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The Challenge of Sustainability: Turning Science into Art

Satish Chandra Mishra [1]

[1] Chairman, Strategic Asia Institute Bali; former Head of the United Nations Facility for Indonesian Recovery (UNSFIR), former Chairman of Strategic Asia.
Email: satishmishrabali@gmail.com

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ABSTRACT

This paper addresses the critical question of how to turn climate concern into climate action as we move forward towards the 1.5-degree Celsius global warming target adopted by COP 26 in 2021 and reaffirmed by COP 27 in 2022. It argues that it has taken scientists more than a Century to accept, first: that climate change is real and second: that it is anthropogenic. Scientists still continue to debate the precise effects of greenhouse gases on weather, fires, floods and food security. Climate optimists continue to rely on the search for new miracle technologies, such as fusion energy or carbon capture. This is all very good. But this is the easy part. What is more critical is to motivate people towards collective action in pursuit of a zero-emission target. This requires harnessing the art of fostering humanist, economically just, collective action rooted in local commitment and transparency. The real challenge of sustainability today is to turn science into art. We do not have over a century and half, as the scientists did to practice this art. Repeatedly, pointing to climate change apocalypse will not be enough.

Keywords: Sustainability, sustainability science, climate change, conference of the parties.

Introduction

The argument

The science of sustainability is all the rage these days. With endless scholarly reports, field studies, projections, simulations, integrated modelling, learned lectures and podcasts the average person in the street would be forgiven for thinking that the matter of climate change was all but settled. If things did not proceed as planned, if the promised move towards particular targets for carbon emissions, especially the substitution of fossil fuels by renewables such as solar, wind or hydro energy were not met; the fault lay with two main culprits: global energy companies that continue to use their prodigious financial and lobbying power to slow down such substitution, or the consumers who failed to consume less and adopt carbon emission lowering technologies for their everyday needs. Human survival would thus depend on the reduction of corporate greed on the one hand and our general willingness to change our everyday behavior and life choices on the other. Put this way, it is both a familiar as well as a superficial argument; intended to lay the blame rather than find a way forward.

This is too simple a tale for a complex, fast moving and by all accounts apocalyptic end to human existence as we know it. It plays into the hands of large corporations and techno giants, and their search for miracle new technologies to reign in greenhouse gases on the one hand and idealist civil society organisations mobilizing international crowds of millions of people, young and old, advocating the return to a simpler age of fertilizer free organic foods, well-engineered clothes and pedal power. The advent of a new generation of post millennials, (who might well have to spend more than half their future lives in an unstable world of droughts, typhoons, forest fires, endless migrations, social conflict and civil or regional wars) adds an ethical dimension to climate change targets. This young generation of climate change activists refuses to be held to ransom by the profligacy of previous generations. It has brought to the surface a global, "moral" force that wants to be both part of the climate change debate as well as an advocate for its remedies.

Such polarization of interests and opinions is hardly conducive to finding ways to arrive at the 1.5degree Celsius global warming target, established by the Paris Accord, and reiterated by the

just concluded COP 27, in November 2022 in Sharm al Shaikh in Egypt. Such an international coalition of the willing must also arrive at a unity of interest. To do that we must take a relatively objective, more achievable, "real politic" view of the climate chance story. This is the central objective of this paper.

The present paper argues that the discussions on climate change have been dominated by the science of climate change and possible technologies to reduce carbon emissions but that it is time to move beyond the science to the art of managing its possible solutions. It argues that in rush to find technical solutions to pressing energy, food, transportation and manufacturing problems, and the inevitable rush of excitement that this generates in both the corporate, government and research organisations around the world, one can easily lose track of the fact that such technical solutions often take generations to be socially internalized and supported. Good science can only solve only a part of the problem of climate change mitigation and adaptation. The art of social persuasion: turning good ideas into daily practice, easing fears of economic injustice and supporting familiar localized solutions to global warming challenges is perhaps not as much if not even more urgent to prevent climate change related catastrophe.

Seen through a historical lens, science provides the starting point and not the finishing line for the climate change story. The path of scientific innovation is riddled with discoveries ahead of their time, which came to fruition and socially accepted, often decades or even centuries after their original theorists, inventors and proponents had ended their lives. Others, as the story of Giordano Bruno and Galileo Galilei amply illustrates, were felled not by scientific experiments but by the power of belief and prevailing superstition.

The debates surrounding climate change today are no less riddled with assertion, denial, belief, misinformation and propaganda. Turning the best of science into human action, when early 21Century humanity is itself hopelessly fragmented into communities, identity politics, economic inequality and a sense of injustice, unequal distribution of both technologies and resources. To bring scientific discovery int daily lives of ordinary citizens requires something in which scientists have been rarely adept: the art of community participation and social persuasion. That requires

transforming the science of physics and engineering into social "Art"; from a focus on Science into a concern for Society.

The art of social transformation requires two key elements. First, an effective identification of the 'winners and losers' in any given social context. Second, a deep understanding not only how human institutions in different national, political, cultural and religious setting actually function; but what it would take to actually move them (Diamond 2005). Science provides the building blocks, though often taking decades or even longer to construct them, prone to internal dissention and false starts, at times lost in the fog of thousands of local experiments and case studies, micro data, statistical trend fitting and individual hunches. This is indeed and important first step. *But first step it is*. To move from science to social action requires a different skill set and many different voices.

This paper is organized using the following building blocks. First, we track the time line of climate change science to understand how where we have arrived over one and half centuries since the first scientists stumbled upon the idea of carbon emission and rising temperatures on earth.

Second, this long sweep of history has brought us to a point where there is now a general agreement that that human activity *has*, despite there being a push-back from a fringe element of climate change deniers, been the major trigger for an unprecedented rise in global temperatures in the 20th Century. At the same time research surrounding the precise impact of global warming on erratic weather, fires, earthquakes and on speed of glacial meltdown is still being modelled, evaluated and the subject of ongoing controversy.

Third, science today has more and more focused on how to achieve the 1.5 Degree Celsius: global warming target adopted at the Paris Convention in 2021. What is interesting here is the fact that it has laid open the exciting possibilities of carbon capture, substitution of fossil fuels by renewable energy including nuclear, reorganization of manufacturing especially steel and cement and transportation and shelter to drastically reduce the carbon foot print, perhaps over time to zero, and the rethinking of food production and diets from animal to plant sources. At the same time, it has brought economics and the behavior of prices and markets into climate change action.

The major innovation here however, is the amalgamation of science and economics on the one hand and an active role played by regulation and government, together with private capital on the other. Given the speed of current global warming, the short time left to reach zero carbon emissions by 2050, there is added emphasis on research and development investment with many high-risk high pay-off options on the table (Gates, 2021)

As if this was not complicated enough, section 4 of the paper discussed how both good science and good economics are only necessary but not sufficient conditions for the grand global project of climate change reversal to succeed. The segment of this paper directs us to the highly complex emotions and negotiations that lie at the core of any united global effort at climate change containment or at some future date even reversal. This is fundamentally the realm of economic distribution, social justice and entitlement (Yergin, 2021; Sachs, 2008; Hulme, 2009; Khanna, 2021; Helm and Hepburn, 2011; UNEP, 2021): the argument that since it is the developed industrial countries of the West that have been the largest carbon emitters, they must be the one to bear the highest cost burden of cleaning up the environment. This cost is not merely in terms of compensating the losers; those whose employment, health and place of habitation is diminished by the rapid rise in greenhouse gases. It is also in terms of foregone consumption at levels that they are hope for and are entitled to enjoy in comparison to the developed countries. This argument has increasing heft especially in those countries, e.g. in emerging Asia that have witnessed exceptional rates of urbanization and the emergence of a massive middle class.

Section 5, warns us that even if all the scientific problems on the drawing board today are amenable to solution over the coming three decades; the story of climate change is far from over. Two issues are relevant here. There is the assumption that if only humanity recognized the 'tipping point' of green house gas levels and the ensuing apocalypse it would trigger some united, coordinated response. The romantics and optimists among us would argue that the sharper the evidence, the more individual steps towards lowering carbon emission are seen to work that would galvanize the interest and imagination of the young activists of the day and create an irreversible wave of support for the zero-emission target reiterated in COP26 earlier this month.

History reminds us that this might be far too optimistic (Macaskill, 2022). A definable trait of human beings over time has been not only to aspire to new technologies and ever more difficult ventures but also the willingness to die for causes that felt were unjust, that robbed them of their fair entitlement and their fair shot at the good life. Heroes and martyrs are often remembered with affection and not as fools who needlessly sacrificed themselves for hopeless causes. Whether it was Leonidas I at the battle of Thermopylae, the Rajput princes of India who committed ritual suicide with their entire families when faced with superior invading families, the Kamikaze warriors of World War II Japan, the suicide bombers of today or the ritual suicides of particular cults in the late 20th Century; not to mention the millions who risked their lives for anti-colonial freedom and civil rights struggles on the mid 20th century: they illustrate a unique feature of the human condition. That is the willingness to die to defend their identity, way of life, religious beliefs and philosophical outlook. In that sense simply *realizing t*hat the world is headed for climate disaster is not enough to mobilise people into action unless the sharing of both burdens and rewards from so doing are considered both equitable and predictable.

Communities threatened with extinction do not *always* adopt and transform. Neither evidence of the threat nor the immediacy of its occurrence is enough *ipso facto* to generate a counter response. The battle for hearts and minds is as often lost as won.

That brings us back to the challenge of sustainability. It has taken over a century and more for the science to convince most of us that climate change is real, it is immediate and catastrophic. Science continues as it must, dotting the 'i's and crossing the 't's; making its finding both more comprehensive as well as deeper. This is a real challenge. But the greater challenge lies before us in the next three decades: finding ways to disaggregate the global target into regional, community level and institutional action programs , to identify pathfinders and leaders who can lead the movement for change towards a zero emission society and to do so without extinguishing the aspirations and energy that has come to define our global coming of age over the last half century.

To do that requires the science of theory, measurement and discovery of the physical transform itself into the art of social transformation. As the history of path breaking inventions across the

ages shows, success cannot be taken for granted. Yet, the future challenges are to be found as much if not more in the art as in the science of climate change.

Building Blocks

The science of climate change: the long, uncertain journey

Scientists preoccupied with the day to day tasks of estimating the impact of rising global temperatures, of building climate models to track the linkages between melting polar ice and the rise of sea levels or of understanding the interaction across different green-house gases, including water vapour, in triggering extreme weather events, can be forgiven for paying less attention to the history of climate science. Faced with the 1.5degree Celsius global warming target, it is easy to attend to immediate challenges and push history into the background. But history matters, especially when it helps us appreciate the challenges of building a universal consensus on both climate impact as well as climate action in the years to come.

By the time that awareness of the possible dangers of climate change on the global environment and economy had reached US president Lyndon Johnson, in the form of a brief by the Presidential Science Advisory Committee in 1965, almost 150 years had passed since Joseph Fourrier discovered that the atmosphere kept the earth warm. BY 1860 John Tyndall was able to make the link between rising temperatures and emission of CO2 in the atmosphere. Tyndall was able to observe that CO2 was transparent to visible sunlight but absorbed infrared radiation. The result was that it led sunlight in but impeded heat from getting out.

In the early 20th century, Svante Arrhenius, a Swedish scientist, concluded that low CO2 levels might have caused the Ice Ages and wondered if the industrial use of coal might warm the planet. Not a bad turn of events given the uncomfortable cold weather in many parts of Europe at the time. Burning of fossil fuels could thus be the trigger for kinder, and healthier weather in the crowded cities of London, Paris, Berlin and others.

With a global emission rate of 2 billion tons of CO2 in the year 1900, the dangers lurking behind the continued use of fossil fuels were largely ignored. By the middle of the 20th Century, anti-colonial freedom movements came to the fore. Newly independent countries such as China, India, Indonesia and many others across Asia and Africa, aspired to build their own industrial economies just as the West had done over the previous two centuries. The rapid, though brutal industrialization pushed forward by Stalin in the USSR, and later by Mao-tse-tung in Communist China, the formulation of five-year industrial plans in India all provided inspiration to a host of countries in this post-colonial era. Speedy, large scale industrialization triggered by a "big push" of massive lumpy investment in heavy industries of steel, chemicals and railways was the model economic programme. The spirit of the age was amply illustrated in Lenin's slogan; "Communism means soviets plus the electrification of the whole country" in the early years of the Bolshevik Revolution. Later by 1930, this was modified by Stalin by adding: 'Let us transform the USSR through socialist industrialization"

In the fever to right the wrongs of the past, to 'catch up with advanced developed countries of the world, no sacrifice seemed to be too great. Stalin's Gulags, Chinese famines, massive reorganization of land ownership all were seen to be a means to an end: a sacrifice of lives in the present to secure a more just and prosperous future. Ideology and rhetoric ruled the day.

Moreover, the benefits of fossil fuel powered industrialization were clear for everyone to see. The Economist (2019), summarized the situation well:

" The explosion of fossil fuel use is inseparable from everything else which made the 20th century unique in human history. As well as providing unprecedented access to energy for manufacturing, heating, and transport, fossil fuels also made almost all the earth's surface more accessible. The nitrogen-based explosives and fertilisers which fossil fuels made cheap and plentiful transformed mining, warfare and farming. Oil refineries poured forth the raw materials for plastics. The forest met the chainsaw"

All of the above goes to show how the use of fossil fuels as the key driver of faster economic growth, across both the developed as well as the developing world, was deeply entrenched in the

post-colonial ideology, psychology and politics of the of the day. It was a belief so strongly held, something so obvious and so convincing that only the naïve or the mischievous would care to dispute it .

In addition, the Cold War with its ominous warning of a global thermo-nuclear war seemed much more of an immediate threat, than the rise in carbon emissions and global warming, over the coming few decades, might have posed. The alleviation of hunger, the employment of the young, the innovations of science that would launch humans in to space and the rush to raise industrial productivity centred around major cities seemed to be more immediate and rewarding activities. Science provided early warnings about green-house gases emissions and the subsequent warming of the Earth. Both social awareness as well a political opinion continued to put this on the back burner: something to attend to in the distant future and if science could not find cheap alternative substitutes for fossil fuels.

The sharp increase in global population was a worry. The demographers pointed to the fact that in no previous Century before the twentieth had the human population doubled. In the 20th Century it "doubled almost twice". Population growth was a concern and many international organisations and country population control programmes were established to manage the growth of population, as witnessed by China's one child policy. However, the driving factor behind this was a desire to increase *per capita* GDP growth and consumption; not to reduce consumption and lower global CO2 emissions and temperatures.

That Lyndon Johnson, by all accounts, never read the 1965 climate change brief prepared by his scientists, while unconfirmed, is not surprising. Moreover, some of the remedies to raise Earth's reflectivity of sunlight, such as billion ping-pong balls covering parts of the ocean's surface did not augur well when placed against the other threats to human kind: Communist wars in Asia, nuclear war, massive hunger and famines.

There seemed to have also been a prevailing technological optimism supported by historical experience. Malthus had predicted exponential famines. Instead, with the help of new seeds and chemical fertilizers and refrigeration of food into public distribution centres, the explosion of

human population did not result in widespread famines. The famines that did take place such as those in Bengal in the 1940s and in China in the 1950/60s were not due to the absence of technology and food. They were the result of distribution failures that led to rapid shifts in 'entitlements' to food, a point made with some elegance by Sen (----).

Thus, it took over 133 years since the publication of Fourier's paper on Green House Gases and their impact on global temperature and the scientific brief to Lyndon Johnson in 1965. The brief was ignored for reasons cited above. The next milestone in the climate change story was the publication of the Brundland Report in 1987; another 22 years since the Lyndon Johnson memo. Brundland was significant. First, because of the extensive consultative process it established. Second it was the output of the U.N.'s World Commission on Environment and Development. The Earth Summit at Rio De Janeiro in 1992 created the United Nations Framework Convention on Climate Change (UNFCC), which laid the foundations for a collective global attention to issues of climate change.

It has taken us another 35 years and the reports of many famous commissions, Reports and Global conferences and agreements to get us to the Paris Accord and 2022 COP 26. The major achievement of CCOP 26 has been to affirm the 1.5degree Celsius global warming target for 2050. Another has been the creation of a fund to help poor countries to address the costs of climate change on the most vulnerable.

In the meanwhile, during the 168 years that it has taken us to get from Fourier to COP 27, the earth has not stood still. In 1965 the CO2 emissions were 320 ppm (particles per million). This was just 40 ppm higher than two centuries earlier, when Fourier was engaged in his climate research. The next 40ppm increase took just three decades. The CO2 level is now 408 ppm and rising by 2ppm per year. As the Economist (2019) concludes:

" In terms of CO2's greenhouse gas effect, today's world is already as far as that of the 18th Century as the 18th Century was from the Ice-Age".

The conclusion from the above narrative is clear. Scientific discovery alone is not enough for a change of either the public mind or that of public policy. History matters precisely because it brings other priorities of day into play. Much has been learned from Scientific research since Fourier. This has helped provide the building blocks for establishing that global warming is in essence *anthropogenic* and not the consequence of random variations of temperature and atmosphere over long periods of time. Yet, even such realization came late in the day. The 1992 Rio Summit, where the UNFCC agreement was signed, agreed to "*prevent dangerous anthropogenic interference* with the climate system."

And, if COP27 is taken as a collective commitment we have just under 28 years to do so.

Climate science today: what seems settled and what is left uncertain?

Commonly accepted precepts

The growing research effort since the Rio Summit and the recognition that climate change is for real has led to many advances in the science of climate change. There is much that is proven. There is also much that is uncertain and requires continuing work.

Two features of climate change are now subject to widespread professional acceptance. The first is the phenomenon of climate change itself and the second that human activity is the most critical driver of higher CO2 emissions into the atmosphere.

The New York Times notes that 90% of scientists, from NASA to the WMO (World Meteorological Organisation) now agree that Climate Change is happening.

" That's an outstanding level of consensus given the contrarian, competitive nature of the scientific enterprise, where questions of what killed the dinosaurs remain bitterly contested" (NYT, 2021, p.2).

Moreover, by 1991, two thirds of the Earth and atmospheric scientists surveyed for an early consensus study said that they accepted the idea of anthropogenic global warming. Four years later, the Intergovernmental Panel on Climate Change (IPPC, 1995), wrote;

"The balance of evidence suggests that there is discernible human influence on climate change.". Indeed, 97% of publishing climate scientists agree on the existence and cause of climate change. This is a major step forward and far from the skepticism of the mid 1960s.

The three graphs below illustrate some of the building blocks of the argument in favour of the existence of anthropogenically driven climate change.

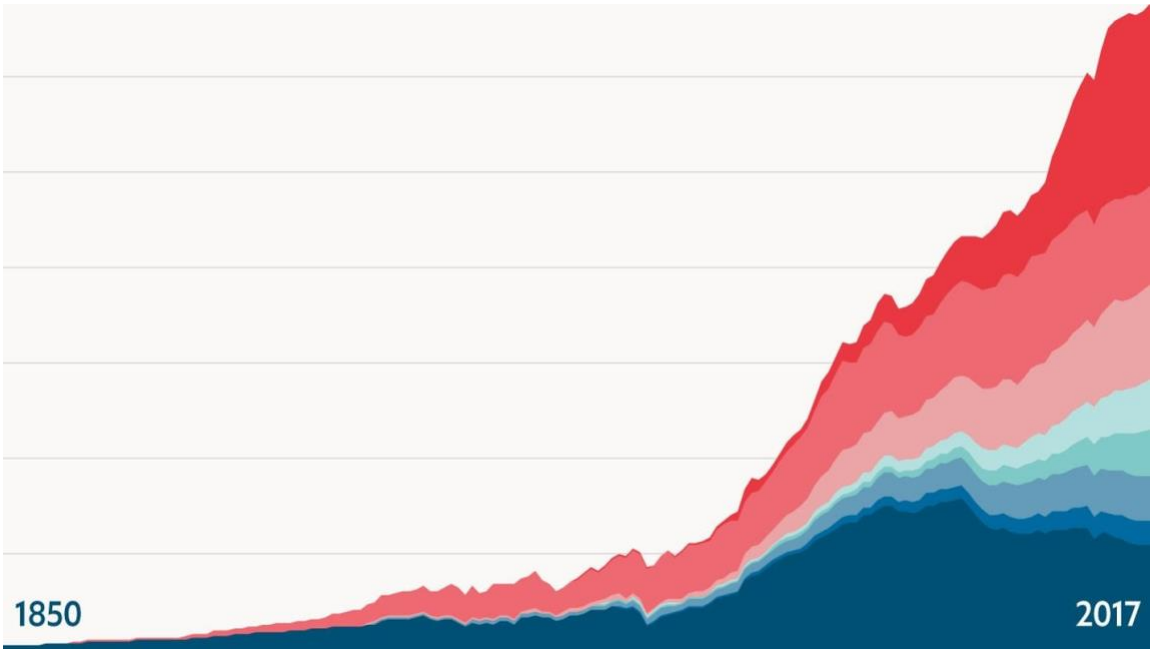

Figure 1: Global average temperatures compared with the middle of the 20th Century (The Economist, 2019).

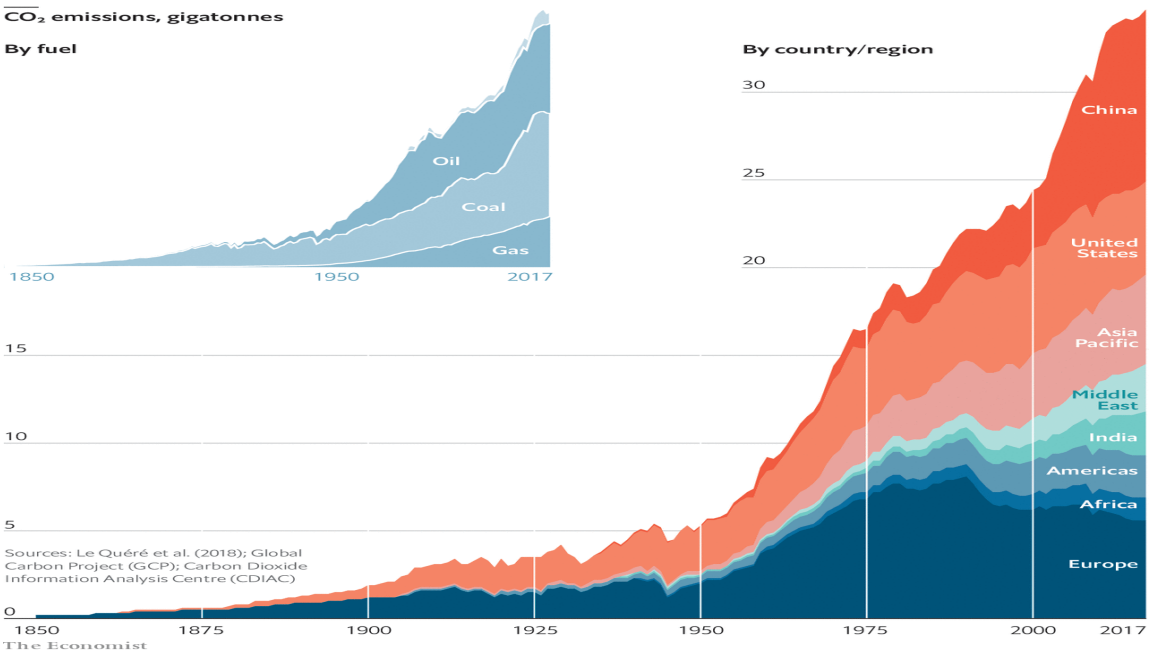

Figure 2: Carbon dioxide emitted worldwide, 1850-2017 (The Economist, 2019).

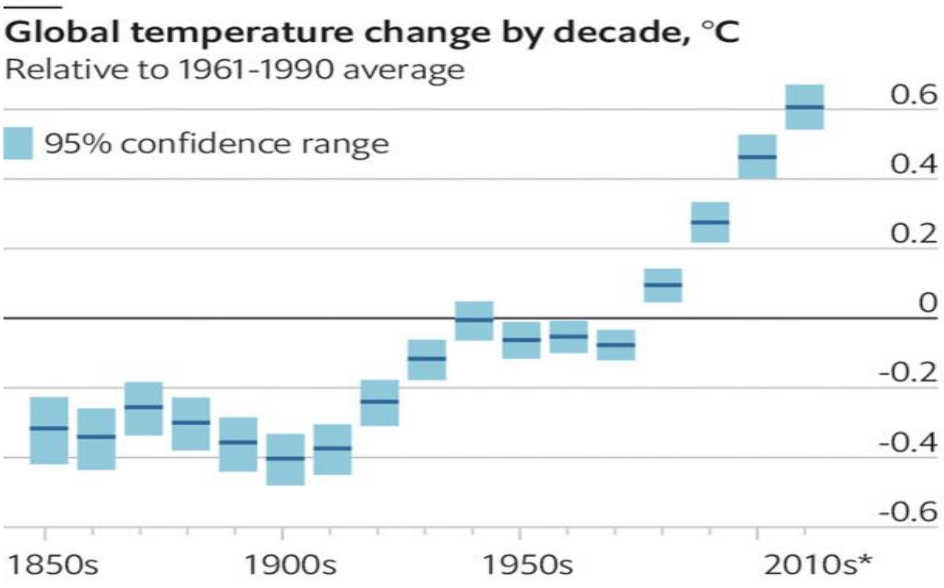

Figure 3: Natural variation cannot produce decadal warming on this scale (The Economist, 2019).

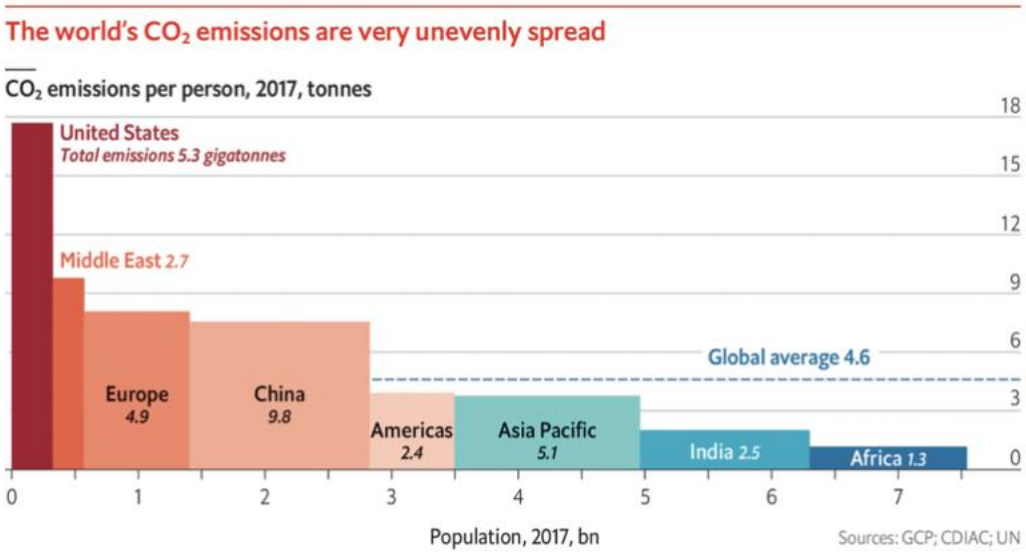

Figure 4: A small shift in the average can hide dramatic changes at the extremes (The Economist, 2019).

The two interlinked questions of the existence and prime cause of climate change have generated a wide range of evidence and argument. In the case of the first, novel approaches such to extend the climate record using tree rings, ice cores, corals and sediments have been used to unearth concealed climate information. The result of these investigations show that global temperature change trends were generally flat for centuries and then turn sharply upward in the last one and half centuries. The overall conclusion on many of such studies is that planet has not been this hot in at least 1000 years and probably longer.

Climate skeptics and climate change deniers continue to voice doubt on such findings despite the volume and robustness of such evidence. A common line of argument is that climate change is part of the random climate variations on earth. There is nothing special about the climate change cycle of today. In addition, if such change is merely a cyclical or random variation one does not need to lay the blame on humans and the burning of industrial scale fossil fuels.

It is true that changes in solar energy, ocean circulation, volcanic activity, and the level of Green House Gases in the atmosphere all tend to vary naturally. Each of the above seem to have been important at some time in the past 300 years. Various ice-ages are evidence in its favour. But the natural, non-human, changes in climate go back much further than that. Thus, as the New York Times survey notes:

" 56 million years ago, a giant burst of Green House Gases, form volcanic activity or vast deposits of methane or both abruptly warmed the planet by at least 9 degrees Fahrenheit, scrambling the climate and choking the oceans and triggering mass extinctions."

"Bubbles of ancient air trapped in ice show that before about 1750, the concentration of CO2 in the atmosphere as roughly 280 parts per million. CO2 levels then accelerated as cars and electricity became part of modern life, recently topping 420 ppm. The concentration of methane, the second most important green-house gas, has more than doubled. We are emitting carbon much faster than it was released 56 million years ago." (New York Times, 2021, p. 4)."

Despite the persistence of climate deniers today, the debate over the existence of climate change and humans as its principal drivers over the last 150 years is all but settled. But this is not the end of the climate change science story. Uncertainties continue to exist and are part of a vigorous political and business debate today.

Climate science: an ever-widening research agenda

Bringing humans into climate impact models

Although the broad debate on the existence and causes of climate change are all but settled, the discussion of its precise impact on unusually severe weather events: hurricanes, floods, forest fires, melting glaciers and extreme temperature variations on the one hand and their respective impact on human activity and existence on the other continue to be the subject of both considerable debate as well as ongoing research. Interest surrounding the consequence of climate change on humans (and biodiversity), have gathered pace if only because the acceptance of the 1.5degree Celsius

global warming target by 2050 has injected urgency and some common purpose in the research surrounding climate change in the 21st Century.

An important reason for the continued uncertainty on the impact of climate change on humans, animals and bio-diversity emanates from the sheer widening of the research agenda. We have moved in rapid succession from proving that climate change is real and caused by humans to a much more complex analytical question: how adverse climate is impacting on the economy, food, housing and health of different sets of humans across the globe? Modelling the impact of climate change on today's human activity requires the integration of physical and chemical variables and socio-economic ones at the very least. This dramatically raises the complexity of the modelling exercise and the degree of statistical confidence with which the results can be interpreted.

Human and market responses to climate change

As in the case of econometric models of particular markets or sectors, the results provided by climate change impact models also need to take into account human responses to *both real as well as anticipated* climate change threats. Superimposed on these mitigation and adaptation strategies of households and communities are also the behavior of markets and prices in response to climate disasters and threats. Thus McKinsey (2020), rightly points to the added complexity of modelling climate change risks and impacts as a result of taking into account both direct and indirect effects of climate change as well as the fact that the direct physical impact of climate change requires an understanding of a particular geographical regional or locality. The fact that climate impacts also take place against a continually moving and non-stationary climate shifts makes the modelling and the projections only that much more difficult.

Inter-dependence, non-linearity and systemic dimensions of climate change impact

There are other analytical issues also. Projections depend crucially on trend fitting on the assumption that once isolated shocks or outliers are taken out, the past would be a good guide to the future. This works well in 'normal' situations where the background of other variables is assumed to be relatively constant, (other things being equal assumption). But in situations of

'historical discontinuity' that climate change episodes trigger, climate change impacts are *'non-linear'.*

Due to knock-on effects of climate change events, the overall impact of climate change is also likely to be '*systemic'*. Simply put this means that any single event or set of events can have a range of impacts across regions and sectors, "through interconnected socio-economic or financial systems".

Nothing ever stands still in climate change impact and adaptation

The shift of attention from proving if climate change is real and that humans are responsible for the dramatic rise in green-house gases to understanding its overall as well as geographical, sectoral, economic, financial and governance implications for particular climate related changes requires vast amounts of new data. This requires *inter alia* recording the patterns of human climate change response, change in financial and price expectations and the speed and scale of community and government responses. Problems of data availability, the appropriate trend fitting tool that should be used, specification bias of particular equations, as well as the multicollinearity across different independent variables within a given equation, all mean a dramatic increase in the scope and complexity of climate change impact modelling. The existence of climate change is accepted widely. So is its anthropogenic nature. When we come to modelling its physical impact and its effect on human populations the picture is significantly muddier. That in turn allows interested business and political lobbies to inject their own biases and interests in the climate change impact discourse.

The 1.5-degree Celsius Global Warming Target: Prospects and Strategies

Climate optimists such as Al Gore (Gore 2006, 2013) tend to view the 1.5-degree Celsius Global warming target reaffirmed in the COP 27 in November 2022 with some relief. At least global warming and carbon emissions are the subject of global attention and that in principle at least countries and regions such as the European Union are setting reduction in carbon emission targets for the period up to 2050. Despite the technical difficulties of disaggregating the global target into

country, provincial, geographical regional, and industrial targets given the urgency of the situation it is no doubt a welcome reaffirmation of the concern the whole world feels about the impending physical catastrophe of global warming and the clicking clock that reminds us of it.

But here again there is as much dissention as unity in different approaches over what to do and where to start? The Economist of 5th November, 2022 opens with a front cover on climate change. It simply says "Say goodbye to 1.5 Degree C", hardly a cheering message. It is not the only one. UNEP's most recent paper (UNEP 2021) is titled "Too Slow; Too Late". There is clearly considerable climate pessimism on the horizon.

That is understandable if one focuses too narrowly on the 1.5-degree Celsius target. It is important just because of the Paris Agreement that adopted it and because COP 27 this year reaffirmed it. According to one view, neither the 1.5-degree Celsius target or 2.0 Degree Celsius for that matter has little importance beyond such global agreements if only because neither establishes a threshold beyond which the world becomes uninhabitable or enters into a tipping point of no return.

Climate change mitigation: innovation and techno-optimism

To survive the disastrous effects and the ensuing human uncertainties of earth temperatures rising considerably beyond the global target, there are of course two interconnected strategies: to mitigate the rise in carbon emissions on the one hand and to adapt to its impact on the other. The former, involves reducing carbon emissions into atmosphere by new green technologies that lower the carbon footprint. The substitution of fossil fuels by renewable energy sources, replacing petrol powered vehicles with electric ones, using green fuels for aircrafts is one obvious choice. There are other possibilities too. Moving from meat to plant-based foods will lower methane emissions. New technologies in food production can lower carbon footprint of feeding a growing human population. Increasing investment in carbon reducing and capture technologies can not only serve to lower carbon emissions but also recapture carbon already released in the atmosphere. As Gates and others argue, a massive increase in new but financially more risky technologies, pushed forward by large global businesses, (as well as global philanthropy), serve to raise the global

Research and Development budget needed to develop such new Green House Gas reduction technologies. However, there is clearly a race against time because 2050 is not far away.

There is an added complication. The variables that go into any equation of overall carbon emissions contain some that are difficult to lower: global population levels for example or per capita consumption of carbon intensive goods (such as televisions and refrigerators and others), identified as the hallmark of modern living in developing countries is likely to witness downturn. This is especially so due to the sharp increase in the size of middle-income groups in fast growing economies of developing Asia and elsewhere.

Raising much higher levels of investment finance for new and less risk averse carbon mitigation technologies is an important response to the lowering of climate risk in the future. But innovation and production of new goods and materials : for instance, in the manufacturing and construction industries through the use of green cement and others, is only the first step. For private businesses to participate actively in the search and production of new materials and processes, governments and regulators need to seed new markets for these products if only to help lower the risks behind such investment.

Of course, mitigation through innovation is an attractive idea especially if the new technology is safe and can be rapidly disseminated at a cost lower than existing technologies. The notion of lowering the 'green premium' on new lower carbon emission technologies by raising the scale and lowering the cost difference between fossil fuels, for example, and renewable fuels such as nuclear, can be a rapid response to global warming. There is a whole menu of green technologies on the global research and development menu.

Technological optimists such as Gates (Gates 2021), also point to the fact that at the global level, conservations on climate change get mired into issues of history and economic distribution/inequality for which there is no convincing political answer. Developing countries, including middle income ones with large populations and rising carbon emissions, such as China and India, both with little domestic reserves of coal or natural gas, justifiably argue that the current predicament on climate change is not one of their making. The process of global warming was

begun by the industrialized countries of the West and they should pay a dominant share of the investment required to clean up the environment. This is not only a matter of historical right or wrong, but given the rise of populism and the emergence of nationalist governments in parts of Europe and North America, it is unlikely to form any lasting basis for an internationally accepted strategy for climate change abatement in the next three decades or more.

In such a context, as Gates and others argue, it is better to focus on what is possible with investment, innovation and pricing of carbon reducing products. This path to climate change mitigation also provides hope. A sudden discovery, such as fusion energy or high capacity batteries that can store renewal energy, followed by rapid elimination of the green premium can be the magic wand that can curtail the perils of climate change. Looks good. Yet behind the scenes, the problem of reaching some collective, binding agreement across big business, government, and local communities across a range of countries beginning with the USA is only marginally less feasible than that across rich and poorer countries seeking a righting of past wrongs.

Mitigation takes time and big bucks: is adaptation the answer?

The sudden and unanticipated discovery of almost free, non-greenhouse gas emitting energy source is what might be called a climate miracle. When the news on global warming trends is not encouraging, the realistic option is not to wait for miracles but to do what one can to manage and weather the impact of whatever global warming might throw in our direction. Adapting to climate and accompanying weather changes is the prudent strategy. It is also the only immediate choice.

Adaptation to climate change is learning to cope with its adverse effects. Adaptation can take physical forms such a relocating homes and infrastructure, building barriers to prevent storm surges, building storage tanks to prevent flood damage or irrigation channels to ensure water for plants in hot weather. It can also take the form of financial savings, insurance against fire and flood damage among others.

Much attention has been paid to climate adaptation over the last two decades if only because new technologies to mitigate the effect of greenhouse gas emissions were still in their infancy. Another

critical reason was the fact that the impact of climate change tends to vary geographically, from industry to industry; such as food production or the establishment of coastal settlements among many others. As was discussed above estimating the climate impact human societies and economy is riddled with data and estimation pitfalls especially when the response to changing climate by humans is taken into account. Predicting the impact and the possible coping mechanisms is at best making an informed guess and at worst relying on one's core belief and prejudices.

In any event, the finding from thousands of analytical case studies across the globe that there is a marked discrepancy across income groups in their ability to adapt to climate change and the extreme weather events that it triggers. In general, the burden of adaptation falls disproportionately on poor households and regions. Lack of knowledge about climate change impact across a number of years in the future, absence of financial security through savings or insurance, weak governance structures that can assist in building public goods in support of the community. In richer societies much adaptation can be done through routine maintenance of key infrastructure such as water storage systems, flood control and land use. Governments also respond to demand variations in energy or water by regulating prices and/or expanding supply.

The result of this marked disparity in the impact of extreme temperature variations, floods and droughts and hurricanes is that poor communities suffer more than others. Moreover, they are the most vulnerable and least able to adapt to or cope with climate change impact. It is therefore not surprising that developing countries have been at the forefront of demanding financial and technical assistance in climate mitigation as a precondition for their support to a global carbon reduction compact.

It was this inequality in the ability of countries to adapt to climate change that trigged the United Nation's Adaptation Framework at Cancun in 2010. Under it, governments were to develop a National Adaptation Plan, unfortunately abbreviated as NAP that was:

"To identify which people, infrastructure and industries are most vulnerable and work out ways for governments and foreign donors to help them".

The intention was good. The reality was that out of 4/5 of developing countries that began the formulation of the NAP, only 1/3 managed to complete it. Most of them, have not finished working out what to do, let alone put the resultant plan to action. Yet they were a good start since they allowed an estimation of the financial implications of the NAPs. UNEP estimated that adaptation spending required in developing countries would be around $ 140 to $300 billion a year by 2030.

Subtracting the climate adaptation expenditure of developed countries, only 10-20% of what was needed was spent on the developing countries. If adaptation was supposed to provide a breathing space to affected communities while climate mitigating technologies took hold, it was from the start mired in lack of organization, effective budgeting, determined action and poor aid disbursement.

It is ironical that the estimated necessary expenditure on climate adaptation is rising as more NAPs are added to the list. On the other hand ,the resources committed are woefully short of requirements. As the Climate Policy Initiative (CPI) estimated, that by 2020 only $46 billion had been invested globally, across developed and developing countries, on climate adaptation.

The financial numbers tell only a small part of the story. Inadequate adaptation to climate change means the loss of livelihood and homes, frequent health shocks and distress sales, migration to more secure locations and the breakdown of social support mechanisms that ensured survival in times of acute need.

The Challenge of Sustainability Today: Moving from Science of Numbers to the Art of Persuasion

The incredible amount of scientific experimentation and climate modelling over the last hundred years and more have provided enough proof that climate change is real, that it is anthropogenic, and that if global carbon emissions are not reduced to zero by 2050 the earth faces an almost irreversible deterioration of the conditions needed to sustain animal and human life as we know it. Awareness of the urgency of climate change action is now global. That awareness has been spread by numerous international agencies and conventions, by the political activism of the very young

and by marches, roadblocks, demonstrations that have brought together people from as far away places as Alaska and Bangladesh, Denmark and the Marshall Islands, the Sahel to Brazil. This alone should have laid the solid foundations for climate action: an unshakeable determination to halt global warming and ensure that the world can meet the 1.5degree Celsius target by 2050.

Yet as late as November 2022, the United Nations Environment Program (UNEP) reported that policies currently in place will result in global warming of 2.8degrees Celsius over the 21st century. Its report on climate adaptation carries a pessimist title: "too late; too slow". Neither provide much room for optimism in the coming decades. This is strange. On the one hand the world is increasing aware of the dangers of global warming, thanks partly to new scientific discovery, data processing and models. On the other, there is lamentable progress in climate action. Science points to the problem. Yet it has failed to trigger commensurate climate action to avert what many see as the most existential threat of the day. So, what has gone wrong?

As mentioned in the opening paragraphs of this paper, the call to climate action through the greenhouse gas emissions in the atmosphere relies on a simple assumption that a climate catastrophe and possible extinction of many kinds of life, shrinking bio-diversity, food shortages and mass migration would be sufficient to impel humankind into united action towards zero carbon emissions by 2050. Humans however, have a long history of wars of extinction based on identity politics, religious dogma, economic interest and belief in racial superiority.

In addition, threats of extinction have failed to unite tribes and particular ethnic groups into a war against a common enemy. Indian tribes of the American West remained divided by history and old disputes among themselves to stand united against the advancing armies and white settlers in the mid-19th Century. A handful of Spanish conquistadors were able to subdue and in a short period of time murder an entire Empire of the Incas. Detailing the possibility of future extinction can inspire people to corrective action, but it can just as easily open doors to new conflict, such as that surrounding mass migration from degraded or flooded land, or intolerable temperatures or the absence of government financial or infrastructure support.

The idea of impending disaster as a trigger of 'collective action' is far too simplistic an approach to political decision-making processes. Wars provide great opportunities not only for patriotic fervor but also of unimaginable profit. The availability of new technologies to boost food production do not only promise the end of hunger but also the eviction of traditional farmers to swell the ranks of the poor in nearby cities; carrying with them age old grievances and longing for revenge.

Collective action at the very least requires collective interest and an equality in the sharing of both costs and benefits. This has been missing in the climate debate where a few large polluters transfer the costs of doing so to the overwhelming majority of other, less developed nations.

What is interesting about *inequality and the sense of unfairness or injustice that it engenders*, is that it not only spans the inequalities and discriminations of the present but the bitterness caused by injustices of the past. The desire to match per capita consumption of developing countries, even large and high growth ones, with that of the industrialized West, is itself rooted in centuries of resentment of colonial oppression, monopoly businesses, military suppression and national humiliation. Against such deeply nurtured grievance, the coming climate disaster of the coming two decades and more merely serve to underscore the point that the richer countries that have already stunted development in former colonies for a century or more, now make financial and technological promises that they do not intend to honour. Indeed, against such a backdrop of pent-up resentment, scientific proof about the immediacy of climate disaster might trigger denial, distrust and global disagreement.

A subtler approach might be to work out a range of targets (1.5; 2.0; 2.5 Degrees Celsius and so on and map what that might mean for specific countries or regions) rather than adopting too rigid a global temperature target. In addition, targets might accompany a global food or medical emergency security mechanisms: an assurance that lives in the developing countries matter as much as the rest of the world. The advance in food technologies has produced remarkable increases in food, stripping the enormous growth of global population in recent decades. A commitment to global food security and distribution networks may not directly generate support for climate action.

But the building of international trust (Fukuyama, 1995) that it can generate can be the first step in demonstrating that there can indeed be a global commitment to collective action.

Besides the issue of collective trust as a foundation for collective public action, there is also the question of the political and institutional context in which such decisions are made. An important feature of the changing institutional scene relevant to collective decision making, is the fragmentation of the global political order. Democracy's fourth wave has turned into a ripple in a pond. Its legitimacy is being increasingly questioned by *rising levels of political apathy* and lack of interest in anything except questions of immediate concern: bread and the cost of health and houses. Opinion polls in many of the world's oldest democracies tend to repeatedly illustrate climate action appearing very low in public interest and support.

The story does not end there. The bitter geopolitical conflict between major powers: USA, Russia, China, parts of the European Union, undermine their ability to put their immediate differences aside and focus on urgent actions directed at a secure future for 'humanity'. It is the voice of the voter that matters in multi-party democracies not the welfare of the marginalized or disadvantaged.

The sustained and dramatic rise in income and asset inequalities over the last three decades, in virtually all the large economies of the world, complicate the decision-making picture even more. Open financial markets, birth of new digital technologies and the creation of global mega-businesses, have established powerful channels for lobbying and political persuasion. The control of international media by a handful of global oligarchs only complicates the picture.

The conundrum does not end here. The rise of illiberal democracies a la Zakaria (2003) and the advent of populist governments in even the oldest of democracies, rooted in a language of social intolerance and 'national greatness', is hardly conducive to the building of an internationalist movement driven by some collective global climate threat projected to peak some 30 years from now. Indeed, the great the belief in national greatness, the greater likelihood of a belief in technological prowess in some, yet unknown, miracle discovery such as nuclear fusion, or carbon capture or low-cost power storage systems. Why worry about human rights or the vulnerable

populations of the world when you could develop some revolutionary new technology and sell it to the entire globe?

The nationalist calculus does not end here. If greenhouse gases are to lead to possible extinction of a share of the human race or deplete the animal population and bio-diversity; why worry about human rights and democratic political systems. A united front on climate change among the largest G20 countries may suffice to trigger collective action plans. Why worry about the rest? If some small proportion of the global population is sacrificed for the greater good of the planet, why not embrace it. Political leaders make such decisions all the time. Generals organize war games just to work out such scenarios.

Furthermore, if dictatorships and repressive regimes can deliver a united climate action program why be concerned about questions of freedom, choice of leadership and their desire to embrace conflict on the international arena? Afterall, Western Democracies have a long track record of entering into such regimes during the days of the Cold War: from Latin America, to Asia and to tribal societies, struggling for independence in Africa.

What is evident is that as soon as we move beyond the projections, the alternative scenarios, the climate impact simulations and the rest, we enter into a totally different, Alice In Wonderland type of unpredictable world where relationships, history, identity, religion and economic self-interest contain the magic key of climate action. Navigating this world is more Art than Science. After a century and half of climate change science; learning this Art is the unquestionable challenge of the day.

There is something else. The economic success of the world after the 2nd World War, and the record economic prosperity of the most populous countries on the planet: China, India, Indonesia, Brazil and Russia, have directly contributed to the growth of a young middle class. Much of this new middle class, lives in some of the world's largest Megacities. These in turn contribute as much as half to three quarters of the national GDP and even more of its financial transactions and trade flows. Increasingly, we are entering in a world where decision making in such Mega Cities if more correlated not to other nation states but to other Megacity trading partners.

The rapid rural-urban migration in developing countries coupled with, geographical economic disparities, (the so-called horizontal inequality: Stewart, 2001), also lays the foundation of latent *violent social conflict*; among them many civil wars in Africa.

The emergence of a global, educated, young middle class only adds fuel to the fire. The rich historical literature on revolutions and peasant rebellions of the 19th and early 20th centuries,(Wolf, 1982) illustrates the fact that it is not the poorest segment of society that are prone to lead civil protests, or violent rebellion: it is the middle income, relatively educated sections of the public with sudden loss of economic entitlements that organize, protest, move entire national populations. The internet and modern social media only allow them to do this faster and more effectively.

Concluding Remarks

Finally, however passionate a plea can be made for urgent climate action to curb the emission of greenhouse gases in our atmosphere, this is not the existential threat that we face in the third decade of our century. The war in Ukraine has brought home the possibility of thermo-nuclear war. The unforeseen arrival of COVID 19 not only ravaged virtually every country on the globe but also demonstrated the enormous power of viruses that can be easily replicated in relatively small laboratories around the world. Expanding information technology capabilities of China, Russia, India and others open up the possibilities of cyber warfare and political destabilization campaigns. The task of building a political, collective, climate action plan, in such uncertain times, that can hold fast over several decades is exceptionally difficult. (Macaskill,2022)

Despite all the talk of the market and financial hurdles to climate mitigating innovation, the introduction of 'green bonds' and green finance; the contribution that can be made by international philanthropy, the search for a modern day Noah whose miracle innovation can save us all; it is the political systems, global corporations, international protest movements and their intricate interactions that might hold the key to unlocking the engine of climate action.

This requires entering into the complex world of human preferences, fears, expectations, obligations and self-identities. This is not some world of perfectly knowledgeable consumers or profit maximizing producers or instantly adjusting prices. It is a non-rational, touchy feely, institutionally confined but ever moving world where people work not only to earn more but also to right past wrongs; a world not amenable to arithmetic calculations but to "animal spirits" and to inveterate gamblers. Inserting the demands of climate action into such a world and coming out with a lasting commitment to zero carbon emission is not the science that we have benefitted from over the last 50 years and more. It is an art that we must work hard first to imagine and then to master.

References

Diamond J (2005), *Collapse: how societies choose to fail or succeed*. New York. Penguin Books.

Dietz S, Hepburn C and Stern N (2009), Economics, Ethics and Climate Change. In: Basu K and Kanbur R (ed) *Arguments for a better world; essays in the honour of Amartya Sen*, Oxford University Press. pp 365-386

Fukuyama F (1995), *Trust: the social virtues and the creation of prosperity*. New York, Free Press.

Gates B (2022), *How to avoid a climate disaster*. New York, Vintage Books, Random House.

Gore Al (2006), *An inconvenient truth: the crisis of global warming*. New York, Viking.

Gore Al (2013), *The future*. New York, Random House.

Greig A, Hulme D and Turner M (2007) *Challenging global inequality.* New York. Palgrave, MacMillan,

Harvey H (2021), *The costs of delay*, Energy Innovation.

Helm D and Hepburn (2009), *The economics and politics of climate change*. Oxford, Oxford University Press

Hulme M (2009), *Why we disagree about climate change: understanding controversy, inaction and opportunity*. Cambridge, Cambridge University Press.

Khanna P (2021), *Move: how mass migration will reshape the world- and what it means for you*. London, U.K. Weidenfeld and Nicholson.

Macaskill W (2022), The beginning of history: surviving the era of catastrophic risk. *Foreign Affairs,* September-October: 10-24.

Marco Grasso (2022), *From big oil to big green*. Massachusetts, MIT press.

McKinsey (2020), *Climate change, risk and response*. McKinsey Sustainability.

Meadows D, Meadows D, Randers J, and Behrens III W (2004), *Limits to growth, the 30 year update*. Hartford, Chelsea Green Publishing.

New York Times (2021) *The science of climate change explained*. April edition.

Olson M (2002), *Public choice: the logic of collective goods and the theory of groups*. Cambridge, Harvard University Press.

Sachs J (2008) *Commonwealth: economics for a crowded planet*. London. Allen Lane.

Shaffer B (2009), *Energy politics*. Philadelphia, University of Pennsylvania Press.

Stern N (2015), *Why are we waiting: the logic, urgency, and promise of tackling climate change*. Massachusetts, MIT Press.

Stewart Frances (2008), *Horizontal inequalities and conflict.* London, Palgrave MacMillan.

The Economist (2019), *The past, present and future of climate change*. September 21 edtion.

The Economist (2021), *Was cop 26 a success?* November 14 edition.

The Economist (2022), *Climate adaptation: special report*. November 5 edition.

UN Environment Program (2021), *Adaptation gap report*, New York.

UN Environment Program (2022), *Emissions gap report*. New York.

UNFCCC (2021), *COP 26 Dialogues*. 31 0ctober- 13 November.

Wolf Eric (1969), *Peasant wars of the 20th Century*. Norman, University of Oklahoma Press.

Yergin D (2020), *The new map: energy, climate and the clash of nations*. London, U.K. Penguin, Random House.

Zakaria F (2003), *The future of freedom: Illiberal Democracy at home and abroad.* New York, W.W. Norton and Company.