

## Technological Progress and the Environment

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In the following pages, I argue that technological progress in the fields of human longevity and artificial intelligence has already had a more negative outcome on our environment and it will continue to have a more negative impact as the technology continues to grow. Before elaborating, it is important to know that the term technology is not just limited to the machinery and the tools that we create. Technology also refers to the knowledge behind engineering and applied sciences. With that, technological progress also then refers to the growing knowledge on different matters such as aging and human longevity.

Two technologies that the human race is developing, artificial intelligence and technology improving human longevity, are ones that have the potential to impact the environment in many ways. The human race has been trying to thwart aging and increase the human lifespan for decades. There are not, however, many machines and physical technologies that are able to accomplish this, but there is ample knowledge and theories that the human race is building upon to accomplish our goals. Artificial intelligence is a concept that has slowly, but not so slowly been scooting its way into society (How Artificial Intelligence Is Edging Its Way Into Our Lives, 2018). Not only are we learning more about this kind of physical technology and engineering feat, but we are expanding our knowledge base on the idea as well.

Technological progress in the fields of artificial intelligence and human longevity has many possible implications and possible outcomes on the planet. I believe that there are three possible outcomes: technological progress in these fields will have an

overall positive impact on the environment, technological progress in these fields will have an overall negative impact on the environment, or technological progress in these fields will have a balancing relationship when impacting the environment.

### **Environmental Condition**

In order to analyze the impact of humanity's technological progress on the Earth, it is important to acknowledge the environmental state of the planet in modern day society. There are multiple places in the solar system where spinning rocks circle the star; however, each one is different in its own right. Earth is a special place in which life thrives. It is our home, and currently, it's the only one that we have. As of 2017, roughly 1.5 million species have been counted and become known to science (Larsen, 2017). This expansive number of known species, each having populations of their own, add up to a sizeable number of organisms living on the planet, each having their own impact. One species in particular has a considerable impact on the Earth: the species, *Homo sapien*. Humans. Humans are an incredibly intelligent species. The human brain is capable of imagining, and then building fantastic and great structures. We are able to alter the environment as we see fit, but we are also able to destroy and devastate the environment in the blink of an eye. We've created technologies that might've seemed like magic just a few centuries ago but are now reality. Many of which have greatly improved the quality of human life, but as a consequence, have had a severe environmental impact.

The Earth has survived its fair share of hardships and devastation. Scientists are able to trace back five extinction level events, the most recent and well-known being the Cretaceous-Tertiary event that wiped out the dinosaurs. The extinction events are

points in history that separate different environments and different states of the planet. Kolbert (2015) argues that the sixth mass extinction is unfolding as the hands move around the clock. She says that this extinction event is comparable to the past five events, but this one is different because it is caused by something different: the human race.

## **Human Impact**

Humanity has played and continues to play a pivotal role in the health and the condition of the planet's environment. Every second, individuals are impacting the environment by living the lives that society has created for each and every person. Humanity's impact has a vast range. From Styrofoam cups blowing into the ocean to burying nuclear waste inside a mountain, our impact is totaling up.

Despite all of the pollution, devastation, and deforestation humanity has brought to table, there are actions being taken to help the environment. Not everything that humans do has a negative impact on the environment. That being said, the positive things that our species does for the environment are only in response to the negative things that are done in an attempt to right the wrongs. In addition, there is an absence of preventative measures for negative influences and we are not being proactive enough to preempt any further environmental damage.

The environment has been in a drastic state of decline due to numerous factors, most of which scientists believe all trace back to the human race. Monroe & Psihoyos (2015) inform their audiences about the factories that emit CO<sub>2</sub> (carbon dioxide) into the air and entering Earth's natural cycles. They discuss that cattle industries, vehicles, and mass production are all releasing catastrophic levels of methane into the environment,

furthering the decline and health of the Earth's ecosystems and species. One way the environmental impact is studied is through the plant species in existence as well as evolution. Plant species and plant diversity are keys to understanding anthropogenic impacts on the Earth. Tilman and Lehman (2001) draw conclusions from field research about plant diversity in different areas of the world by saying

Anthropogenic changes in environmental limiting factors are likely to cause significant loss of plant diversity, leaving many niches empty and creating plant communities dominated by weedier species (poor competitors but good dispersers). The extent of this effect will depend both on the number of constraints that are changed (i.e., dimensionality) and on the magnitude of such changes. Because the impact of multidimensional environmental changes is expected to be multiplicative, a series of relatively small changes may be as important as a single major change.

It is relevant to note the last sentence and recognize that even the smallest changes to the environment have the potential to be just as big and important as a major change. The wolves in Yellowstone National Park and their impact on rivers is a shining example of this. Abrantes (2017) tells the story of how the reintroduction of a single species, the grey wolf, into the environment of Yellowstone National Park had a grand impact on the physical appearance, size, and meandering of the rivers. This resulted in increased predation on species such as elk that often occupied the river banks and the valleys of Yellowstone. The elk eventually caught on and left these areas, allowing vegetation and plants to thrive in their absence, which ultimately, reduced erosion and stabilized the river banks. All this came about because of the reintroduction of a single species (more information on this later).

Tilman and Lehman (2001) also go on to discuss how human interaction with the environment fuels the introduction of species into foreign environments. Studies have constantly shown that invasive and exotic species greatly change the environment they

are introduced to whether the change be to the physical environment or the other species that occupy it.

The environmental state has overall declined throughout history, and it rocketed even deeper into decline during the Industrial Revolution. Our species made numerous technological advancements that dazzled the populations of the time period, but it came at a cost. Smoke poured out of smokestacks of factories, smog polluted the skies and acid rain began to fall, polluting waters and the Earth that it fell on (Otero-Pailos, 2011). Otero-Pailos (2011) also goes on to describe how innovations in the iron, stone, and concrete industries contributed to the rapid rise of cities at the cost of mass deforestation, habitat loss, water pollution due to port cities, and all-around disturbance of the nature that these cities replaced.

Since then, pollution and deforestation have only grown with the growing world population. There is the potential for this continue on; however, developments in different technologies such as artificial intelligence are hopeful to eliminate a lot of the pollution and better provide a healthy environment for growing populations that are trying to increase their lifespan.

### **Human Longevity**

It's no secret that individuals want to live as long as they can. As humans, we are limited as to how long we can live, how long we can remain healthy, and in general, how long until we kick the bucket and see the light. Technologies to improve the human lifespan are incredibly relevant to the environment because our species is responsible for much of the degradation and the harm that has come to the Earth. Increasing the human lifespan would mean a much larger population of humans as well as individuals

living for longer periods of time. Overall, there is a much higher demand for space and resources as well as a spike in the environmental consequences. There is not a lot of physical technology that is actively able to increase the human lifespan, but there is a lot of knowledge, theory, and informational progress that is fueling human longevity research. Before elaborating on how human longevity research and new technology impact the environment, a little bit of background is necessary.

### **Aging Theory**

Human longevity refers to the healthy human lifespan and aging. Scientists are still working to understand aging and the mechanisms behind it. Goldsmith (2016) refers to different theories such as programmed aging and non-programmed aging.

Programmed aging refers to a biological lifespan programmed into us at birth that biological mechanisms purposely limit the human lifespan. Non-programmed aging or the error theory refers to the different aspects of life that we are exposed to and the environments that we put ourselves in affecting our bodies, therefore affecting our lifespan.

Jin (2010) discusses the different subunits of the two theories. When discussing the programmed aging theory, he highlights the three subunits as Programmed Longevity, Endocrine Theory, and Immunological Theory. Programmed Longevity relates to certain genes being switched on and off by the body, eventually triggering the decline of health and the physiological signs of aging. Endocrine Theory pertains to the idea that hormones regulate the pace of aging, and the Immunological Theory is that the immune system is designed to decline over time, eventually declining to a point that means organism death. Jin then goes on to describe a few subunits of the Non-

programmed or Error Theory, specifically the Wear and Tear Theory. The Wear and Tear Theory insinuates that different parts of the body eventually wear out from repeated use. In addition, this theory also accommodates the idea that our body is exposed to many different environmental stresses, bacteria, microbes, and countless scenarios throughout our lifespan that eventually, our body wears down. I cannot say for sure which theory is right or wrong but recognizing both theories is important to unlocking the human longevity riddle (Blagosklonny, 2010).

Another progressive research theory is the Telomere Theory. Garber (2012) introduces the Telomere Theory and explains that at the ends of our DNA strands, we have telomeres. Over time after multiple replications, the telomeres begin to shorten. There is, however, an enzyme that works in cancer cells and in stem cells that works to maintain the telomeres of our body. The reason that our DNA shortens is because one strand of replicated DNA is always shorter than the other. If this is not fixed and the DNA is not filled in, the single stranded DNA denatures and begins to degrade. Telomerase is an enzyme that works to prevent this by producing complimentary DNA on the shorter strand to match the longer strand. The believed reason we age is because our somatic cells (all of our other cells) don't regularly have active telomerase, so the telomeres are shortening without being repaired.

### **Cancer Research**

Many scientists believe that the key to unlocking the longevity riddle is discovering the cure and/or the cause of cancer. Cancerous cells form tumors that come in all shapes, sizes, locations, and danger levels. Each cell has an unwavering ability to grow, replicate, spread, and oddly enough, not age. Scientists and researchers

all dream of discovering what makes the cancer machine work. Day by day, discoveries are being made. In fact, as of March, 2018, scientists made the incredible discovery of an entire new organ in the human body: the Interstitium. Although there is still more to be discovered about this new organ, the discoverers and researchers hypothesize that it could be a potential way for cancer to travel throughout the body (Benias et al., 2018). This discovery is a prime example of the fact that discoveries and advancements are being made every day. Piece by piece, the puzzle is beginning to form a picture. Technological advancements in the medical and cancer fields have led to new discoveries and a deeper understanding of what makes cancer tick and continue to grow.

### **Tying Cancer Research and Aging Theory Together**

Both cancer research and the different aging theories provide the foundation for the development of new technologies to increase the human lifespan. By understanding how we age and how cancer cells operate, we are able to formulate a hypothesis about how we can lengthen the human lifespan. From there, the hope is that technology is able to prolong human life from birth through genetic engineering, ensuring that individuals will live long and healthy lives from the get-go. Is it the *best* idea? That is an ethical topic for conversation. It brings questions of how long is too long, what are the consequences, and what happens when we live forever? Bias and opinions aside, the technology and knowledge levels continue to progress.

If the telomere theory is correct, then cancer and telomere research will coincide heavily in the process of eliminating cancer and aging. Brooker et al. (2017) informs readers of telomeres and the science behind how they shorten over time. On a

microscale, they don't shorten very much, but if every telomere in your body is shortening, over time that can have a very large impact in the form of aging. However, as we talked about before, there is an enzyme that proactively works against the shortening telomeres. Telomerase has been found in 90% of human tumors (Garber, 2012). This indicates that a plausible cause of cancer cells being so indomitable and long lasting is due to their ability to repair the telomeres of their mutated, cancerous DNA.

### **Environmental Impact**

There is not a lot of tangible technology that pertains to increasing the human lifespan. Technology that would allow us to bioengineer humans to live longer straight out of the womb is a nice idea, but the technology is not yet at that point because we aren't able to see the full picture of aging. The technology of human longevity is mostly knowledge, theories, and information. There are still a lot of missing puzzle pieces, but many of the impacts are easy to foresee. The technology itself will not have that large of an environmental impact, but the receivers of the technology and the repercussions will have the greatest negative impact.

Possible repercussions that increasing the human lifespan will have will be the higher demand for resources. One might say that production and resource allocation will be faster and more efficient because there are more people to do the work. This might be true to some extent, but the demand for these resources is too high and eventually, the space and the land that we are allocating these resources from will run out. Vonnegut (1961) wrote a short story called *Tomorrow and Tomorrow and Tomorrow*, where the human race has created a serum to cure aging. It was popular and amazing

when the technology was first revealed, but society soon realized that there weren't enough resources to go around. Air and water became more polluted, food was harder to come by and more expensive, but more importantly, they ran out of space. The human race ran out of space to build and expand around one another, so they started building higher and above one another. Many individuals were even comforted at the thought of prison because they would have their own space. Some even wished to die. I understand that this is just a short story and it is fiction, but it is a possible direction we could head for if we were to achieve human longevity.

The human race's current demand for resources causes massive habitat loss and the destruction of ecosystems. Tilman and Lehman (2001) point out that our impact on the planet has caused the reduction of animal and plant variability and viability. The disturbances of the soil and of the Earth prevent much of the plant life from rooting and being able to grow. Ecosystem disturbances also drive out animal species or worse, kill them off. These are both happening now with our current population. Bradshaw and Brooke (2014) highlight that the planet's large, growing, and overconsuming population is rapidly chipping away at the Earth's natural ecosystems and life support systems. Already, we are consuming more than we can produce and eventually, in combination with a growing population and increasing lifespan, it will cause the demand on the ecosystem to reach far beyond a sustainable level (Flynn, 2015).

Increasing the human lifespan would rapidly grow our current population of about 7.6 billion people. As of now, our population is projected to reach 8.3 billion by the year 2030, and about 8.9 billion by the year 2050 (Population Facts, 2017). These numbers would likely be much higher if we throw human longevity into the mix.

If the human lifespan is prolonged through technology, I believe that there will be a more negative impact on the environment. If humans are the cause of the next mass extinction, then prolonging our lives would absolutely have more of a negative impact and would catalyze that extinction. With the introduction of technology that pertains to human longevity, we will eventually reach carrying capacity and we will drain the environment that keeps our species alive (Olin, 1976). It's definitely confusing for me to debate whether or not prolonging human life is a good or bad thing because well, I am human. I would love to live a long and healthy life, but if every human is collectively doing so, there is going to be a high environmental demand and strain to support this burst of thriving life. To be blunt, the more we live, the more the environment is going to die.

### **Artificial Intelligence**

Many of us imagine artificial intelligence as something similar to the depiction in the movie *I, Robot* (Proyas, 2004). We picture humanoid robots that can think for themselves, have super human capabilities, and are most likely plotting to cleanse the Earth of the parasites (humans) that are bleeding it dry. Books such as *Robocalypse* (Wilson, 2011) tell apocalyptic tales of artificial intelligence killing off millions of humans with their own agenda. For some reason, the human race always paints artificial intelligence in our own image, maybe in attempt to play God (Herzfeld, 2009). Maybe that incarnation of artificial intelligence will happen, maybe it won't. Regardless, the most realistic technological innovations have occurred in different forms of artificial intelligence.

Artificial intelligence (AI) is a technology that our species has been trying to successfully develop in which the artificial machine will be able to have thoughts of its own and make decisions based on the environment in which it exists. Hollywood movies like *I, Robot* and novels such as *Robopocalypse* depict artificial intelligence as mechanical organisms that take the shape of humans and wreak havoc over the human race, but in reality, artificial intelligence is not nearly that scary, nor is it quite as smart – yet. In fact, the closest the human race has gotten to creating artificial intelligence in our image is Sophia, the world’s first humanoid robot citizen. Sophia was granted citizenship in Saudi Arabia in October, 2017. She was able to be granted citizenship due to her cutting-edge AI technology that allows her to hold eye contact, have an intelligent conversation, express feelings, and even have a sense of humor (Stone, 2017).

Despite the exception of Sophia, artificial intelligence takes different, simpler forms today in society. What’s more, many of the forms that AI takes today are ones in which scientists and engineers are hopeful about to help the environment.

One such way is in vehicles. Artificial intelligence is being implemented into vehicles in an attempt to increase efficiency. Smart cars are becoming more prominent in society and they are constantly being improved upon. Williams (2017) discusses how currently, transportation accounts for more than one quarter of greenhouse gas emissions. These greenhouse gasses are what biologists and scientists hold responsible in aiding the depletion of the ozone layer. She then goes on to discuss how increasing driving efficiency could drastically reduce this number. Williams believes that AI can be used to provide vehicles with faster routes and fewer crashes, resulting in

higher efficiency driving and fewer vehicles on the road for shorter amounts of time, thus lowering the amount of emissions from vehicles. Lowering the number of crashes would also lower the amount of manufacturing needed and as a result, decrease the amount of materials needed from the environment. She also highlights that AI algorithms can be used to discover different materials used in manufacturing cars, especially ones that have fewer environmental consequences. There are, however, more logistical and legal issues surrounding artificial intelligence in cars such as the accountability being taken off the humans behind the wheel and instead, put on the machines (Keating and Nourbakhsh, 2018). Legalities and logistics aside, it's not a perfect solution to the problem created by vehicles, but I believe that there is the potential for a decrease in the environmental impact.

### **Environmental Decision Support Systems (EDSS)**

Remember that study about the wolves and the elk in Yellowstone? What if there was a way that we were able to predict changes such as the elk and the wolves and then propose a new way of handling these environmental changes? Recall that information, because another hope for artificial intelligence is to use the technology for Environmental Decision Support Systems, or EDSS (Cortés et al., 2000). The authors recognize that human development and our technological progress is very dependent on the natural environment and all of its species included. They discuss how our growth plays a pivotal role in changing the conditions essential to life on Earth. Artificial Intelligence's role in the EDSS would be to predict and formulate decisions based on current species populations, and to suggest possible actions to preserve said species. Cortés et al. (2000) provide a figure for the process of creating an Environmental

## Decision Support System

shown in Figure 2 to the right.

To apply this to a scenario: an environmental problem would be presented such as wolf/elk overpopulation and would then be analyzed. The AI scientists would then collect the data on species population numbers, predation statistics, and/or habitat condition, and run these through data mining, statistical analysis, and cognitive analysis (see Figure 2.) The AI would

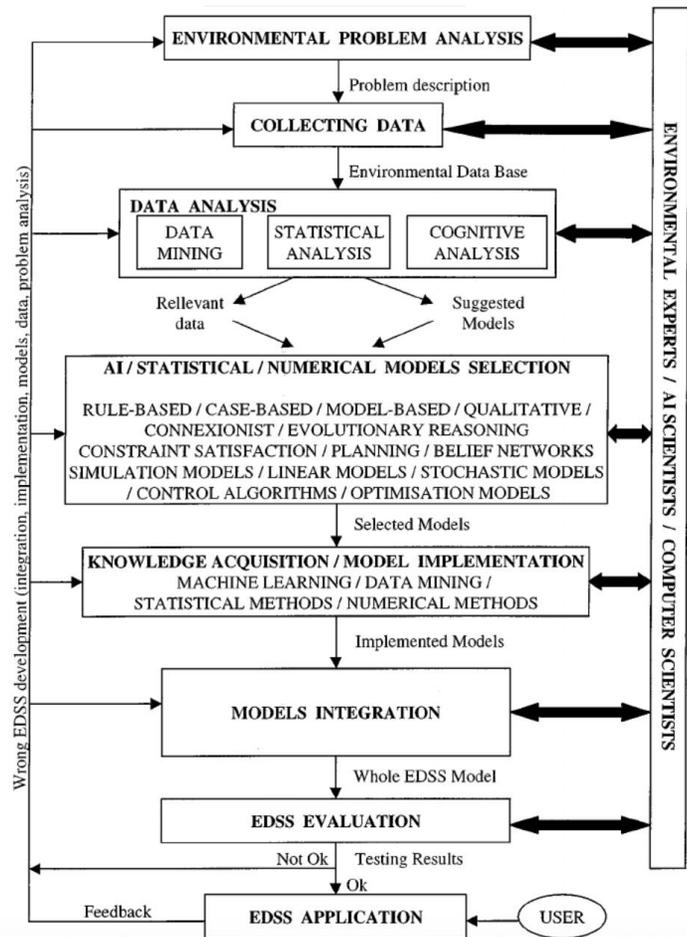


Figure 2. Development of an EDSS.

then take this analysis, collect the relevant data to form models and potential courses of action to maintain a healthy population and ecosystem. These models would be implemented and integrated, and if the results are negative, the whole process would be done again.

## Environmental Impact

Artificial intelligence has the potential to do a lot of good. There is significant progress in the production of this technology and the knowledge behind it is being implemented every day. Although there is still a lot of progress to be made to meet our ideal forms of AI, this technology is attempting to do the right things for the environment.

Right now, artificial intelligence is working to relieve a lot of the environmental strain put on by the human lifestyle. We are working to reduce our carbon footprint through artificial intelligence by ensuring vehicles to get from point A to B efficiently, effectively, and in an eco-friendlier way. AI will be able to foresee climate and environmental changes and hopefully be able to propose the next course of action to ensure that the human race is able to sustain a healthy environment. This all sounds amazing, but I believe that it is easier said than done. I think that the *ideas* behind artificial intelligence are more supportive of the argument that technological progress in the fields of artificial intelligence has a more positive effect on the environment, but unfortunately the ideas are just not a reality.

The environmental cost for artificial intelligence to operate in today's society with all of our other technologies is much too high. Right now, most of the energy produced in the United States is generated by burning fossil fuels and coal (Electricity in the United States, 2017). In 2016, burning natural gas amounted to about 34% of the electricity generation. That is coupled with about 30% of electrical generation coming from the burning of coal, both of which contribute massive amounts to the world's pollution. The electrical demand for artificial intelligence is very high, so if an alternative for power is not presented, this would only escalate to even higher percentages. There is however, a potential alternative presented by Wolfe (2017). Wolfe (2017) believes that AI will revolutionize the energy industry. He says that if we were to upgrade all of our power plants and modernize the energy grids, we could accommodate the high demand that Artificial Intelligence would need. He proposes that we create a "smart energy grid" and AI would be the brain of the grid itself. The technology would collect

and synthesize data from millions of smart sensors nationwide to make timely decisions on how to best allocate energy resources as an alternative to all of the individual power plants we use now. The wrench in the gear is that the smart grid would rely heavily on the internet, which is not an eco-friendly technology. In fact, the information communications and technology (ICT) industry that provides internet, videos, and other cloud services produces more than 830 million tons of CO<sub>2</sub>, approximately 2% of the global emissions (American Chemical Society, 2013). As I stated before, it is all easier said than done.

To top it all off, all of this amazing technology and advancements end up in the same place: landfills. Some of the electronic waste is recycled and reused, but unfortunately, we are covering up massive amounts of land with e-waste. In the article, “11 Facts About E-Waste” (2015), the authors relayed information from the U.S. Environmental Protection Agency that says that a large portion of what is labeled and considered “e-waste” is actually readily marketable material that can be reused and recycled by companies and technicians. As of the present day, e-waste represents 2% of America’s trash in landfills, but ultimately equals 70% of overall toxic waste (11 Facts About E-Waste, 2015). A lot of the electronic waste stems from broken down old circuit boards, cathode ray tubes, and other machine parts that sit in the earth, leaking heavy metals such as lead, barium, and tin into the ground water. These release toxic phosphorous and other chemicals into the water, air, and everything in between (Pinto, 2008). I believe that artificial intelligence technologies will only aggravate the e-waste issue. The existing technologies that are going to pave the way for artificial intelligence to thrive currently just have too high of an environmental cost to say that AI is worth it.

Could this change in the future? Absolutely, but we need to start by fixing the root of the problem before digging ourselves into a deeper hole. Unfortunately, machine parts aren't a good fertilizer.

### **Conclusion**

I believe that the human race is the most influential species on the planet. For centuries we have been changing and terraforming this spinning rock we call Earth in ways that we are still trying to understand. One thing we do know for sure is that we are having a massive impact on the environment and our technological advancements and innovations will continue to either harm or help our environmental state.

The human race is continuing to grow in population and advancements in technology that will improve the human lifespan are being made. These advancements will result in a human population that is not only growing but living longer. This means that more resources will be required to sustain the population which unfortunately, will eventually deplete the Earth's resources until there is nothing left. Our reality is slowly creeping towards the plot of Cameron's (2009) fictional movie *Avatar*, where the human race outgrew and ultimately killed the Earth, so they move on in search of another viable, healthy planet only to repeat the destructive process. A pattern always seems to emerge: the more we live, the more the environment tends to die.

It's the plot to every movie about artificial intelligence: humans are the problem; artificial intelligence is the solution. Research-lacking viewers would think this silly; however, upon further investigation, there might be some truth to it. Artificial intelligence has the potential capability to solve many problems that humans have created, ideally as long as it doesn't involve human genocide. Potential, yes, but this is not quite reality.

The environmental cost is still too high, and machine parts just don't work well as fertilizer.

I believe that the two technologies, longevity and AI, are ones that have the potential to balance each other out—AI fixes the problems that humans solve. That being said, I would argue that there is still more of a negative impact on the environment from technological progress in these fields because the technology is not yet to the point where we would like it to be. As I stated in earlier paragraphs, I believe that the development of artificial intelligence technologies in our current world will place a large, negative strain on the environment. This impact will be coupled with the negative impact that will arise from the everlasting and growing population of humans and the environmental demand that comes with us. Due to the fact that artificial intelligence technology is not quite to the point where we want it to be and humans are continuing to live long lives and grow our population, the negatives are outweighing the potential positives, ultimately having an overall negative impact on the environment.

Who's to say that we won't eventually reach the point of a healthy and level balance? After all, advancements are being made every day.

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