



People's Needs or People's Greed

It is an amazing sign of the times when the youth across many nations are uniting in their will to raise awareness about the perils of global warming and the need for immediate action.

Former U.S. President Obama cautioned about the urgency of this debate when he declared at the UN Climate Change Summit in September 2014 in New York [1], "For all the immediate challenges that we gather to address this week—terrorism, instability, inequality, disease—there is one issue that will define the contours of this century more dramatically than any other, and that is the urgent threat of a changing climate." Eight years earlier, former U.S. Vice President Al Gore helped raise awareness of global warming through his 2006 Academy Award-winning documentary *An Inconvenient Truth*. There is also a push in the U.S. Congress toward adopting legislation in favor of a Green New Deal to address challenges posed not only by climate change, but also by economic inequalities. It is not clear how successful this legislative effort will be due to its broad scope and the many critics of its viability. However, it is testimony to how the dynamics in the realm of climate change is evolving across continents.

Fewer than five years after Obama's remarks, we now witness a wave of protests sweeping the globe led by the

younger generation. They are driven by the inaction at higher levels of decision power, and by the lack of a political will to address the problem of global warming more systematically. Although 97% of climate scientists agree that some of our actions are contributing to warming and climate change with a high degree of confidence [2], we have nevertheless been slow at adopting viable counter measures and policies. Some even go as far as disputing the validity of the scientific evidence. Understandably, there are many issues at play, including the nontrivial economic implications for any new policies and their impact on the modern way of life. Perhaps Gandhi put it best when he stated, "Earth provides enough to satisfy every man's needs, but not every man's greed." This beautiful quote motivated the title of the editorial.

Since earlier this year, there has been an expansive line of protests moving through Western European countries (Ireland, Belgium, Germany, Switzerland, France, The Netherlands, and the United Kingdom) that are spreading into other continents. Middle and high school students are skipping school and demanding action to address the perils of climate change. On 15 March 2019, literally hundreds of youth strikes took place in more than 50 countries in Europe, the United States, Australia, Bra-

zil, Japan, the Middle East, and other locations. It is fascinating to note that most of the participants in these strikes belong to the younger generation of students who cannot yet vote in their countries! However, their voices cannot be silenced and should not be ignored. That would be a fatal mistake.

The youth are determined to send a message, loud and clear, that the future matters because the future belongs to them. They even published a letter in

The Guardian. In characteristic youthful enthusiasm they declared [3], "We, the young, have started to move. We are going to change the fate of humanity, whether

you like it or not. United we will rise until we see climate justice. We demand the world's decision makers take responsibility and solve this crisis. You have failed us in the past. If you continue failing us in the future, we, the young people, will make change happen by ourselves. The youth of this world has started to move and we will not rest again."

Politicians should take notice. It is only a matter of time before these younger activists march confidently into the voting booths.

The 16-year-old Swedish student Greta Thunberg has inspired this recent call for action. In the summer of 2018, while in ninth grade, she initiated her campaign by staging a sitting protest

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in front of the Swedish parliament asking for action on climate change after a string of heat waves and wildfires swept through Sweden. This past January 2019, she attended the Davos meeting in Switzerland, after traveling for 32 hours by train, determined to reduce the carbon footprint of her journey, while more than 1,500 private jets and limousines carried a long list of luminaries and delegates to the meeting including, among others, heads of state and some of the world's most influential government, academic, and business leaders. She told her audience that “adults keep saying: we owe it to the young people to give them hope. But I don't want your hope. I don't want you to be hopeful. I want you to panic. I want you to feel the fear I feel every day. And then I want you to act. I want you to act as you would in a crisis. I want you to act as if our house is on fire. Because it is.” She sounded the alarm.

The purpose of the youth protests is to call attention to the serious effects of global warming on climate change. Global warming is caused by the greenhouse effect. The word *greenhouse* is borrowed from the analogy with the glass building that is used to protect plants from cold weather. For our planet Earth, the greenhouse effect refers to the phenomenon by which gases in the atmosphere trap heat from escaping into space. Among these gases are carbon dioxide (arising, for instance, from the burning of fossil fuels), nitrous oxide (arising from the use of fertilizers), and methane (arising from the decomposi-

tion of waste and animal livestock). At normal levels, the greenhouse effect is helpful. However, at higher concentrations, these gases trap more heat than necessary and lead to rising temperatures at a global scale.

I was struck by the two images extracted from NASA's Global Climate Change website (Figure 1) [2]. Figure 1(a) shows the distribution of global surface temperatures in 1970 and Figure 1(b) shows the same distribution almost 50 years later in 2018, where the dark red color refers to areas that are warmer than average. What a remarkable transformation! Anyone can deduce that something real is happening, whether we call it global warming or not should not matter.

Interestingly enough, our signal processing discipline has a significant historical connection to the greenhouse effect. The French mathematician Joseph Fourier (1768–1830) of Fourier series fame is credited with the discovery of the effect in 1824, although he never called it by this name [4]. According to his entry on Wikipedia, Fourier “calculated that an object the size of the Earth, and at its distance from the Sun, should be considerably colder than the planet actually is if warmed by only the effects of incoming solar radiation...Fourier's consideration of the possibility that the Earth's atmosphere might act as an in-

solator of some kind is widely recognized as the first proposal of what is now known as the greenhouse effect...” Fourier went on to write a treatise on the Theory of Heat, where he introduced the now-popular Fourier series technique to solve the heat equation. Today, Fourier analysis and the Fourier transform form the backbone of many signal analysis methods. Our signal processing discipline should also take pride in enabling a good part of the technology that monitors and tracks climate change patterns and brings them to life through remote satellite imaging, distributed sensing, data analysis, and inference and prediction methodologies.

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Wallace Broecker, a long-time professor at Columbia University, popularized the term *global warming* in modern times and predicted its dangerous effects in an article published back in 1975. That was nearly half a century ago! Broecker was awarded the National Medal of Science by President Clinton in 1996 and was a member of the U.S. National Academy of Sciences. Days before his recent passing in February 2019, he recorded a video message to top climate scientists urging them to “examine more extreme solutions to the climate crisis” including geoengineering. That is the mark of a true scientist: he faced his own mortality while still thinking

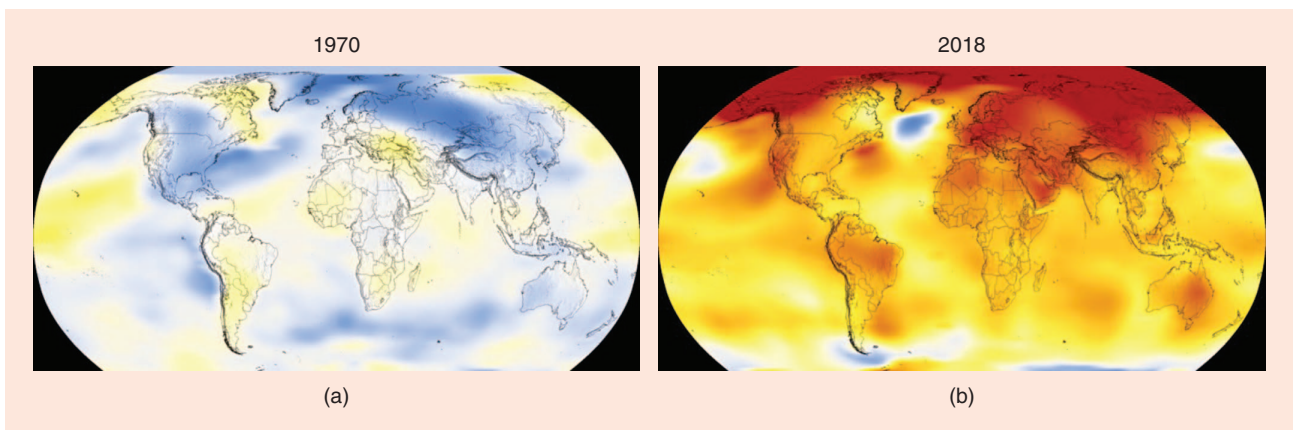


FIGURE 1. The change in global surface temperatures over the last 50 years: (a) temperatures in 1970 and (b) temperatures in 2018. (Source: NASA's Global Climate Change; <https://climate.nasa.gov/vital-signs/global-temperature/>.)

about his science and the well-being of future generations.

It is predicted that, absent any serious action, global temperatures will continue to rise. This translates into more heat waves, stronger hurricanes, and more droughts. For example, the last five years have been declared to be the hottest years on record globally. The sea level is also expected to rise by up to 77 cm

by the end of this century due to melting ice and glaciers [5]. Many regions and poorer populations will be affected. Hundreds of small islands in the Pacific and Indian Oceans are threatened to disappear. Among them, the Marshall Islands in the Pacific Ocean (with more than 1,000 islands and 53,000 inhabitants) and the Maldives in the Indian Ocean (also with more than 1,000 islands and 425,000 inhabitants) face an existential threat [6]. The Maldives is, on average, 1.5 m above sea level, while the Marshall Islands are on average 2.1 m above sea level.

There are steps that can be taken to ameliorate the warming trend, such as moving toward renewable energy sources (electricity, solar, and wind) and away from fossil fuels, building more energy-efficient structures (buildings and factories), promoting public transportation and electric-powered systems, advancing battery technologies, reducing CO₂ emissions from buildings, stopping deforestation (so that trees can absorb the CO₂), and the list goes on. Here again, our signal processing discipline has an important role to play by embedding these solutions with intelligent monitoring mechanisms, sensing, and data analytics to promote efficiency and adaptability.

Unfortunately, technology alone is not sufficient to address the foreseen

perils of global warming. Above all, it is necessary for governments worldwide to adopt policies and directives aimed at curbing the warming effects. Countries need to work side by side to

create a meaningful impact. It does not help for some countries to move in the right direction, while other countries persist on the current path. After all, we all share the same planet Earth

and the same atmosphere. The 2015 Paris Agreement was a consensual step in this direction. Its purpose is to limit the temperature rise in this century well below 2° to avoid serious ramifications.

Still, even with our best efforts at both the technological and political levels, the state of affairs is such that scientists estimate that the effects of global warming will take decades and perhaps centuries to weather off [3]. A recent report by the U.N.'s Committee on Climate Change estimates that we have a window of 12 years to keep global warming below 1.5 °C before the damage becomes more permanent. Generations to come will have to deal with some difficult consequences. This is an unfortunate and deeply concerning reality. Just consider the following fact.

Our civilization has been successful at fighting disease and at developing wondrous technologies. However, we have been largely powerless in one domain. We have not been successful at resisting the wrath of nature when it strikes, from strong hurricanes, to powerful tsunamis, to volcanic eruptions, or devastating earthquakes. The 2004 Indian Ocean earthquake and tsunami claimed close to 280,000 lives alone. The 2011 Tohoku earthquake and tsunami in Japan claimed close to 16,000

lives. The 2017 hurricane in Puerto Rico claimed close to 3,000 lives. These are devastating and tragic events, with many lives lost. There are many other equally painful and calamitous disasters. Continuing on the current trend, with the rising CO₂ emission levels, rising greenhouse effect, and rising global temperatures, natural disasters of this magnitude are likely to become stronger and perhaps even more frequent. Late Pope John Paul II once stated, "The Earth will not continue to offer its harvest, except with faithful stewardship. We cannot say we love the land and then take steps to destroy it for use by future generations." But it appears that we have been moving in that direction.

We are leaving to our future generations the arduous task of fighting disasters that we have failed miserably at tackling.

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