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New Approaches for Ecological and Social Sustainability in a Post-Pandemic World

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Abstract: Two vital challenges facing the world are global inequality and global climate change. Solutions to both these problems are urgently needed, but, given current policies, they can potentially conflict with each other. The United Nations has set 17 Sustainable Development Goals (SDGs) to be met by 2030. Even in 2019, the world was not on track for many SDGs, but the 2020 coronavirus pandemic has made their timely attainment even less likely. Similarly, atmospheric carbon dioxide concentrations have continued to rise, even in the first half of 2020. Clearly, present approaches to solving both problems are not working. This paper suggests several non-mainstream approaches that have the potential to address both challenges. A prerequisite is deep reductions in fossil fuel energy. Possible policies to achieve this include major cuts in air and car travel, shifts to a vegetarian diet, a global carbon tax and transitioning to some form of universal basic income.

Keywords: climate change; coronavirus; energy reductions; carbon taxes; inequality; pandemic; renewable energy; Sustainable Development Goals; vegetarianism; universal basic income

1. Introduction

Two main problems must be addressed and overcome for a sustainable future for Earth. In 2020, the COVID-19 pandemic is understandably seen as the number one global problem, but even if a vaccine is developed and deployed within a year or so, its effects will be felt for decades, according to the World Health Organization (WHO) [1]. Unlike the current pandemic, the two other challenges humanity faces are not new. The first arises from biophysical limits on both resource use and pollution absorption capacity, and is dominated by the risk of catastrophic climate change. Global climate change has been seen as a possibility for over a century, and as requiring urgent action since at least 1990, when the first Intergovernmental Panel on Climate Change (IPCC) report was issued.

Steffen et al. [2] have defined nine planetary boundaries and attempted to determine safe limits for each, such as CO₂ parts per million (ppm) for the global climate change limit. For all boundaries except that for ozone layer depletion, they argued that the risk of transgressing the safe limit is rising. Further, Lade et al. [3] have stressed that the multiple interactions between the planetary boundaries act to shrink the safe operating space for each boundary. As an example, declining crop productivity under climate change could lead to extra land clearing for agriculture, which would in turn increase carbon emissions.

Focusing on the global climate system, Steffen et al. [4] looked at set of 15 climate-related tipping points and classified their likelihood of tipping as global temperatures rose. Five of these they identified as having likely tipping points between 1–3 °C above pre-industrial average temperature. The recent IPCC report [5,6] produced evidence suggesting that some of these tipping points could be crossed

between 1 °C and 2 °C—and the world has already warmed 1 °C. Lenton et al. [7], in a *Nature* article entitled “Climate tipping points—too risky to bet against”, focused on nine of these tipping points. Most of these relate to high latitude regions, with two concerning ice loss from the Greenland and Antarctic icecaps. They reported that the world may soon be committed to perhaps 10 meters of sea level rise. True, such rises will not occur soon or be sudden, but could become inevitable, with huge implications for intergenerational equity. the rate of rise is beyond our control; we cannot control it. However, we somehow still have “adequate” time, in a sense, to react because it is not an abrupt, flood-like, or tsunami-like, sea-level rise.

Like Lade et al., Lenton et al. [7] reported that if a tipping point in one climate or ecological system is crossed, it can lead to other tipping points being crossed. As Ripple et al. [8] have warned, we are in the midst of a climate emergency. Furthermore, even though CO₂ emissions from energy fell during the first half of 2020, overall global CO₂ atmospheric concentrations continued to rise [9], presumably due to rising deforestation.

The second challenge, inequality among people and nations, has been recognized as a problem for millennia. One useful way of viewing the various dimensions of global inequality is by examining the United Nations Sustainable Development Goals (SDGs) [10]. These 17 development goals (further divided into 169 sub-targets) were adopted by the UN in 2015, and were planned to be met by 2030. However, even before the pandemic, the 2020 UN Report showed that the world was not on track to achieve these goals by 2030. For example, for Goal 2; “End hunger, achieve food security and improved nutrition and promote sustainable agriculture”, the UN reported that the share of global population “affected by moderate or severe food insecurity” had risen from 23.2% in 2014 to 26.4% in 2018. With the coronavirus pandemic, the UN Report felt that few of these goals seem likely to be achieved. For Goal 1: “End poverty in all its forms everywhere”, the Report claimed that in 2020 an extra 71 million people “will be pushed into extreme poverty”. The current pandemic is also expected to adversely impact on eradication programs for malaria, TB and HIV [11].

However, even before the pandemic, there was criticism of the SDGs [12,13]. Griggs et al. [13] warned that ecological sustainability could be compromised by some of the development goals, such as the potential conflict between climate change mitigation and providing more energy in low-income countries. Rehbein et al. [14] showed that even renewable energy projects can pose a threat to biodiversity in many cases. Hydro reservoirs can drown forest areas, and lead to adverse changes in freshwater ecology. Bioenergy in many low-income countries can be at the expense of natural forests. In Indonesia, palm oil plantations have also led to forest area reductions. Naidoo and Fisher [15] have pointed out that improving the road network (a part of target 9.4), particularly through tropical forests or nature reserves, can be in conflict with Goal 15 (which concerns the sustainable use of terrestrial ecosystems). As Laurance and Arrea [16] have argued, such new roads can lead to “land encroachment, wildlife poaching, forest fragmentation, exotic-species invasions, and illegal mining”.

According to Naidoo and Fisher, achieving the SDGs by 2030 was predicated on the twin assumptions that both economic growth and globalization would continue. With the pandemic, both could have an uncertain future. Many of the targets will need to be scrapped, but some will be needed more than ever to cope with the current pandemic. Even the UN has realized that drastic revision is needed [17]. Naidoo and Fisher further argued that supporting a selected 30 (18%) of the targets would reduce the probability of any future pandemic. They concluded that: ‘Every goal and target should be screened according to three points: is this a priority, post-COVID-19; is it about development not growth; and is the pathway to it resilient to global disruptions?’ [15], p. 201. In summary, while the key goals of eliminating poverty, hunger and gender inequality, and providing good education and health are fundamental, others will need to be rethought in the light of the changed economic circumstances and the urgency of the need for effective climate change action.

The overall aim of this discussion paper is to examine what policies could help solve both the global inequality problem and environmental sustainability (especially climate change) problems, based on a critical reading of a broad range of literature. Nearly 40 references are from year 2020, and so

incorporate lessons from the ongoing pandemic, and many of the rest are from 2019. Particularly for the global equity question, the discussion is necessarily values-based. The pandemic has driven home to all how uncertain the future is; this discussion merely presents ideas which will surely undergo revision as the uncertain future unfolds.

Given the foregoing, Section 2 looks at the vast global changes that have occurred since 1950 in a variety of parameters, both physical and social. Rising energy and vehicular transport use, among other factors, have increased global environmental and resource problems. Some welfare indices have improved, but at the individual level, income and wealth inequality are rising. Section 3 critically examines the proposed solutions for mitigating climate change, and argues that it will be increasingly difficult to find workable technical solutions for this problem. Given the ineffectiveness of existing policies and proposed technical solutions for climate change mitigation, Section 4 puts forward some ideas for tackling the twin challenges, including deep energy reductions, vegetarianism, and introduction of a universal basic income. Finally, Section 5 discusses the prospects for success in moving to a future equitable world in which the human family live within Earth's biophysical limits, including the most urgent one, the need for climate stability.

2. Global Changes Since 1950

Vast changes have occurred since 1950. Global primary energy use, including oil and electricity consumption, and levels of air and surface travel, have all risen many-fold. The growth in activity results from a combination of the almost three-fold population rise and the four-fold increase in per capita GDP. Overall energy use has risen seven-fold; this increase is largely due to increased fossil fuel use, mainly for industry, buildings and transport. The 30-fold rise in cement production demonstrates the rapid growth in buildings and infrastructure. The increase in atmospheric CO₂ levels appears modest, until it is recalled that the increases are really from a pre-industrial base of about 280 parts per million (ppm). To use the terminology of Beddoe et al. [18], as late as 1950, we could still reasonably refer to the world as “empty”, whereas today we have a full “world”. In a full world the risk of unintended consequences because of increased interactions are multiplied.

The ecological footprint (EF) is another (albeit controversial) way of tracking global change in the biosphere. According to Galli et al. [19], the EF ‘adds up ecological services people demand in as far as they compete for biologically productive space’. For EF analysts, there is a growing divergence between the human demands on Earth (the EF) and the biocapacity of the planet. Lin et al. [20] have calculated that the ratio of these two figures in 2014 was 1.7, and still growing. Put simply, the claim is that we are using 1.7 Earths when we only have one; we are thus in ecological overshoot, a condition which can only be temporarily maintained.

Some of the data for social welfare is more encouraging. Life expectancy and adult literacy have both registered large gains (Table 1). Although not included in Table 1 (because of the lack of 1950 data), household access to electricity has risen from 72.7% in 1980 to 89.65% in 2018 [21]. Nevertheless, at the international level, average per capita electricity consumption varied in 2018 by more than three orders of magnitude [22]. Telephone ownership is now at high levels. Indeed, mobile phone service subscriptions (7.86 billion in 2018) now outnumber the global population, and ownership is now widespread even in the poorest nations. Nevertheless, hospital beds per 1000 show little consistent improvement since 1970 [21].

The picture for global income equality is more mixed. When examined at the international level, equality has clearly improved: a much larger share of the global population now lives in countries with average per capita incomes in the mid-range [21]. Furthermore, the proportion of the global population living in extreme poverty (defined as less than 1.90 US dollars USD) in 2011 Purchase Parity Prices (PPP) values) declined from 42.3% in 1980 to 10% in 2015 [22]. However, within countries, inequality is mostly rising. In some cases, regional disparities in average income are large, as in comparisons of the wealthier seaboard provinces in eastern China compared with the inland provinces. Usually, however, income inequalities occur between residents of the same region or city. Alvaredo et al. [23]

have examined changes in individual shares of income and wealth worldwide between 1980 and 2016. They reported the following: “According to our benchmark results, the global richest 1% adults captured 27% of total income growth since 1980, that is two times more than the bottom 50% adults, who collectively captured 12% of total growth over the period. The top 1% income share increased from 16% to 20% over the period” [23], p. 2. The 2020 pandemic is already exacerbating such inequality, and could well inaugurate a shift to even more extreme inequality [24].

We also need to consider the interactions between climate change and equality. The first equity question is how to divide up the remaining allowable CO₂ emissions (the “carbon pie”) between countries, or even individuals [25]. Much has been written about how to allocate these among the world’s nations. Although the mature industrial countries are responsible for most of the cumulative emissions of this long-lived gas, their share of annual emissions is falling. In 1965, the Organization for Economic Cooperation and Development (OECD) countries accounted for 69% of global CO₂ emissions from energy and industrial sources, with East Europe producing most of the rest [22]. Yet by 2018, even the enlarged OECD (including Mexico, South Korea and other recent entrants) only accounted for 36.6% of such emissions [22]. Furthermore, unlike many non-OECD countries which are still undergoing net deforestation, forests in the OECD countries have been increasing their carbon storage in recent years. Given this, the CO₂ emissions share from all sources for non-OECD countries in 2018 would be appreciably higher than 63.4%. A key country for non-OECD CO₂ growth is China, where energy/industrial emissions rose roughly 20-fold from 1965 to 2018 [22].

In summary, the OECD countries are historically responsible for most cumulative emissions, and even today have per capita annual CO₂ emissions much higher than average. Nevertheless, the non-OECD countries are now the origin of a large and rising share of global annual emissions. Even if the OECD greatly reduced its emissions, in the absence of reductions from the rest of the world, CO₂ ppm would continue to rise. All countries, except the poorest, must reduce their greenhouse gas (GHG) emissions.

The second equity case for reductions, especially in the high-income countries, arises when the likely distribution of adverse impacts from climate change is analyzed. As Schiermeier [26] has reported, the adverse effects of climate change are likely to impact the tropical regions—home to many of the world’s lowest income nations—more severely than the temperate regions. Although temperature rises and ecological changes are—and will continue to be—much greater in the cold high latitude regions, these changes will affect only a few million people, and could even bring some benefits. In contrast, the tropics are home to billions of people, and many ecosystems there are only adapted to narrow temperature ranges [27]. Temperature increases could reduce the yield of important agricultural crops [28]. Furthermore, temperature rises may already have begun to exceed the heat tolerance of populations in some tropical and sub-tropical regions [29] (see Table 1).

Table 1. Global data for 1950 and 2018.

Parameter	1950	2018	Growth	Growth/Cap.
Population (billion)	2.53	7.63	3.02	-
Primary energy (EJ)	89	625	7.0	2.33
Oil use (EJ)	20	195.2	9.76	3.24
Electricity use (EJ)	3.1	95.8	30.9	10.2
Atmospheric CO ₂ level (ppm)	310	407	1.31	-
Energy/industry CO ₂ (ton/cap.)	2.2	4.44	2.02	-
Vehicular surface travel (trillion p-k)	3.3 ¹	39.5 ¹	11.9 ¹	3.96 ¹
Passenger cars (million)	51.3	1133	22.1	7.32
Air travel (trillion p-k)	0.03	8.7	290	96.1
Cement production (million ton)	136	4050	29.8	9.87
GDP (2017 USD trillion, PPP)	10.2	125.9	12.3	-
GDP/capita (2017 USD, PPP)	4030	16,500	4.09	-
Urbanization (%)	30	55	1.83	-
Life expectancy (years)	45.7	72.4	1.58	-
Adult literacy (%)	55.7	86.3	1.55	-

¹ Authors’ estimate. Sources [21–23,30–39].

3. Proposed Solutions to an Urgent Global Problem: Climate Change

Apart from the urgent need to bring the current pandemic under control, the most pressing problem is climate change (CC) [8]. Even if all parties could agree on the need for CC mitigation, few of the many proposed paths for achieving this aim may be feasible. They may well be theoretically possible in the sense that they do not violate well-established physical laws, such as energy conservation laws, but they may still have a low chance of success. In the complex bio-physical and the socio-economic worlds that we simultaneously inhabit, it is not always easy to distinguish approaches with a reasonable chance of success from those that don't. Because technologically-based solutions have both seemingly served us well in the past, and are a better fit to existing economic structures and power relations, they are the preferred solution to the environmental and resource problems the world faces.

In this section, the various solutions proposed (and in some cases, at least partly implemented) for mitigating CC will be critically examined. These responses include: various forms of carbon dioxide removal (CDR), both biological and mechanical; replacing fossil fuels (FFs) with non-carbon sources of energy; various forms of geoengineering, particularly solar radiation management (SRM); and economy-wide energy efficiency improvements.

Any proposed solution should employ an Earth Systems Science approach, to ensure that all climate effects are accounted for. To illustrate this point, consider reforestation and afforestation, which are often advocated as a cheap way of sequestering large quantities of carbon e.g., [40,41]. Such carbon storage is also perceived as “natural”, insofar as it would partially reverse the historical carbon loss from forests and soils. However, this CDR proposal has been heavily criticized from a number of different angles, which together demonstrate the difficulties facing even natural technical fixes in a “full” world.

Veldman et al. [42], claimed that the sequestration potential in the Bastin et al. [40] paper had been over-estimated by about a factor of five. Included in their criticisms was the proposed utilization of savannas and grasslands for afforestation, areas either already utilized by humans or important for biodiversity [43]. Moreover, savanna and grassland soils already store large volumes of carbon; replacing them with trees would not add to this store. Veldman et al. also stressed that although tree planting may sequester carbon and thus reduce global warming, albedo changes from new forests would have a warming effect. At high latitudes (and altitudes), replacement of snow-covered surfaces by green foliage will decrease albedo (the fraction of insolation directly reflected back to space). Even in warmer regions, tree cover will have a lower albedo than bare soil. Forest trees also emit a mixture of chemicals, some of which have a warming effect [44]. Clearly, all climate change effects must be assessed, not just atmospheric CO₂ removal. Holl and Brancalion [45] further pointed to non-climate drawbacks: tree planting can conflict with other aims and can have unintended negative effects, such as water supply reductions.

Questions have also been raised about the permanence of forests given the ongoing changes in climate [46–48]. Anderegg et al. [48] have stressed that the present risks to forest carbon storage from “climate-driven forest dieback caused by fire, drought, biotic agents, and other disturbances”, are likely to worsen under continued CC. If so, any benefit from such carbon drawdown may only be temporary, and lead to rapid carbon releases in a few decades time. Nor are these risks limited to tropical forests: boreal forests are already experiencing an upsurge in the extent and frequency of fires, and the release of soil carbon by combustion [49]. Pereira and Viola [50] have even argued that rapid loss of forest carbon alone could lead to catastrophic climate change.

The other proposed solutions involve much greater levels of technology than tree planting does. Some researchers have argued that a shift to non-carbon energy sources (renewable energy and/or nuclear) can largely solve the climate change problem e.g., [51,52]. Other researchers (including the present authors) are skeptical of this claim [53–57]. The critics have claimed that non-carbon energy sources are not really green [54,57,58], and that they could well merely replace one problem (CO₂ emissions) by another (rising energy and environmental costs of scarce materials needed for solar or wind capture devices) [59–61].

Further, given that we face the risk of catastrophic climate change (CCC), an important question is whether non-carbon fuels can replace fossil fuels in time to avert CCC. A crucial factor here is the energy return on energy invested (EROEI). Clearly for feasibility, energy output from say, a wind turbine must exceed by some margin the energy inputs into its manufacture, operation and maintenance. If the EROEI for RE sources is low, too much annual energy has to be diverted to building up non-carbon energy infrastructure, leaving less for powering the non-energy sectors [62–64].

For three decades now, carbon capture and storage, involving CO₂ capture directly from exhaust stacks of FF power plants, followed by compression and burial deep underground. But presently only tens of millions of tons of CO₂ are so treated, compared with the tens of billions needed. Moreover, the time frame for major deployment is decades, time we do not have. Energy costs will also be high for plants not optimized for carbon capture, and very few are so optimized.

The most ambitious technical fixes are both untried at scale: negative emissions technologies (NETs)—other than increasing forest and soil carbon—and geoengineering, especially solar radiation management (SRM). NETs include capture of CO₂ directly from the air, again followed by compression and burial. Another NET technology is enhanced weathering of rocks, such as basalt, which involves grinding rocks to fine powder and spreading it over land to absorb CO₂ [65]. Beerling et al. [66] have argued that enhanced weathering could simultaneously enhance agricultural productivity by neutralizing soil acidity. However, its possible adverse health effects must be considered [65,67], as well as high energy costs for rock grinding. Direct capture of CO₂ from the air also has very high energy costs, because of the low CO₂ concentration in the atmosphere (about 410 ppm).

SRM would involve the annual placement of millions of tons of sulphate aerosols in the lower stratosphere. The aerosols would block some insolation, reducing global average temperatures. It cannot be a permanent solution on a finite Earth, even if its political and possible technical problems could be overcome. Ocean acidification, already a cause for concern, would continue. FF reserves would be eventually depleted, forcing reliance on non-carbon sources, with their probable limited annual availability, as already discussed. Other, non-fuel mineral reserves would also deplete. Gardiner [68] has documented the many ethical problems that confront SRM. We also need to consider that SRM may not work as planned, or may have presently unknown side effects. The uncertainty surrounding the value of such a basic parameter as climate sensitivity [69,70] indicates the need for “knowledge humility” [71], when it comes to assessing powerful new technologies aiming to modify climate.

Energy efficiency advocates believe that a much better approach is to reduce energy needs by greatly improving the energy efficiency of vehicles, power stations, or buildings [72]. However, in a growth economy, any efficiency improvements to devices mean unit lower energy costs, which can have the unintended effect of increasing their use. Further, in our unequal world, even when looked at on a national basis, levels of private vehicle ownership or air travel can vary by orders of magnitude [32,35]. Global energy intensity (measured as energy per unit of GDP) may be falling, but total energy use (and even FF use) is still rising [22]. Given these huge national differences, further moves toward OECD high consumption levels by presently low- and middle-income nations (along with expected population growth) will swamp any conceivable efficiency gains, as it has in the past [73]. In summary, further reliance on technical fixes are unlikely to solve the many biophysical problems facing an already overloaded planet. At the very least, it would be unwise to rely on such approaches.

4. New Proposals for a Sustainable Future

We all want to know what the future holds for us, both next week and in several decades time. In the post-pandemic era, an increasing number of options appear possible [74]. Futurists sometimes refer to possible, probable and preferred futures; both probable and preferred futures must be drawn from the range of possible futures. Preferred futures are openly normative, and are used in backcasting, where we decide what future we want, and then work out the best path for getting there. However, different groups within any one country, let alone different countries, have very different views on their preferred future. For instance, it can be expected that fossil fuel companies and oil-exporting

nations will resist calls to drastically reduce fossil fuel consumption, which would leave them with stranded FF assets.

The following thus represent just one set of preferred futures, but given the failures and limitations of the approaches discussed in Section 4, ambitious proposals for addressing the global equity and climate challenges are urgently needed. These proposals may seem politically infeasible, even utopian, but, once, so did universal franchise and women's equality. Further, a number of the possibilities for climate action that existed at the time of first IPCC report in 1990, are being steadily foreclosed. Compared with Ćirković [75], who argued that colonization of space remains our only option, or economist Gowdy [76], who proposed a return to hunter-gathering, our solutions may seem almost mainstream; our setting is still Earth and the proposed changes are in the context of modern societies.

An obvious first step is to remove all subsidies from FF, including externalities. According to Coady et al. [77], total FF subsidies in 2015 totalled USD 5.3 trillion in 2015, or 6.5% of global GDP. The total comprised production subsidies, consumption subsidies, and externalities, which included a major item for the imputed cost for CO₂ emissions. This CO₂ externality cost raises the question of carbon taxes. Such existing taxes, at varying but generally low rates, were estimated in the late 2010s to cover around 20% of all global GHGs. Carbon taxes could even be used to improve national income distributions if some, or even most, of the revenue collected was distributed to all citizens on an equal per capita basis [78].

More ambitious proposals envisage a global carbon tax, combined with income redistribution to presently low FF energy use countries [79]. Given that most CO₂ emissions to date have been from industrialized countries (see Section 2), a global carbon tax with redistribution of revenues collected would help redress global income inequality and at least partly compensate historically low-carbon economies for present and future adverse climate change effects. One possibility among many would be to tax carbon emissions above a per capita cut-off point in high-emission countries, with low emission countries receiving such revenue based on their level of per capita emissions. It would also help address the problem of increasing numbers in extreme poverty (see Section 2), partly as a result of the pandemic.

Such a carbon tax with redistribution would need to be accompanied by other policy changes aimed at deep carbon (and, probably, energy) reductions. Consider transport, which is responsible for nearly one quarter of both global energy use and related CO₂ emissions [36]. In land transport, particularly in urban areas, the priority given to private motorized travel over other modes would be reversed. This could entail, for example, drastic reduction in both road speed limits and urban parking spaces, conversion of some road and car park space to other uses, and priority for non-motorized and public transport modes. Unlike fuel cost increases, these non-price policies would be equally felt by all, regardless of income level [80]. This equal burden on all citizens would also be perceived as fair, increasing the chance of their acceptance.

Air travel would also need to be cut to a fraction of today's levels. Even before the current pandemic, many researchers were questioning the need to physically attend conferences. Climate scientist Corinne Le Quéré [81] does not believe air travel should return to pre-pandemic levels. Price [82] has reported that even if physical presence conferences resume, most registrants could well attend on-line. In effect, the world is conducting a vast experiment in IT as a travel substitute. This huge rise in working/studying from home and attending virtual meetings as a response to pandemic lockdowns, will probably also lead to a rethinking of how much travel is really necessary. The world may indeed be moving to a "low mobility future" [83].

The result of this combination of carbon taxes and policy changes would be a marked reduction in energy use in high FF energy use countries, which in turn would necessarily lead to much unused capacity in their FF energy systems. Only modest annual growth in RE capacity would be needed. In contrast, in low-energy use countries, the extra energy capacity needed for equity should come from RE sources, perhaps subsidized from global carbon taxes. Because of the adverse environmental effects of hydro and bioenergy noted in Section 1, this energy should mainly be produced from wind and

solar energy. The additional energy could still occur even in the context of declining global primary energy use: in 2017, the lowest 10% of the global population by electricity use (at the national level) accounted for about 2% of global electricity, whereas the top 1% used 10% of global electricity [36]. Even quadrupling their electricity use, for example, would only require a small share of possible high-energy country reductions.

Although equity must be considered in policies for both mitigation and adaptation to climate change, as Klinsky et al. [84] have argued: “Despite strong references to justice, human rights, and equity in the Paris Agreement’s preamble, the concept of equity is largely absent from its substantive components”. While such a global carbon tax with revenue redistribution would improve global equity, the revenue to be distributed would steadily fall as either FF use fell, or (possibly) CDR or SRM were adopted, as discussed in the previous section. For continued equity gains, a universal basic income (UBI) scheme could be introduced. Although UBI projects have been trialed in a number of countries, Spain plans to introduce a large-scale scheme as a response to the economic upheaval caused by the current pandemic. Some 850,000 low-income households will be offered a monthly payment of USD 1145 to spend as they choose; valuable lessons will result from this large-scale experiment. Other countries are also studying UBI as a possible response to COVID-19 [85]. Clearly, coordination between a carbon tax with revenue redistribution and a UBI would be needed, whether both were instituted at the local, national, or global level.

By itself, though, a UBI scheme would not help mitigate climate change. Negotiating meaningful climate change mitigation will inevitably involve tradeoffs, but if equity considerations are downplayed, or ignored, the chances of reaching agreement for achieving rapid reductions in GHG emissions are reduced [84,86]. Patterson et al. [86] summarized their study as follows: “Proactively engaging with social justice is therefore critical for navigating urgent 1.5 °C societal transformations”. Or, as Klinsky et al. [84] put it: “Excluding equity from analyses of trade-offs signals a tacit agreement to sacrifice the most vulnerable groups and most silenced voices for the benefit of “the greater good”, which in the real political world generally favors those more privileged”.

A global shift toward vegetarianism would greatly help reduce GHG emissions. According to Godfray et al. [87], over the years 2005–2007, global food-related GHG emissions were 7.5 Gt (gigaton = 10^9 ton) CO₂-eq (carbon dioxide equivalent), of which 4.6 Gt CO₂-eq were from red meat and poultry. By year 2050, the equivalent values were projected to be 11.35 and 7.1 Gt CO₂-eq, respectively. Meat production (like agricultural production in general), produces not only CO₂ emissions, but also emissions of the other major GHGs, methane (CH₄) and nitrous oxide (N₂O). Production of meat, especially from ruminant livestock, incurs more GHG emissions per kilojoule of food energy than plant-based food, such as grains, because of energy conversion losses at each trophic level [87]. According to a recent IPCC report, in the extreme case of no animal-based food, 8 GtCO₂-eq of GHGs could be avoided annually. Even diets with some meat and dairy could still produce around half of these savings [88]. Vegetarianism can help mitigate climate change in another way, by curbing illegal deforestation in the Amazon for cattle farms [88].

Vegetarianism would also improve health in high meat-consumption countries [87]. Even more important from a global health viewpoint, vegetarianism would also greatly reduce the risk of future pandemics. Over the past century, an annual average of two viruses have crossed over to humans from their natural animal hosts [89]. An end to both consumption of bushmeat or intensive animal raising would reduce the risk of this transfer to humans. Shifting to a plant diet may even be necessary for a growing world population to adequately feed itself in future.

5. Discussion and Conclusions

The present policies for dealing with the many urgent problems we face are clearly not working, which has provided the motivation for this exploratory study. Since the first IPCC report in 1990, the CO₂ emissions from fossil fuels and industry have risen 59% to reach 32.9 Gt in 2018 [22]. As mentioned, for only one of the nine global environmental/resource limits considered by Steffen et al. [2] is Earth

moving in a safe direction. Until 2019, some of the SDGs had shown improvement, but the current pandemic looks set to make matters worse. We cannot continue on our present path; indeed, insanity has been defined as “doing the same thing over and over again and expecting different results” [90].

A feature of many existing approaches to the twin challenges of global inequality and climate change is that they often address the wrong questions [91]. Instead of focusing on access, they examine ways to increase the energy (and carbon) efficiency of vehicular mobility—getting more vehicle-km from each liter of fuel. In health, the focus is still biased toward cure rather than prevention. Although we clearly need a vaccine for the present pandemic, Dobson et al. [89] have shown that expenditure on monitoring of the wildlife trade, monitoring of zoonotic diseases, ending the wildmeat trade in China etc, would have a total annual cost of USD 20–31 billion. This expenditure could have prevented the emergence of COVID-19, with costs in 2020 alone they estimated at roughly USD 8–16 trillion, and help prevent future zoonotic disease outbreaks. In agriculture, the emphasis is on improving yields and output for each commercially grown food type, rather than measures that will enable an adequate diet for all, while keeping within sustainability limits for Earth. Overall, growth in GDP is still the main economic aim of nations, rather than increases in human wellbeing.

A vital question concerns the feasibility of policies needed for achieving a sustainable and equitable world. Several commentators have seen the current pandemic crisis, as offering new hope for such an outcome, e.g., [92–96], even though its effect on SDGs has been negative. Cohen [96] has written that “COVID-19 is an opportunity to reduce over the longer term the prevalence of lifestyles premised on large volumes of energy and material throughput”. Comerford [92] has pointed to several similarities between the pandemic and the climate emergency. Both involve an escalating risk of disaster; the need for profound and rapid lifestyle changes; and coordination—individual changes will achieve little unless there is a general change.

However, some of this optimism is predicated on the rapid growth of a green economy. Advocates of “green economic growth” argue that moving to non-carbon sources of energy, perhaps with assistance from CDR, especially reforestation, can enable economic growth to continue in an ecologically sustainable manner. The arguments put forward in Section 3 implicitly cast doubt on green growth, as do other researchers, e.g., [97,98]. A variant of this idea, also discussed in Section 3, is that growth in energy (and materials consumption) can be decoupled from economic growth. This view has been questioned by several research groups, e.g., [99,100]. The results of modelling work by Nieto et al. [101] suggested that reliance on green growth would not only lead to reductions in global GDP, but would also not be able to keep below the 2 °C limit. Furthermore, as mentioned, even though energy intensity is steadily falling, total energy use and resulting CO₂ emissions are still steadily growing.

A fall in global GDP may well be needed for climate and ecological sustainability, but it need not adversely affect equity. For some decades now in OECD countries, rising GDP per capita has been accompanied by declines in more relevant measures of human welfare [102]. As the authors wrote in an earlier paper: “Much of our consumption is geared toward satisfying corporate needs for ever expanding growth, dressed up as human needs. And conversely, those human needs that cannot presently be catered for by the market are shortchanged” [103]. A more equitable and ecologically sustainable world is possible, but bold changes are needed, including a shift from a stress on economic growth to a human needs approach.

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Abbreviations

CC	climate change
CCC	catastrophic climate change
CO ₂	carbon dioxide
CO ₂ -eq	carbon dioxide equivalent
EF	ecological footprint
EJ	exajoule (10 ¹⁸ joule)
EROEI	energy return on energy invested
FF	fossil fuels
GHG	greenhouse gas
GJ	gigajoule (10 ⁹ joule)
Gt	gigatonne (10 ⁹ tonne)
IPCC	Intergovernmental Panel on Climate Change
OECD	Organization for Economic Cooperation and Development
NETs	negative emission technologies
p-k	passenger-km
ppm	parts per million
PPP	Purchase Parity Prices
RE	renewable energy
SDGs	Sustainable Development Goals
SRM	solar radiation management
TWh	terawatt-hour (10 ¹² watt-hr)
UBI	universal basic income
WHO	World Health Organization

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