

Review

Avoiding a Grim Future: The Climate Crisis and Its Effects on Human Aggression and Violence

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Abstract

As the climate crisis has progressed, scientists have begun to ask, "How does a rapidly warming ecosystem impact human behavior?" As aggression scholars and non-professional environmentalists, it has become increasingly clear that the impact of the climate crisis, without intervention, will dramatically increase humans' exposure to risk factors known to cause aggressive and violent behavior. This article describes a model that explains the indirect and direct effects of the climate crisis on aggression and violence, both on an individual level and broadly on group dynamics. We propose that systemic and global intervention strategies must be adopted to mitigate the severity of the climate crisis. This manuscript outlines the research demonstrating how climate change will increase human aggression and violence and then discusses potential interventions, such as holistic policies addressing immigration and income inequality. In discussing this topic, we provide insight into the intersectional nature of the consequences of rapid global warming.

Keywords

Climate change; aggression; violence; global warming



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1. Introduction

While there may be debate amongst policymakers and the public about the extent and reality of the climate crisis, scientists have been unwavering and unanimous in their understanding of how human activity has rapidly altered the climate patterns of our planet [1, 2]. Because of the severity and immediacy of this issue and the potential negative consequences for human civilization, it is of utmost importance for scientists of all backgrounds to come together and understand the *holistic* nature of climate change. Navigating and mitigating the outcomes of rapid global warming will require a global effort with global thinking in mind. Refusal to approach species-level problems, such as the climate crisis, with a holistic framework is one of the many reasons there have been pushback and systemic challenges to developing, implementing, and adopting climate-focused measures so far [3].

So for social scientists, the question becomes, "How is the climate crisis altering human behavior? Furthermore, how will that look in the future?" It is essential to clarify that this is a **two-part** question, as it is imperative to denote that the climate crisis is active and current and will only worsen with time at this current trajectory [2, 4]. Most of the current estimates suggest two significant problems with our recent course of action: the first being that the present action goals are not realistically drastic enough to curb the worst outcomes of the climate crisis—that is, to meaningfully slow the warming of the earth [2] and that most of the goals from current agreements and legislation are simply not being met [1].

One of the adverse outcomes seldom discussed is how the climate crisis contributes to, and will continue to, increase aggression and violence. Given current inaction and polarized dialogue surrounding the climate crisis, we posit that allowing the current dynamics to remain unchanged will significantly increase many key risk factors known to predict aggressive and violent behaviors.

This manuscript aims to describe how the climate crisis is and will continue to raise the risk factors associated with aggressive behavior and implore scientists across disciplines to work together and produce scholarship and calls to action to address the climate crisis holistically. We will start by presenting the history of research examining how different known consequences of climate change (increased heat, migration, and resource scarcity) will lead to more human aggression and violence. We hope this manuscript will bring awareness to scientists who may not consider these human-level impacts of the climate crisis and what actionable steps we can take to address these social issues. We also intend this manuscript to be a "call to arms," so to speak, to help scientists across disciplines identify the areas of needed collaboration and further research.

2. The Climate-Change Aggression Model

Figure 1 displays a theoretical model that captures how we, as social psychologists, have conceptualized the impact of climate change on human aggression. This occurs via one "direct" pathway and two "indirect" ones. The direct path is that people exposed to uncomfortably hot temperatures display increased aggressive behaviors, thoughts, and perceptions, otherwise known as the "heat-aggression hypothesis" [5-7]. The indirect pathways occur because of the increased prevalence of known "risk factors" for aggression and violence that result from rapid global warming. The rapidly changing and deteriorating material conditions of the climate will impact social, economic, and political systems, therefore putting civilization at risk for more conflict and exposing more of the population to the risk factors that negatively influence human development.

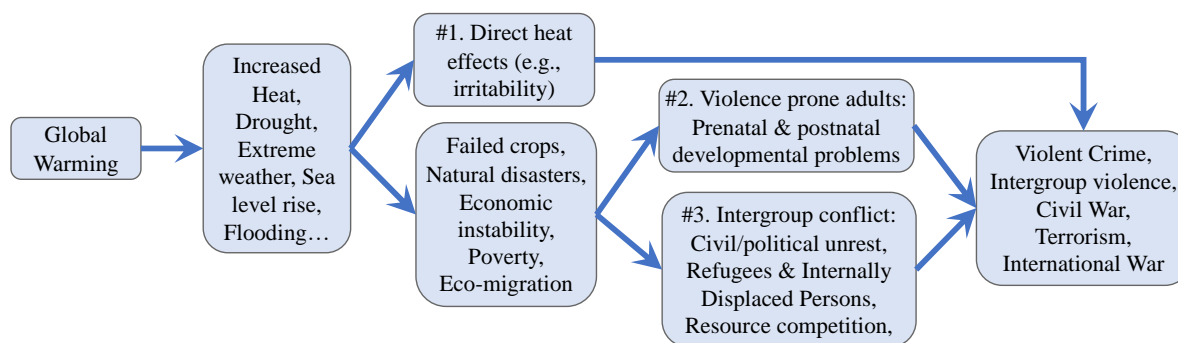


Figure 1 How Rapid Climate Change Increases Violence from Miles-Novelo & Anderson, 2019 [5].

All three of these paths tie into increased aggression and violence that is measurable and observable by increases in severe violent crime, increased intergroup violence, war, terrorism, and other large-scale violent conflicts. However, these indirect paths (namely paths #2 and #3) are *intersectional*, and we encourage readers to consider how these paths interact with each other. For instance, the risk factors for developing violence-prone adults (e.g., malnourishment, familial instability) are directly associated with the material realities of group systems, such as political stability. A drought that creates political instability that leads to the displacement of countless refugees is an event that contributes to the increased likelihood of aggression on an individual and developmental level, as well as on a group level.

For psychologists, "risk factors" denote anything contributing to an adverse behavioral outcome¹. "Aggression" is *a behavior intended to harm another person who wishes to avoid harm*. There are three types of aggression that psychologists then frequently distinguish: verbal aggression (e.g., screaming at someone or using a racial slur), relational aggression (e.g., spreading false rumors about someone), and physical aggression (e.g., slapping someone). "Violence" is a *severe form of physical aggression*, so severe that a successful violent behavior attempt will likely warrant immediate medical attention. Psychologists think of aggressive behavior as existing on a continuum, where violence is at the extreme end of physical aggression. So, while all acts of violence are aggressive, not all acts of aggression are violent.

There are a couple of points of importance. The first is that aggression is about the *intent* of behavior, not the *outcome*. A car accident resulting in severe injury does not count as an act of aggression or violence if it is an accident. This also excludes behaviors where typically negative outcomes are perhaps sought out, such as *pain*. One may have many reasons to choose to feel pain, whether because they need to (a medical procedure) or because they may want to (exercise/sport, spicy food, some sexual practices).

¹ This term will be used to denote some specific conditions, however, when predicting human behavior, scientists are much better equipped to do so on broad group-level than on an individual one. This is due to the large number of factors that can influence a person's behaviors in any a multitude of specific contexts.

3. The Direct Path – Route #1

The positive relation between heat and aggression has been found in numerous studies and is somewhat intuitive. People who frequently behave aggressively can be called "hot-headed," and those who temporarily act in a hostile manner are described by themselves and others as "being heated." Research has even demonstrated that impulsive and risky behaviors are associated with warm words [8]. However, this is not merely an implicit association; something casual about this relationship between heat and aggression makes us more reactive to potential adverse events and how it changes how humans perceive the environment around them. When people are hot, they are much more likely not only to act aggressively but also to perceive the behaviors of others as more aggressive, hostile, and threatening. Thus, they are more likely to respond aggressively to these perceived threats [9-12].

This "direct effect" of heat on aggressive behavior has been the subject of psychological research for decades (see [7, 13] it is one of the most well-established of psychological phenomena. Moreover, its validity has been demonstrated through experimental studies and cross-sectional crime and violence data from various geographic regions and time frames.

3.1 Experimental Studies

Numerous experimental studies have demonstrated heat's independent effect on aggression. This starts even before actual heat is applied, as some experiments have demonstrated that even simply priming participants with the idea of heat can increase aggressive behaviors, thoughts, and feelings. In one such study, participants were shown images and words commonly associated with heat [8]. The research team found that priming some participants with heat-related words and imagery led participants to perceive neutral facial expressions as aggressive and to have more aggressive thoughts. Additionally, priming participants with thoughts of heat made them much more likely to interpret another person's neutral behavior as aggressive and led them to behave more aggressively than control condition participants [14].

Experimenters have also gone so far as to manipulate the actual temperature participants experience during the study to see how their perceptions, cognitions, and behavior changes as a function of heat stress. For example, one experiment examined police training and found that officers who ran through a standard training scenario in an uncomfortably warm room were more likely to draw and fire their weapons than their counterparts who did the training in a room that was cooler [15]. Other experiments have found that making participants sit in an uncomfortably hot room increased (relative to comfortable participants) hostility and aggression [15]. Although these studies help establish and isolate the effect of heat on aggressive behaviors, perceptions, and cognitions, it was still necessary to see if this effect generalizes to real-world observations of actual violence.

3.2 Comparing Geographic Regions

One method scholars have used to do so is comparing crime reports across geographic regions with similar circumstances (nationality, socioeconomic conditions, and other demographic characteristics) to see if local differences in climate are associated with violence rates. Such studies have consistently found that hotter cities, regions within countries, and countries have relatively

high violent crime rates even after statistically controlling for numerous potential confounds [7]. Interestingly, the heat effect is more robust in violent than nonviolent crimes, which fits the psychological theory about the underlying processes involved.

A relatively recent finding is that whereas heat has an independent effect on violent crime rates, this effect can be "amplified" when combining it with other known risk factors such as poverty [16]. For example, a survey done in the U.S. city of St. Louis, Missouri, found that the poorest neighborhoods and the neighborhoods with the most material adversity showed the highest increases in violent crime reports "as a result of anomalous temperatures" [17].

While looking at similar areas geographically and demographically helps isolate the heat effect, another way to test its validity is to survey many geographic areas and test for potential differences in demographic and socioeconomic variables that are known correlates of violent crime. As noted above, this was done in several early major geographic region studies, primarily across several hundred U.S. cities.

Similarly, a recent study examined violence data from across 60 countries and found a significant relationship between heat and violence levels, especially in areas experiencing conflict [18]. Using this data, those authors produced statistical models that suggested that every 1 degree (Celsius) increase that the globe will experience due to the climate crisis could cause a corresponding increase in homicide rates by as much as 6% [18]. A similar analysis found that these increases could be more extreme. For example, a 1.1°C increase in global temperatures could produce 25,000 more cases of severe and deadly assault in the United States [19, 20]. In sum, when looking at differing geographic regions, warmer places experience higher rates of violence that cannot be explained away as artifactual results of demographic and socioeconomic differences.

3.3 Comparing Violence Over Time

A third way that researchers have examined the heat hypothesis is to compare rates of violence in the same geographic location during differing periods that systematically differ in temperature. Is violent behavior relatively more likely during the hotter time periods? Time period differences can be as little as a handful of minutes or hours [21], days [22], months, or even years [23]. We have already discussed one such study that found that hotter time frames in the same areas were correlated with higher levels of violence [17]. These results largely replicated time-period studies from prior decades [13, 21, 22, 24].

This is true across countries and types of crimes. For example, Bushman et al. [21, 24] looked at reports of physical assault in the U.S. city of Minneapolis, Minnesota. They found that the relationship between heat and time period (broken down to as little as three-hour time blocks) found a greater frequency of physical assault in the warmer periods. This aligns with other studies, such as reports of domestic violence after heat waves in Madrid, Spain [25] and Brisbane, Australia [26]. A study of bus driver assaults in Vancouver, Canada, also reported that physical assaults against drivers were more frequent in hotter months [27]. One study looked at data from nearly 60 years of crime reports in the U.S.; it found that violent crime rates were higher in hotter years.

Furthermore, this pattern can be broken down by season. That is, crime rates in the summer were higher than in the other seasons [19]. Furthermore, the usual summer increase in violent crime was more substantial in hotter summers than in cooler ones. A recent analysis of violence rates in prisons found that hotter days had more incidents of violence [28].

Similar analyses have been done with other types of aggressive behaviors and negative experiences as well, not just reports of crime. For example, psychiatric intakes have been observed to be more frequent during hotter time periods [29]. In addition, the relative frequency of U.S. riots was higher during hotter weather [30], and aggressive horn honking by drivers without air conditioning is more frequent on hotter days [31]. A fascinating example comes from an analysis done on professional baseball pitchers. This research found that major league pitchers were more likely to hit batters with their pitches on hotter days, even after statistically controlling the pitcher's control during that outing or for how often that pitcher struck batters in their career [32].

Overall, all three types of studies of the heat/aggression effect converge on the same conclusion: uncomfortably hot temperatures increase the likelihood of aggressive and violent behavior. Note, however, that although this heat effect is consistent and similar in both rich and developing countries [33], this effect is relatively small and does not "outweigh" other known violence risk factors such as resource scarcity, malnutrition, and poverty.

3.4 Explanatory Mechanisms of the Heat-Aggression Effect

So, why does the heat make us more aggressive? The answer lies in what psychologists call "irritability," a state in which the body is deprived of equilibrium (e.g., too hot, too hungry, too thirsty). It also is a state that arises when social needs— such as belongingness, competence, and self-and/or group esteem needs—are not met. When irritable, humans are much more likely to respond in antisocial ways, primarily because they perceive and interpret their social environment in the most hostile and threatening ways. In short, irritability (temporary or more permanent, induced by physiological or social events) instigates active coping attempts, and many of these behavioral attempts are more antisocial than usual. However, irritability alone is not a direct cause of violent or aggressive behavior, though it certainly is one of the many risk factors.

Part of the explanation behind the physiological response to being irritable when one is hot is that the part of the brain that is responsible for regulating body temperature is the same part of the brain that is involved in emotion regulation and appraisal [34-36]. Think of the human brain as a computer running software programs that regulate and control our bodies. As you run more programs (behaviors, thoughts, body regulation, etc.), it stresses the limited resources our brains have. Something like heat, hunger, or an overabundance of stimuli can cause the "programs" running to run out of the resources needed to be efficient and effective or can be overridden to make sure other more critical "programs" such as immediate survival can run. For instance, adrenaline is produced in higher amounts when people experience heat stress. This can lead to increases in aggression in certain conditions (such as being provoked) as our bodies produce adrenaline as a "fight or flight" response to threats and threatening conditions [37]. Results such as these and other studies help us understand the "hardwired" connection between our physiology and aggression [34-36].

Discomfort is another aspect of "irritability" that is important to consider, as discomfort comes from our bodies recognizing a potential area of need or concern. For example, when we experience an increase in temperature triggers discomfort, followed by irritability and other aggression-related precursors, such as increased perceived hostility [9]. The physiological explanations of "irritability" and the psychological ones are fundamentally simultaneous.

Other theories also contribute to understanding this direct heat effect. One notable theory is Routine Activity Theory (R.A.T.; [13, 22]). R.A.T. postulates that human behaviors and activities change in accordance with the weather. For instance, when it is warmer outside, people are more likely to engage in outdoor social activities, which can foster more person-to-person interaction. This increase in social interaction and other behavioral changes (e.g., more beer consumption?) that accompany the changing weather can explain the noticeable increases in crime when it is hot outside.

Research has found that there is more violent crime on weekend days than during the traditional work week (e.g., [22]), so there is certainly evidence for R.A.T. However, while some may consider R.A.T. a counter to the heat-aggression hypothesis (that heat itself directly affects aggression and violence), we should stress that it is our view that R.A.T. and the heat-aggression hypothesis work *in conjunction* with each other. That is, not only does heat have a direct physiological and psychological impact on making one more likely to behave aggressively, but the changes in social behaviors during different weather cycles also play an essential role. Experimental studies, for example, rule out R.A.T. as an explanation for their findings. It is both the changes in social behaviors and physiology that helps explain why it is that violence is more regular during hotter weather.

This is not to say that there are no moderators on the heat effect. As discussed earlier, many known factors for violence (such as lack of material resources) often *magnify* heat's effect on violence. For example, one study found that developing countries with more demanding and extreme weather (both hot and cold) were more prone to different acts of violence [38].

The CLASH model helps to try and disentangle how things such as culture mitigate the relationship between climate and violence [39]. For example, CLASH (Climate, Aggression, and Self-Control in Humans) has shown that cultures in colder climates tend to be more future-oriented rather than emphasizing the present. This could explain differences in behavioral outcomes as a product of cultural and societal norms and scripts that become accessible in any given interaction. These results, combined with some of the other research discussed, help illuminate that not only does heat have a direct role to play in increasing aggression and violence in the wake of the climate crisis but that other environmental, cultural, and social factors will exacerbate this effect.

4. Increased Developmental Risk Factors – Route #2

When thinking about any behavioral outcome (whether from individuals or groups), one needs to remember that there are numerous operative factors. While on some level, this may make it seem impossible to disentangle the causes of behavior, decades of research on aggression and violence have identified critical predictive risk factors. This knowledge can be used to assess whether increased violence is a likely outcome of rapid global warming. One significant predictor of aggressive behavior is the presence of certain risk factors during child development, from fetus to adult. For example, poor pre- and post-natal nutrition, resource scarcity, family instability, forced migration, and exposure to violence are some predictors of later violent behavior.

Over the past two decades, it has become increasingly clear that the climate crisis increases the proportion of the world's population exposed to high levels of violence risk factors during their biological and psychological development. That is, because of the rapidly warming climate, the "downstream" effects (increased frequency and severity of natural disasters, famines, water

shortages, etc.) are going to expose more people to risk factors known to lead to the development of violence-prone adults [5, 19, 40].

Natural disasters are becoming more frequent and more severe as the climate crisis continues, and levels of carbon emission and, thus, global warming influence the trajectory of this trend. For instance, a review of 28 weather events spanning all seven continents found that 14 directly resulted from anthropomorphic-induced climate change. As natural disasters continue to increase in severity and frequency, the likelihood of events that are considered catastrophic in their human impact will also continue to escalate. With these increased natural disasters, there is an expectation that access to food and water supplies will be significantly hampered worldwide [1, 20, 41]. Farming and agriculture practices must be radically overhauled to reduce these potential impacts (as well as their harmful effects that are causal contributors to the climate crisis).

Even in economically wealthy and stable countries, many individuals and communities struggle materially and cannot afford or gain access to essential resources. For example, in the United States, 1 in 8 households struggle to have consistent food security [19], and we know that this figure is likely an underestimate, especially globally. In addition, malnutrition significantly predicts the development of aggressive and antisocial behavior [42]. Two studies are especially relevant to this discussion. In one, Mauritanian children were assessed for malnutrition at three years old. Those who were malnourished were more likely to develop hyperactive and aggressive behaviors and to have more frequent reports of misbehavior and aggression in their later school lives than their more adequately fed peers [43].

Another study examined male children born shortly before and after World War II [44]. During the war, a German blockade split the western Netherlands, drastically impacting food supplies to various parts of the region. The study compared two cohorts of males whose mothers were pregnant during the war, mothers on either side of the blockade. Due to the interruption of food supplies, males on the side of the blockade that was cut off were malnourished while developing as fetuses in pregnancy. Meanwhile, those born on the other side of the blockade did not face the same food and water shortages. This quasi-experimental study found that those males whose mothers were malnourished during their pregnancy were about 250% more likely to develop antisocial personality disorder in adulthood [44]. A physiological explanation for this difference in adult behavior is that malnourished mothers release more cortisol (a stress hormone) during pregnancy. Other research suggests that high cortisol levels during pregnancy may be a causal factor in child/adult antisocial behavior [45].

This and other prenatal effects of mothers' malnutrition likely interact with other downstream impacts of the climate crisis, such as increasing poverty and income disparity, other known risk factors for creating violence-prone adults [46]. Countries and regions currently facing the brunt of the climate crisis will continue to experience disproportionate harm relative to wealthier countries and regions. This includes, of course, poor regions within countries and even within cities [47]. Harmful social outcomes, such as economic inequity, poverty, and malnutrition, will continue to increase as the climate crisis worsens, especially among the already impoverished [48]. Here is one policy decision point: farsighted changes could mitigate climate change increases in violence. Wealthy countries could use much more of their wealth to reduce inequities in food, water, and social resources (e.g., schools, jobs) within their own country and in hard-hit populations in other countries.

Note that poverty *itself* is not a direct causal factor for aggressive behavior, but perceptions of economic inequality (along with other material, social, and systemic inequities) can be an essential motivator for violence [49, 50]. This can instigate a "feedback" loop [51], where inequity creates the conditions for violent outbursts, thus continuing the conditions that sustain and encourage violence. Looking at the climate crisis, it is easy to see how this feedback loop can continue unless direct material interventions are implemented. Furthermore, when research shows how rapidly occurring catastrophic events such as natural disasters can exaggerate this effect of perceived inequity, thus motivating the outbreak of violence [52].

One particular outcome where these environmental and social outcomes are essential in developing violence is terrorism. The motivations to join and engage in terrorist violence result from a complex intersection of social environment, economic depravity, resource scarcity, and ideology [53]. One of the main motivating factors is the perceived lack of tangibly impactful options [52]. When one has lost their livelihood, family, home, neighborhood, culture, etc., a belief or feeling that there is no just or realistic way of improving their conditions can make people particularly vulnerable to being recruited into terrorist activity [52, 54]. Research from Sierra Leone [49], Palestine [55], and Managua [56], has demonstrated that this perception of environmental, social, economic, and political deprivation is a critical motivational factor in the joining of violent militia groups. Additionally, it has been found that the motivation to join these groups is also coupled with an attempt to regain a sense of power and belonging, often when those have been violated by outside violence and social systems [52, 55].

Droughts have continued to be a main focal point of the increasing severity of the climate crisis, as they have become more severe and frequent and will continue to do so for the next 50 to 100 years [1]. As demonstrated earlier, droughts pose not only material and nutritional risks, but the increases in droughts will likely create more opportunities for violence as well. By using global data related to group conflict and nearby droughts (both in time and distance), one study demonstrated that every standard deviation increase in droughts (as a result of rapid global warming) would increase intergroup conflict by as much as 62% in the affected regions [57].

Of course, the nutritional and material risks from adverse weather events such as droughts are not the only harmful outcome that can contribute to developing violence in later adult behavior. Exposure to family and neighborhood violence is a developmental risk factor for creating violence-prone adults. For instance, one study has shown that even brief exposure to war, famine, and droughts can significantly predict the development of later high-risk behaviors (such as violence; see [19]). This is true for other forms of violence, such as childhood maltreatment and abuse. Some studies have found that exposure to childhood maltreatment can even interact with certain genetic conditions to increase the risk of future antisocial behavior. For instance, a genetic condition that affects how much monoamine oxidase A we have in our brains (MAOA – an enzyme that works with neurotransmitters) has been found to interact with exposure to childhood maltreatment to predict future antisocial behavior. While only 12% of individuals in their sample had a genetic risk of low MAOA activity levels, they comprised approximately 44% of total violent crime convictions in that cohort. 85% of those convicted of violent crime had genetic and environmental risks, such as childhood maltreatment [58]. Not only that, but this genetic predictor only manifested when maltreatment was reported, highlighting how important the environment and biology of any individual play an important part in the development of violent behavior. Such variable interactions are essential at the individual and group levels of violence resulting from the climate crisis.

5. Increased Risk Factors for Group Conflict – Path #3

Several known risk factors increase the likelihood of group conflict, many of which, like developmental risk factors, are becoming increasingly severe and relevant as the climate crisis worsens. The effects of the displacement of large numbers of people within and between countries are of particular interest. Even in average climate conditions, such displacements result from regular events like floods, droughts, and political and economic upheaval (including war). History is replete with migrations leading to increased intergroup conflicts, ranging from relatively small localized violent events to much larger wars. The difference between these pre-climate-crisis events and now is that the frequency and magnitude of severe weather events are increasing. Therefore ecomigration (i.e., mass migration resulting from ecological disasters) is increasing. That is, the ongoing climate crisis will continue to increase the severity and frequency of natural disasters, which according to reports from the IPCC, will displace millions of people, possibly billions.

Moreover, much like poverty, displacement and migration are not always a direct cause of increased intergroup violence, but many factors that go along with migration directly lead to intergroup violence. This is particularly likely to happen when the region to which the displaced groups are migrating does not have adequate infrastructure, resources, and political will to accept and integrate the migrants into their region and culture. Of course, the first place ecomigrants travel often is adjacent regions that are very likely to have inadequate resources. In addition, significant religious, ethnic, racial, and cultural differences between the migrating group and groups in the region to which the migrants are going make violent intergroup conflict almost inevitable.

One recent illustrative example is the civil war in Syria. In Syria, an unprecedented drought caused many rural citizens in farming communities to relocate to Syrian cities for economic and material resources [59]. Because of existing political and economic conditions, the Syrian government failed to deal adequately with the drought and this rapid mass migration, all of which contributed to the breakout of civil war and the fleeing of migrants (both rural and urban) from Syria. Because of this intense refugee crisis, and other political and economic attitudes and policies, the resulting mass migration stoked many anxieties and tension with the new immigrant populations, leading to an uptick in conservative and anti-immigrant political rhetoric in other parts of the world as well. In the United Kingdom, this shift in political attitudes towards Syrian immigrants was one of the causal motivations behind support for their leaving the European Union (aka, Brexit; [60]).

5.1 Political and Social Unrest

Syria is not the only country to have gone through these sorts of events. For instance, a similar drought in Uganda drastically increased food prices, creating social and political instability that has given way to violence, and that violence has fueled mass migration [5]. In Bangladesh, more than 10 million people have migrated from and into India due to various social and environmental issues. This stoked many anti-immigrant attitudes as Indian citizens believed the migrants were stealing farmland, causing violent conflict between Indian citizens and the immigrants. As a result, about 2000 migrants died [48].

In the United States, Hurricane Katrina led to the relocation of thousands of residents of New Orleans and surrounding areas. The cities that agreed to take in these refugees (technically, *internally displaced persons*) saw rather sharp upticks in homicide rates, increasing hostility towards

the refugees. This also was coupled with already preconceived harmful attitudes about the refugees, as most were low-income individuals who belonged to minority demographics or ones who have been historically oppressed, further cementing the hostile and harmful attitudes directed at them [5, 48].

Many areas of the globe with high population density are already at increased risk for violence and conflict, especially if they face other material and environmental challenges, things that the climate crisis is actively worsening [18, 61]. Nevertheless, these results are not independent of areas facing instability and scarcity. Therefore, it is important to stress that even in "developed" areas where resources are relatively accessible, we should expect this not to continue to be true as the climate crisis worsens. Economic and environmental inequity will become more salient for under-resourced groups, exposing more individuals and groups to the risk factors associated with violence and aggression [46]. Data from St. Louis, Missouri, U.S.A. demonstrates this well, showing that the most disadvantaged neighborhoods saw disproportional increases in violent crime during hotter weather [17]. One such under-discussed aspect is how these conditions become ripe for harmful rhetoric towards outgroups, which can help excuse and condone violence conducted toward them.

5.2 Attitudes Towards Outgroups

Research into how perceptions of the threats of climate change exacerbate negative attitudes towards outgroups has demonstrated that increasing the saliency threat of climate change encourages people to act more aggressively towards outgroups [62]. Because of the dramatic, rapid, and devastating effects of the climate crisis, it should be expected that many groups will be forced to interact in ways they have not before, including relying on each other to share resources, take in refugees, and give material support to try to create stability.

The crisis in Syria again serves as an excellent precedent to see how the rapid adoption of refugees into a new community can be met with anxiety and backlash. Often, Syrian refugees have been described in political rhetoric as terrorists, rapists, and deliberately aggressive thieves. This has led to social movements to either support the refugees or to try and stop the flow of refugees into countries and to justify limiting their access to infrastructure, material resources, and economic opportunity. One such movement was the #refugeesNOTwelcome movement that helped feed rhetoric in support of Brexit and morphed into other anti-immigrant attitudes and dialogue [63].

The overall increase seen globally in anti-immigrant rhetoric and policy has been fueled by increasing support, influence, and presence of far-right groups and ideologies [60, 64], painting a grim picture of the future of those who are in harm's way from these downstream effects of climate change. This holistic picture of violence (or Figure 1) yields a dangerous future for humanity if major social, economic, and political mitigating is not taken. Unfortunately, the current waves of hateful political rhetoric and ideologies create an environment where harm to immigrants is actively supported. As anxieties about resource availability and economic stability become more salient, outgroups such as refugees and immigrants will continue to receive the brunt of blame and hostility for perceived (and actual) economic, crime, and other problems. That can further fuel hostile attitudes, beliefs, actions towards outgroups, and thereby more support for right-wing politics. Instead, much more attention and energy should be focused on dialogue and action to create positive systemic and structural ways to deal with global mass ecomigrations.

Many of the frustrations that lead to violent ideologies and intergroup conflicts (including war) stem from legitimate anxieties (e.g., *I am frustrated at my material conditions*) and fears (e.g., my prospects and those of my family are being eroded). However, what happens is that legitimate concerns and fears can lead to seeking an explanation for them, especially explanations involving who is to blame and how we can fight back. Often, this attribution/action process is both inaccurate and maladaptive, being directed *away* from truly at-fault systems, social structures, and environmental events and *towards* more visible (but not at-fault) groups of people such as migrants. Again, this misattribution of blame is even more virulent when the migrants differ in race, ethnicity, or religion.

One way such outgroup attitudes are shaped is through mass media. A crucial social factor to consider is how the media depicts outgroups and how those depictions push specific ideological, economic, and political agendas. To be blunt, media portrayals of outgroups strongly influence people's attitudes and beliefs about outgroup members, thus influencing people's support for specific political and economic policies [65]. Muslims are one group where these impacts have been researched [66].

For example, media depictions of Muslims saw a radical shift after the September 11th, 2001 attacks in New York City, depicting Muslims more frequently as terrorists and as a hostile "outgroup," a shift that was felt globally [67, 68]. This shift in mass media content coincided with a shift in public perceptions of Muslims that is overwhelmingly negative [69, 70]. Recent research shows that Islam and Muslims are commonly associated with violence and terrorism by those who are non-Muslim [71, 72]. This is true of all forms of media as well, including news, movies and T.V. [69], and even video games [70, 73]. As stated earlier, even benign depictions of Islamic/Muslim people or groups of people often stimulate immediate associations with terrorism [74]. Furthermore, research has shown that negative attitudes about Muslims are significantly associated with these media narratives [75, 76].

This is not unique to media depictions surrounding Muslims, and this association with outgroups and violence is quite common in media narratives. Similar associations in media can be found among Black populations, particularly in the United States [77, 78]. Research has demonstrated that watching news clips about general crime will "activate" negative stereotypes about black minority groups [78, 79]. This, of course, then turns into support for violent policies against those groups. Seeing black suspects, as opposed to white ones, increases people's support of capital punishment and three-strike policies [80, 81]. These automatic negative associations are so ingrained in cultural norms and media portrayals, which makes overcoming these stereotypes difficult [74]. This process has a direct impact on the ability of individuals, groups, and societies to understand, navigate and take positive actions around social movements, such as both the recent Black Lives Matter movement, as well as older social movements, such as the Civil Rights movement of the mid 20th century.

This is because the formation of most of our attitudes and beliefs about outgroups that one does not interact with are based on the media presentations of them that are accessible - precisely because many people do not have much real-world experience with "them" [66]. Research on American media has shown a particular issue with negatively presenting minority and underrepresented groups as "others" [82]. These frameworks given by the media become most troublesome because they are somewhat difficult to "replace" when new information is learned, mostly because humans tend to ignore contradictory information about our attitudes towards

outgroups [75]. For example, studies of American samples have shown that the mental link between terrorism and Muslims is so strong that simply providing cues about terrorism (with no reference to Arabic countries or people of Islamic faith or Muslim background) increases people's implicit biases against Muslims. It also increases support for policies harmful to Muslims, their communities, and predominantly Muslim countries [76, 83].

The hostility and anger directed at outgroups can create a social environment where violence perpetrated against outgroup members is condoned and actively encouraged. In the long run, what human societies cannot afford to do is to continue to dehumanize migrant outgroups and to continue to legitimize violence against them. We suggest that policymakers, the public in general (e.g., voters), and scholars need to come together to look at the current attitudes and how the policies proposed and the representation of outgroups in the media influence the creation of outgroups. For example, more positive (and accurate) stories about various groups of people can decrease hostile attitudes and beliefs about them [84]. This way, more can be done to investigate ways to interrupt violence-enhancing cycles of prejudice, hostility, and violence and to create humane material policies to help the groups in the most need. More humane immigration policies will reduce the future frequency of violence through both the *violence-prone adults'* path and the *intergroup conflict* path.

6. Interventions

6.1 Path #1 – The Direct Effect

While the direct effect of heat is quite interesting to understand, little can mitigate it directly. Some potential solutions lie in how we construct our urban areas and create more opportunities for affordable housing in more temperate climates as in other parts of the globe. However, some exciting research has demonstrated one potential avenue: increasing tree cover.

Studies have shown that increasing tree cover in urban areas reduces rates of violence [85] and reduces medical emergencies attributed to heat exposure [86]. Additionally, trees are one of our best sources of carbon capture [87], making the need to plant, raise, and maintain more trees apparent and urgent. However, other research has shown that the amount of tree cover found in urban neighborhoods correlates with that area's economic status, as areas with more material wealth and resources often also have the most urban greenery [88]. Therefore, ensuring equitable infrastructure that encourages the planting, growth, and longevity of urban greenery in all neighborhoods is one policy strategy that can be adopted immediately to mitigate this direct effect on aggression.

6.2 Path #2 – The Indirect Effect

In our view, the best way to handle these issues is with the development and support of scientifically effective, socially proactive, and holistic material and social policies. This is especially important because millions (and perhaps billions) of people will be displaced due to the climate crisis. Strong governmental policies and social safety nets will be essential in helping provide people with the resources they need for survival and security. Ideally, such policies would adopt the view that immigration of displaced peoples (whether ecomigrants or war migrants...) is an opportunity for increased economic growth and political stability, rather than the default view that immigrants

are only a "problem" to be solved. The absence of such policies and resource allocation increases the likelihood of the adverse outcomes discussed.

One example of a policy proposal attempting to incorporate a more positive holistic vision to address the climate crisis is the Green New Deal Resolution proposed by several United States politicians. The proposal not only seeks to address our carbon output, the usage of fossil fuels, and the development of "green" infrastructure but also outlines some material policies to help those facing the devastation of the climate crisis head-on, such as: providing universal healthcare, providing a jobs-guarantees, creating more public housing, and viewing necessary resources such as housing, clean water, and affordable (and sustainable) food, as a part of fundamental human rights. While the proposal is not "perfect," it is the first significant piece of climate legislation that attempted to address the crisis holistically. To combat these indirect consequences of the climate crisis, proactive and preventive legislation such as this needs to become a primary focus of policymakers globally.

7. Conclusion

Discussing how the climate crisis will increase aggression and violence is not a particularly easy or "fun" discussion. However, it is vital for scientists, policymakers, educators across the globe, and human civilization. As scientific research uncovers the many layers of harmful outcomes due to the climate crisis, discussions among scientists, policymakers, and the public must recognize these outcomes' holistic and interactive nature. An encouraging sign is in the most recent series of IPCC reports, all of which stress the systemic and holistic nature of the climate crisis and its solutions. As these efforts to identify these outcomes of the climate crisis continue to emerge, we hope that more social scientists in the crisis as it relates to human behavior and the functioning of human society.

As it relates to understanding aggression and violence, some recent empirical work has already been done, and work that examines the three pathways and tests if these theorized outcomes can already be detected. For example, one such study aimed to use our model to test whether there is a causal relationship between heat -> extreme weather -> clean water scarcity -> and then to increased homicide rates. This research team found that they could model this casual path [89]. However, more research is desperately needed. As readers may have noted, there is not much new work in this area, given that many of these psychological and sociological phenomena have been well-established. While that is natural for a discipline, these new revelations on the intricate nature of our environment and behavior warrant more scholars' investigation. We believe it is the work of cross-discipline research teams that can best identify the most significant and most immediate risks of the climate crisis and what policies are needed to address them.

It is clear from the data that the urgency and scope of the climate crisis require this kind of holistic thinking and societal reconstruction. Scholars interested in the human-behavior outcomes of the climate crisis must continue to work together—among themselves and with climate change scientists, environmental groups, and others—to understand precisely how the climate crisis affects human society. Those with access to power and resources to address those issues must become ready to accept that challenge.

Author Contributions

Dr. Miles-Novelo was the lead author and writer on the manuscript. Dr. Anderson supervised the original draft and helped edit the manuscript in response to reviewer comments.

Competing Interests

The authors have declared that no competing interests exist.

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