the ability of shell-forming marine life to survive including some of the microscopic plankton that forms the base of the marine food chain. Coral reefs comprise less than 1% of the ocean floor yet support over 25% of all known marine species and provide food to over one billion people [63]. Increasing ocean temperatures and acidification portends an increasing probability of this fragile ecosystem's collapse [64]. Biological sequestration is also problematic as a recent publication indicated a greater number of biological consumers than producers [65]. These processes could eventually lead to the collapse of the food chain and mass starvation. Therefore, increasing biomass will likely be only a small part of any climate change solution.

Of these, the most effective approach is to reduce the production of GG as part of an integrated strategy as proposed by Project Drawdown. Project Drawdown's mission statement is to help the world reach "Drawdown" - "the the point in the future when levels of greenhouse gases in the atmosphere stop climbing and start to steadily decline, thereby stopping catastrophic climate change — as quickly, safely, and equitably as possible" [66]. While an integrated approach using all modalities available is logical, any viable solution must minimize the impact of future climate change by a significant reduction in the production of GG. Notably, the wealthiest 10% of the planet produces nearly half of GG emissions whereas the people in the lowest half of global income produce only 10% of these gases [67]. In 2014, the top CO₂ emitters comprising 70% of all emissions were China (30% of total), the United States (15% of total), the European Union (9% of total), India (7% of total), the Russian Federation (5% of total), and Japan (4% of total) [68]. Thus, the United States and China were responsible for nearly half of all CO₂ emissions. While the entire earth is vulnerable to climate change, the greatest impacts are likely to occur in countries that were not major contributors to GG production. The countries most vulnerable to climate change often have the greatest degree of population growth and relatively lower educational levels in their populace. These socioeconomic disadvantages are risk factors for extremism that increases the probability of violence and reduces the probability of collaboration [69].

8. Ethical solutions for climate change

It should be clear that climate change is underway and that failure to act will have catastrophic consequences. While each ethical approach has inherent advantages and

disadvantages, utilitarianism and deontology are not viable ethical constructs for this issue. Economic realities are such that it is highly unlikely that a universal standard of living acceptable to all humanity can be achieved in the current political climate. Deontology is unlikely to be a successful strategy as humanity does not subscribe to one religion much less one set of “divinely” or “naturally” inspired moral principles. Given the general lack of scientific literacy and current anti-science movements, it is unlikely that humanity will embrace science over belief systems that predate recorded history. Humanity must accept acknowledge its history, recognize that there is an ongoing disease, reject maladaptive behaviors and embrace a new paradigm that will enhance our survival as a species. As the late Japanese athlete Morihei Ueshiba stated, “Each and every master, regardless of the era or the place, heard the call and attained harmony with heaven and earth. There are many paths leading to the top of Mount Fuji, but there is only one summit – love” [70]. Humanity must embrace one concept of relativism that that there are many belief systems but only one summit, which is that of mitigating climate change. Humanity needs to focus on this common goal for failure to act may endanger our future survival. We can opt to exercise individual autonomy and elect political leaders who are committed to embracing science and addressing the current climate crisis. These political leaders should partner with religious authorities to encourage all their constituencies to act in a manner congruent with mitigating climate change for the betterment of all.

Humanity must also reduce its per capita resource consumption so that our use of the earth’s resources does not exceed its regenerative capacity. This can be realized either by reducing the amount of resources consumed per person or population reduction with the same average rate of resource consumption. While the concepts of beneficence and justice would assess these approaches as equivalent, non-maleficence would favor a voluntary population reduction as this would not require lessening the standard of living for some to achieve global economic parity. Population reduction can be achieved through education and gender equality as educated women tend to have fewer children [71]. This article also cited Project Drawdown, which listed potential solutions to mitigating climate change, including an estimate that educating girls and securing women’s voluntary right to high-quality family planning together could reduce atmospheric carbon dioxide by 85 gigatons, making this one of the most powerful solutions to climate change [72]. Thus, to be concordant with Beauchamp’s and Childress’ four ethical pillars, gender equality must be achieved. At the present time, no country has achieved gender equality although the top 10 countries include those in Northwestern Europe, New Zealand, the Philippines, and Nicaragua [73]. Implicit in women’s rights and gender equality is the worldwide elimination of child labor and slavery, which adversely affects both genders but disproportionately affects females [74].

As stated in the introduction, autonomy is of less importance than the other ethical principles when global solutions are involved yet autonomy remains important. The author CS Lewis remarked that “Integrity is doing the right thing even when no one is watching” [75]. We are all empowered to make choices everyday including decisions regarding recycling, public versus private transportation, resource consumption and family planning. Minding the science underlying climate change and the other three ethical principles should guide us in making proper individual choices that minimize our impact on climate change.

9. Climate change conflict resolution

As previously stated, conflict resolution can be achieved by five different methods; avoidance, competition, accommodation, collaboration, and compromise.

The scientific evidence is such that avoidance is not possible. Climate change is underway such that a rise in global temperature will occur even if all GG production ceased immediately. Competition does not necessarily imply an adversarial approach as a friendly competition among nations to reduce GG production would be beneficial. A contrary approach is one in which warfare is used to compete over scarce resources, which is an event that would likely add more GG and result in greater degrees of environmental degradation. Accommodation to the new normal might be possible for wealthier nations but is probably not viable for those nations most vulnerable to climate change. Of these options, collaboration and compromise provide the best pathways forward for climate change once most of humanity recognizes the scope of the problem. Adherence to the four ethical pillars will favor solutions based on collaboration and compromise. Given human nature, the author hopes for worldwide collaboration and compromise but fears that failure to act in the early stages of this disease will lead to global warfare and unprecedented destruction.

10. Conclusions

Climate change is underway. It was induced by human activity that commenced with the Industrial Revolution. The medical disease model frames climate change as the downstream effects of a rise in global temperatures caused by humanity's overconsumption of resources and the production of GG. If the earth is viewed as the human body, then humanity can reduce the amount of toxin production or behave like a metastatic cancer consuming all desired resources, which will eventually result in the organism's death and the demise of the cancer as well. Those who created the problem are obligated to address it. Humanity must acknowledge the current climate crisis, agree on a factual framework, and identify viable solutions. Irrespective of the ethical framework utilized, treatment of this disease process requires the application of the four pillars of autonomy, beneficence, non-maleficence, and justice. Thus, everyone must act to reduce individual resource consumption and the production of GG. It is unlikely that these goals will be realized without gender equality that will attenuate human population growth and its associated rate of resource consumption. Project Drawdown has proposed a roadmap for addressing climate change. It remains to be seen if humanity will rise to this challenge.

Author details

Daniel Londyn Menkes
Department of Neurology, Oakland University William Beaumont School of
Medicine, Royal Oak, Michigan, USA

*Address all correspondence to: daniel.menkes@beaumont.edu

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