An Optimistic View on Humanity's Role in Mitigation of and Adaption to Climate Change

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Introduction

Today, as our predecessors have before us, we find ourselves in a world of increasing complexity. Year by year, the world follows a perpetual path of increasing chaos; This makes one wonder, "will humanity survive in this increasingly complex world?" This question is especially relevant when considering our Earth and its ability to sustain life. A similar question asks, "will humanity be able to come together to solve our sustainability problems?" Clearly, the answer to this question is more complex than a simple “yes” or “no”.

To answer this question, one must first consider how far into the future we can realistically forecast our survival. Second, we must look at the scope of our sustainability problems. For one, no one can predict the innovations that humanity will construct 100 years from now or the problems or solutions that will arise from them. Thus, this paper will focus on humanity's ability to come together and solve the environmental problems that we currently know about through 2100. This discussion will be comprised of the physical and environmental impacts of climate change along with important societal challenges that we must overcome. Second, current mitigation and adaption methods will be discussed along with my opinions on what humanity must do to overcome our sustainability problems. This paper will argue that humanity should be optimistic about our ability to solve our sustainability problems through international governmental unification, private industry incentive alignment, and humans' innate ability to adapt and come together in the face of adversity.

Climate Change Overview

Climate change, an important topic of research and discussion for decades, is finally getting some of the spotlight that it deserves. People around the world are seeing, first hand, some of the negative impacts that a warming world can have on their livelihood. Increased frequency of floods, droughts, wildfires, and other extreme weather events are consistently making the news while, in some places, warmer summers and longer growing seasons have been a welcome change to many. Either way, once considered a problem of the future or for others to solve, much of the world has begun to take serious notice about our Earth's changing climate and its far-reaching implications.

Observed Physical and Biological Impacts

"Warming is unequivocal, and it is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century (IPCC, 2014)." This harsh reality is conveyed by the Intergovernmental Panel on Climate Change, also known as the IPCC. Established in 1988, the IPCC was adopted by the United Nations in 1992 to serve as a trusted entity providing objectives and scientific views on climate change, its impacts and risks, and suggestions on mitigation and adaption responses. The IPCC along with other major organizations doing climate research, such as NASA, have concluded with very high certainty that humans have been the leading cause for global warming since the 1950s (IPCC, 2014). The source of this unprecedented rise in temperature is due to the increasing amount of greenhouse gases emitted into the atmosphere. These gases, such as carbon dioxide, methane, and nitrous oxide, increase the atmospheres ability to trap heat (IPCC, 2014; NASA, 2019). Many problems have and will arise should these gases continue to be emitted at current rates into the atmosphere.

Atmospheric CO_2 Adjusted for Seasonal Cyclicality

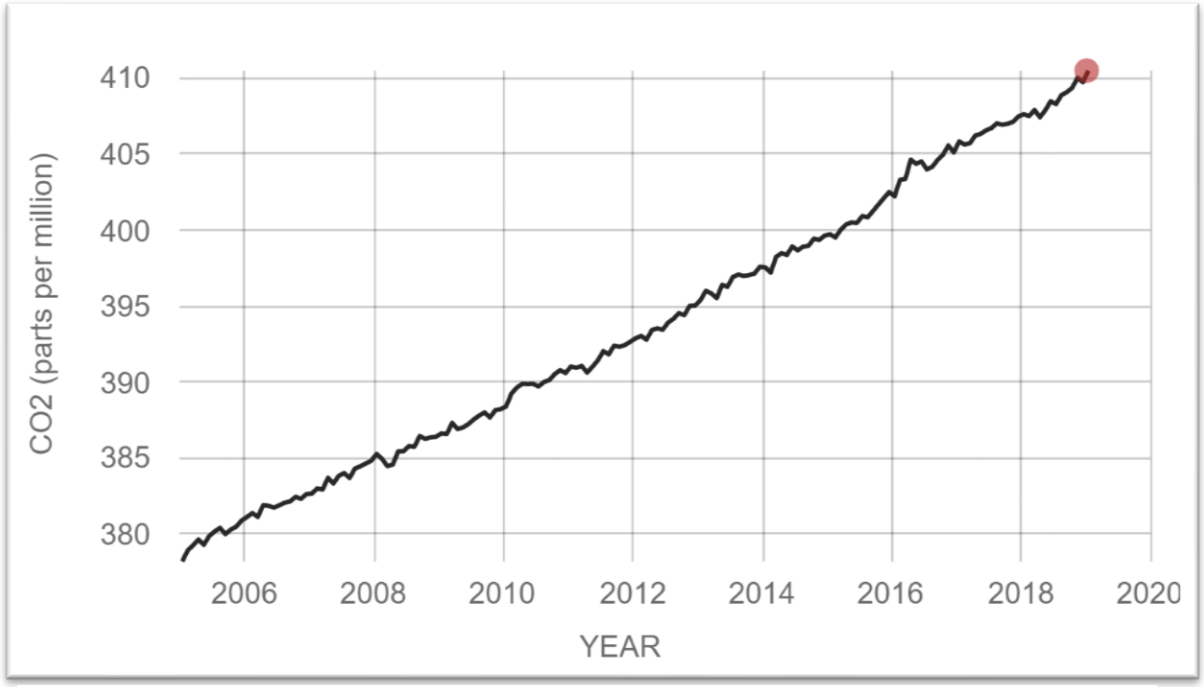

Figure 1 – NOAA, 2019

Contributions to Observed Surface Temperature Change 1951-2010

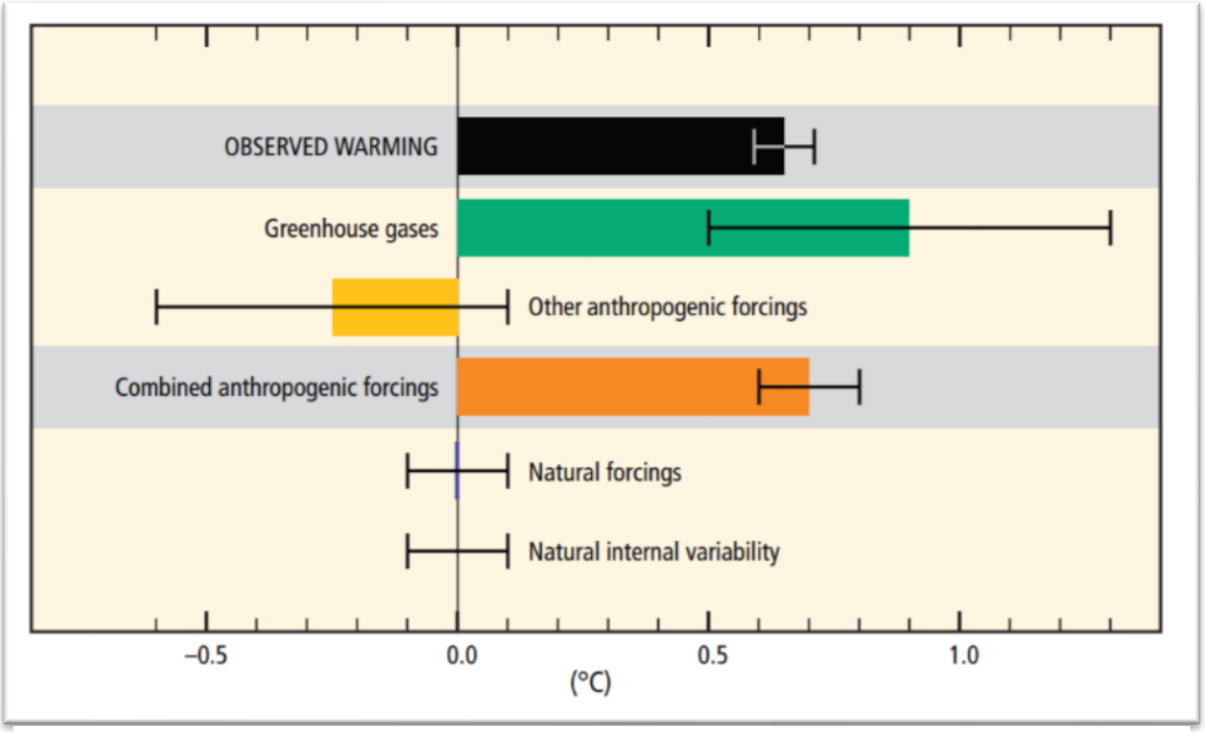

Figure 2 - IPCC, 2014

Global Warming

At the heart of most of our climate problems, global warming is the key driver. Human's contribution to the greenhouse effect has led to unprecedented increases in global surface temperature over the last half-century. Discussed in the following sections, these increases in temperatures are having majors impacts on our planet and its inhabitants.

Observed Change in Surface Temperature 1901 - 2012

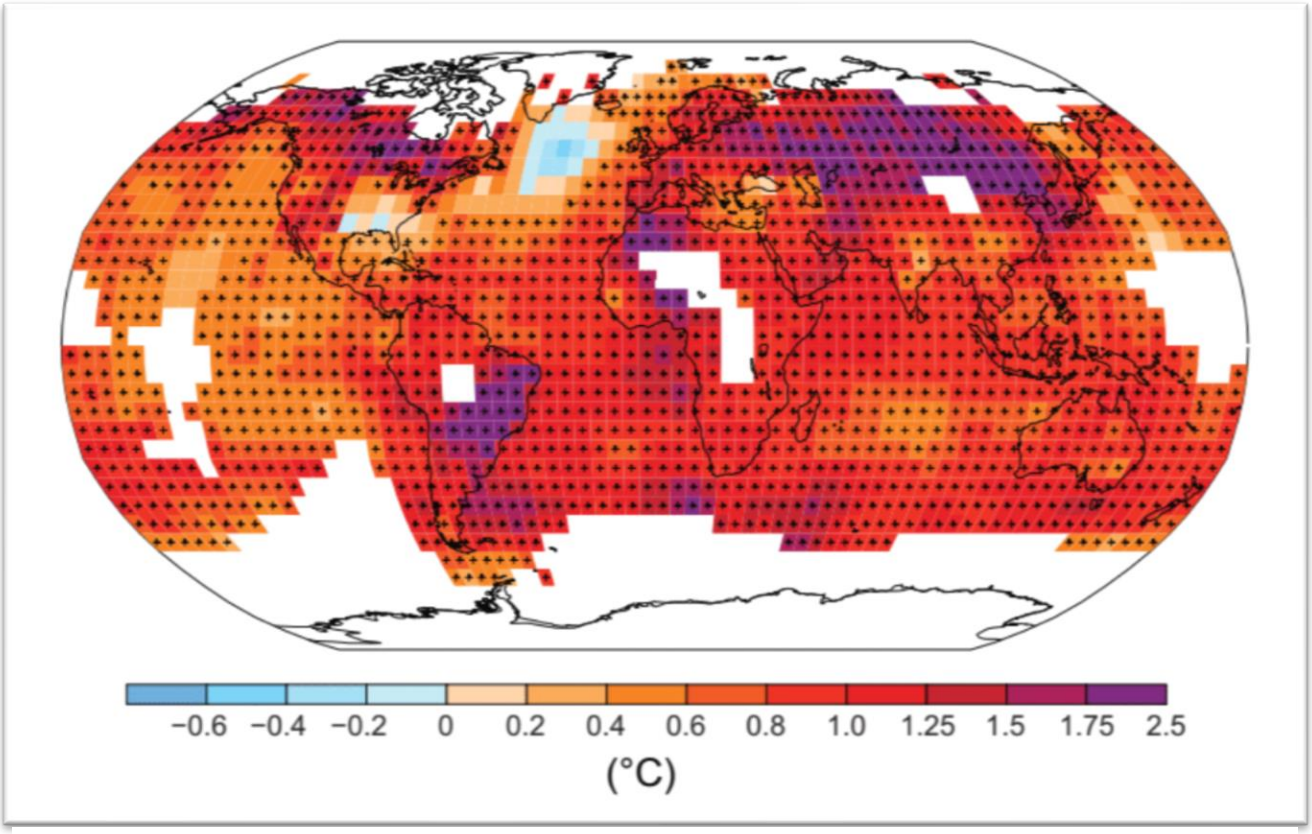

Figure 3 – IPCC, 2013

Sea Level Rise

Sea level rise is one of the clearest, direct effects of a warming Earth. Over the past two decades, the Antarctica and Greenland land masses have lost an average of 127 and 286 gigatons of ice *every year* (NASA, 2019). To put that into perspective, a gigaton is equivalent to one-billion metric tons, an unfathomable amount. Consider a large African male elephant weighing

about 6.8 metric tons. A single gigaton is equivalent to over one-hundred million African elephants (Mooney, 2015). If the incredible ice loss between those two land masses wasn't enough, Arctic ice is down 13% over the past decade (NASA). To further the problem, methane stored under these ice sheets is being released at increasing rates. "Methane is roughly 28 times more efficient at trapping heat in the Earth's atmosphere compared to carbon dioxide, and current levels of methane in the atmosphere are higher than at any point in the past 2,000 years (NOAA, 2019)."

Unprecedented melting of ice along with decreasing snow has led to sea level rise across the globe. Major cities are beginning to see some of the devastating impacts of coastal erosion and reclamation. With continued melting, sea level rise could be a major problem for the 40% of the world living within 100 km of the coastline (NASA, 2019).

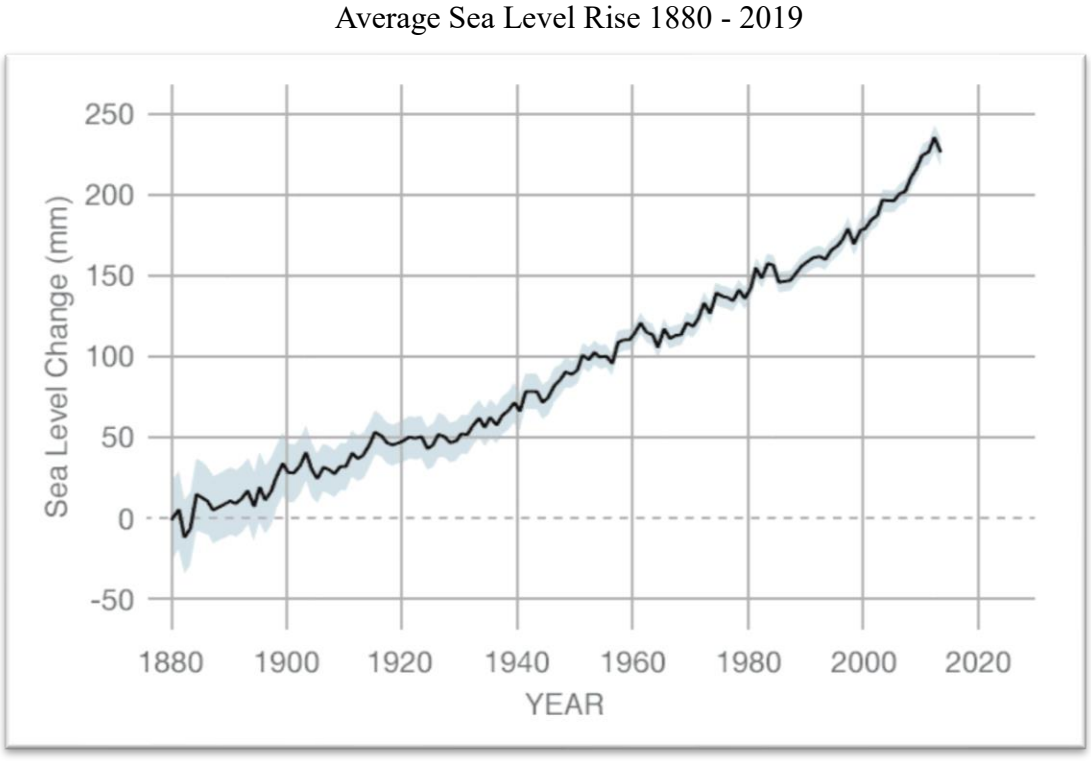

Figure 4 – CSIRO, 2019

Extreme Weather Events and Water Cycle Changes

Extreme weather and climate events have seen changes since 1950. These changes include, most notably, increases in warm temperature extremes, high precipitation events, and droughts. They can be linked, with high certainty, to human-influenced global warming (IPCC, 2014). Continued increases in greenhouse emissions into the atmosphere will further increase the likelihood and frequency of several weather events. Due to the increased solubility of the atmosphere, clouds can hold more water for longer, leading to higher intensity rains and, in some cases, far lesser days of rain. “In 2017, the U.S. was impacted by 16 separate billion-dollar disaster events,” costing a record $300 billion. Further, 8 of the 10 hottest years on record occurred in the last decade; the record begins in 1880 (NOAA, 2019).

Change in Average Precipitation 1986-2006 to 2081-2100

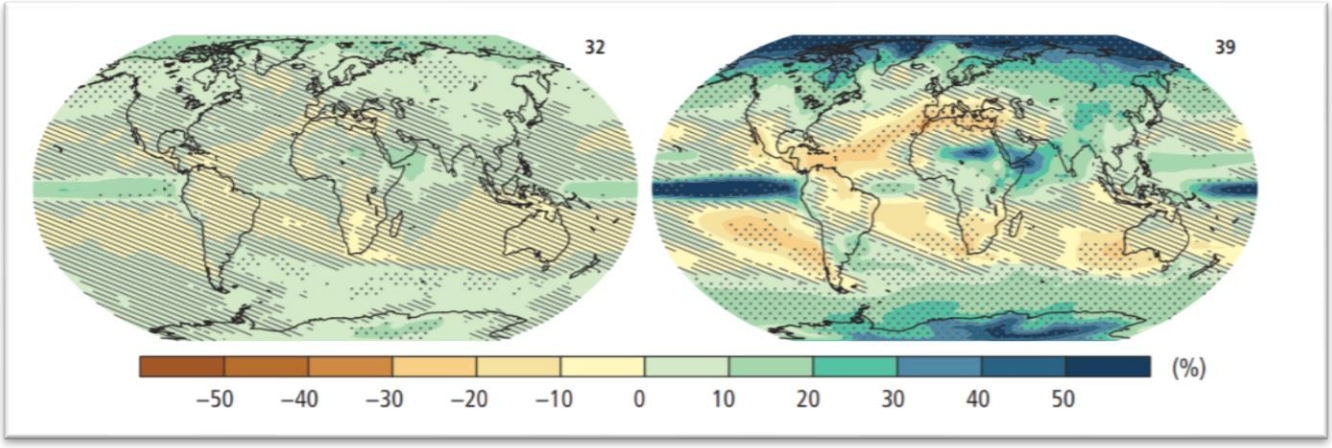

Figure 5 - Left shows RCP 2.6 representing peak emissions before 2020, Right shows RCP 8.5 representing increasing emissions through 2100 – IPCC, 2013

Observed Change in Annual Precipitation Over Land

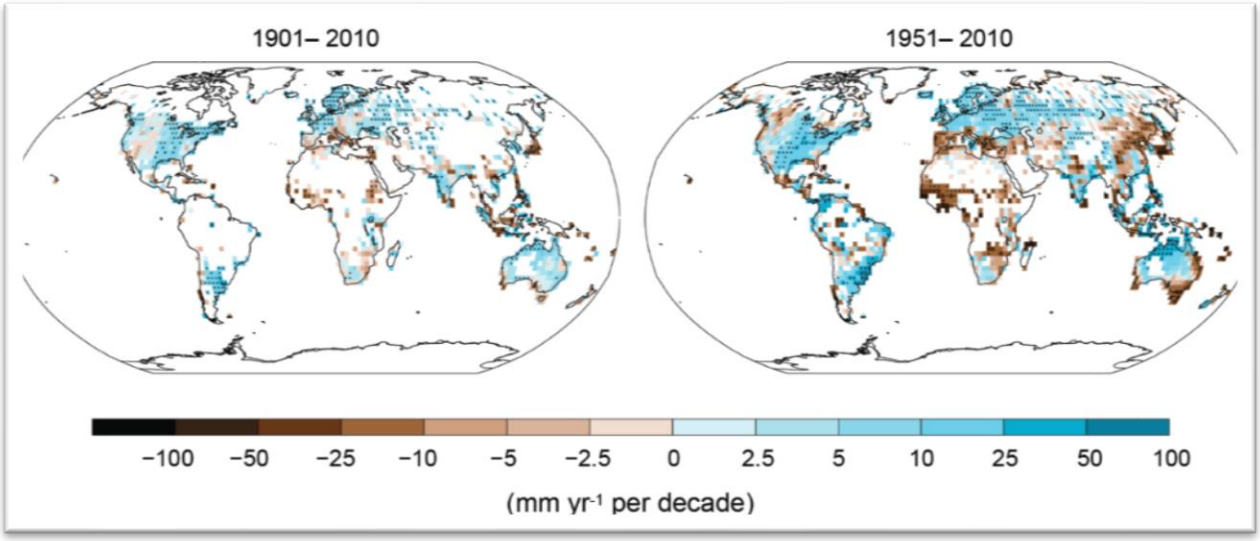

Figure 6 – IPCC, 2013

Ecological Impacts

If the physical impacts on the earth weren't enough, the ecological impacts could be just as significant. Decreasing snow cover and changing temperatures has and will cause massive shifts in ecological systems. To make matters worse, global warming has created a positive feedback loop in this case by further melting snow which leads to decreased albedo and, thus, more warming. Many species do not have the ability to adapt to changing environments like humans, putting up to 70% of known species at risk if emissions continue on their current path (IPCC, 2014). Coral is dying, putting many fish species is dire danger and wildfires are becoming so intense that some species are finding it difficult to recover from them. Consider the graph below showing predicted increases in ocean acidity through 2100. In the worst case, marine life will face mass extinctions in an increasingly acidic habitat. These are only some of the massive impacts that climate change could have on living organisms on earth.

Change in Ocean Surface PH 1986-2005 to 2081-2100

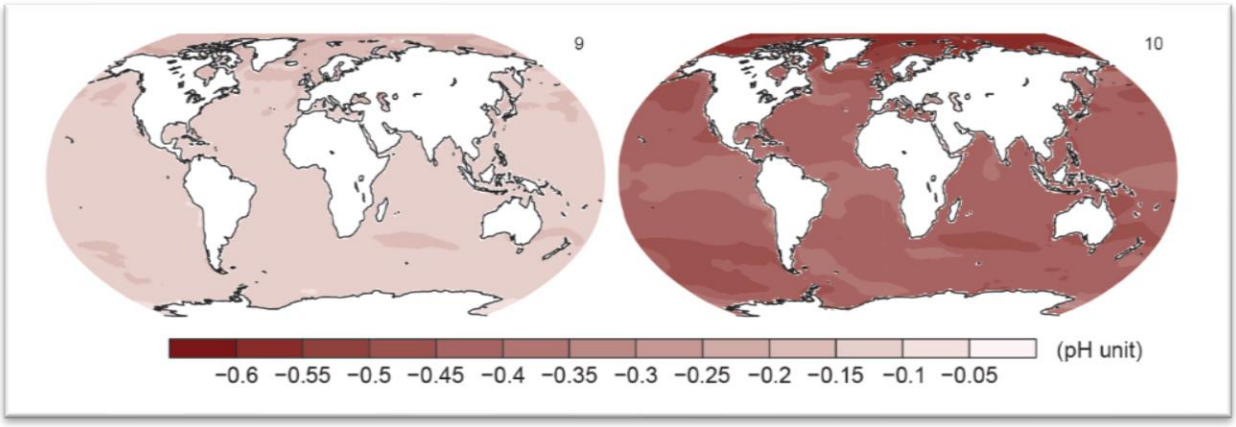

Figure 7 - Left shows RCP 2.6 representing peak emissions before 2020, Right shows RCP 8.5 representing increasing emissions through 2100 - IPCC

Societal Challenges

Aside from the challenges that climate change may directly bring upon humanity, human's themselves will need to consider several major challenges. Of course, society has many problems to work out, but I have identified two factors that will have major impacts on our ability to fight climate change, increasing population and differing incentives.

Population Growth

As it is today, the world population sits around 7.6 billion people. However, by 2015 the United Nations predicts the world population will reach 8.6 billion, 9.8 billion in 2018, and 11.2 billion in 2100 (UN, 2017). Several problems arise from a continued massive influx of people. First, more land will be used to cater to the growing needs for living and food production. However, the ability to produce food in low latitudes is likely to decrease as the regions become arider (IPCC 2014). Second, as countries emerge into developed nations, notably China, consumption among their people will drastically increase. It would be extremely problematic to

have China's population of 1.4 billion people consuming at the rate of the average U.S. citizen today. Major problems will arise as the world decides how to manage several billion more people especially as nations become richer and want to consume more.

Misaligned Incentives

One of the clearest problems that humanity faces is misaligned incentives between governments. Mitigation and adaption to climate change comes at a cost, which will be discussed further later, but there is clearly a conflict of prioritization for world leaders over maximum economic growth and fighting climate change, a, potentially, growth inhibiting task. Many political systems around the world give their leaders set terms to lead their countries and make the improvements they want to see. Unfortunately, when elections come around, these leaders tend to be judged on what they've accomplished in their previous terms, with heavy weight on the health of the economy. From a different perspective, individual humans are competitive, and many have grown up in societies rewarding spending and consumption. Incentivizing low consumption and environmental sustainability practices is a major cultural shift that must take place.

Another clear problem is the incentives of the developing world and their energy usage. With cheap access to fossil fuels, much of the world's rich nations had some form of the industrial revolution as they emerged from the developing world. Could the world handle major, fossil fuel powered industrial revolutions in the emerging nations in Africa over the next century? Do rich countries have the right to hinder their growth, costing lives, by saying no to their use of cheap energy? These are pertinent questions that the world must address.

Mitigation and Adaption

The problems that climate change poses are vast and increasingly urgent to address. Thus, climate scientists have centered their proposed approaches to addressing these problems around two strategies, adaption and mitigation. These strategies aim to reduce and manage the risks of climate change. The IPCC states that "substantial emissions reductions over the next few decades can reduce climate risks in the 21st century and beyond, increase prospects for effective adaptation, reduce the costs and challenges of mitigation in the longer term and contribute to climate-resilient pathways for sustainable development (2014)." Considering all the problems that have been identified with a human-induced warming planet, humanity needs to make significant changes if long term sustainability is desired. Mitigation primarily involves reducing our output of greenhouse gases into the atmosphere and increasing Earth's ability to store these gases. Even if major mitigation efforts were to occur in the next few years, widespread global impacts will still take place as the planet adjusts for the greenhouse gases pumped into the atmosphere over the past few decades (IPCC, 2014). Thus, one could go on endlessly discussing the options that humanity should take in the coming years. However, in the following sections, I will discuss some of the strategies for mitigation and adaption that have already begun as well as changes that I believe must take place for humanity to come together and solve our sustainability problems.

International Governmental Unification

Governments may provide the most important roles in the coming years to fight climate change. Why is that? Governments, generally, hold the duty of managing and protecting the public goods of their respective nations. Until recently, much talk of protecting public goods centered around National Parks, lakes, rivers, and other internal environmental systems. This is still the case today, but the ever-growing importance of protecting our *global* ecosystem has become a much more important issue for our global leaders, for a good reason. As seen with the UNFCCC Paris Agreement of 2015 along with other recent international climate agreements, many nations around the world have realized that climate change is a problem that must be tackled by the entire world. National leaders have realized that one bad acting, major economy could detriment the entire world years down the road. For this reason, nations are coming together and forming goals and standards for reduced emissions. The topic of international unification for climate change and the correct policies for nations to abide by is a daunting task. There are, clearly, many problems that need to be overcome such as what limits should be placed on developing economies as they emerge into richer nations, historically a fossil fuel-rich endeavor. Nevertheless, we are experiencing the beginning of an international effort to fight climate change. There will be much debate and further conflict, but with a continued increase in the urgency of the issue across the globe, global leaders will come together with effective policy to solve humanities sustainability problems including agreed upon punishments for those who stray from the plan.

Private Industry Incentive Alignment

One of the major problems of fighting climate change, especially in capitalist societies, is that incentives are aligned primarily on economic efficiency. This priority has proven to be extraordinarily successful for economic growth, competition, and, in turn, innovation across all industries. However, one major criticism and a clear flaw of pure capitalism is its lack of incentive to protect public goods. Without governmental policies or major negative social sentiment, companies have no incentive to protect a public good such as a river at the base of their factory. For this reason, governments play a key role around the world in aligning the incentives for their domestic private industries.

Today, many countries have instituted subsidies and tax incentives for items like solar panels, electric cars, reduced carbon emissions, and more. Consider Britain, with government backing, the country has experienced 6 straight years of decreased CO_2 emissions with a 39% decrease since 1990 (The Economist, 2019). Most of the reductions have come from incentivizing cleaner energy such as natural gas as a replacement for coal; Programs are already in place to work towards replacing the natural gas with renewable energy and nuclear power. They have missed goals and still have much work to do, but their progress should be noted. Many countries have also instituted disincentives such as taxes on plastic bags and pollution and emissions standards that companies must abide by. There are several examples across the world, especially in the auto industry, of countries pushing industries in a more sustainable direction. With the mass migration and consolidation of populations into cities, governments are able to increase public transportation use, and some have gone as far as completely eliminating private vehicles from their city centers, like Olso, Norway.

I am optimistic that incentives for private markets will continue to align with our goals for climate change mitigation across the globe. Extreme growth in the renewable energy industry and increased battery efficiencies has led to many places finding it more economical to use these technologies than traditional fossil fuels; this will continue across the globe and government implemented economic instruments will help speed the process. Humanity will vastly improve its ability to achieve sustainability problems when the incentives of world business are targeted at a sustainable future.

Human Nature and a Global Cultural Shift

It is easy to forget that humans are among the many species of the world; an animal among our peers in the kingdom. But humans quickly advanced to the top of the hierarchy as a far superior species with highly developed dexterity, adaptability, and intelligence. For 200,000 years, homo-sapiens have evolved and adapted to every challenge thrown their way. Some of the problems that climate change poses, however, seem insurmountable. It is difficult to believe that, in a world with so many problems and drastically different views, we can all come together to fight such a global problem. But, humans have an innate ability to adapt, and I strongly believe that humanity will come together to solve our sustainability problems for this reason. No one can predict the innovations that will occur decades from now or their abilities to counter our climate problems just as our predecessors had never imagined some of the inventions being produced today.

I am optimistic because I believe in humanity's ability to adapt. However, I also believe that humanity must also go through a global cultural shift of viewing climate action as a primary concern in their lives. Like a nation coming together in a time of war, I believe the world will come together in a war against our sustainability problems. The beginnings of this shift can be

seen in the actions of nations coming together in pledges, environmental movements across nations, and pressure on the private industries by consumers to act sustainably. The world will come together in prioritizing actions against these problems. Nobel Prize winner and top environmental economist, Paul Romer is also confident about our environmental future. He worries that too "many people think protecting the environment will be so costly and so hard that they just want to ignore the problem or…deny it exists (Rathi, 2018)." He argues for effective action today like an increasing carbon tax which, if implemented correctly, could even lead to net economic benefits. It is important to understand that optimism is not synonymous with complacency. Optimism is acting now knowing that humanity can solve any problem it faces.

Conclusion – Solving our Sustainability Problems

Climate change is, arguably, the most important long-term problem that humanity currently faces. It will come with many complex problems that, if nothing else, will take major efforts to adapt to. However, humanity has the opportunity to mitigate these impacts and come together in the face of adversity. Major strides are being made across the globe in forms of climate research, international pledges, and innovations for a sustainable future. These achievements are a beginning, but the world must work together as we face these challenges through international governmental unification, business incentive alignment, and strong cultural optimism in this fight. Yes, the world's complexities do continue to grow, but humanity *does* have the ability to solve its sustainability problems.

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