HOCO-ECO Newsletter for December, 2016

The Church of the Holy Comforter

WINDOWS

"Lord, when did we see thee? . . ." **(Mt 25:37)**

What we see through the window depends on the frame. Is it a periscope peering at sea level? Is it a lens focused on the hairs of a fly's leg? Is it the Hubble telescope looking 13.5 billion years into the past? Is it a panoramic view of the Himalayas from the picture window of a palace? Or is it the view from the other side of the wall that hides the Annawadi slum of 3000 people living on the hundreds of tons of garbage produced daily in the bright corridors of the Mumbai International Airport? Shifting from frame to frame, from window to window, and magnitude to magnitude is part of our divine path through this world. Who or What is the Other? What is the other's world? Making a transition from one way of life to another begins with big and little shifts. The significance of a rain garden or a recycling program lies in its contribution to a larger effort.

In this newsletter, I offer a window on the issue of population growth. It is a formal and technical paper that was mainly written by a friend of mine, Rajan Jaisinghani, a local engineer. Unlike most of us, he has seen the effect of rapid population growth because he has continued over the years to revisit his home town in India. Perhaps you know that in some parts of western India the water table is tapped out, requiring the rail delivery of drinking water. Try looking out this window. As you see through Rajan's window, what are your questions or answers?

My son, Robert Rose, has presented Rajan's window in the form of a computer model into which you can input your own data to come up with solutions on your own. Please try it out.

Finally, the issues of population growth and climate change are "drivers" of other kinds of change about which many of us care so much—water for life, biodiversity and extinction, pollution, injustice, and inequity. Patricia Boyce Simms, an activist in the "transition" movement, gives us the view from her own window:

"The Great Transition is a systemic framework for understanding how we might hospice outworn ways of living that no longer serve us and the Earth, and give birth to an emergent, more compassionate and resilient future. A broad spectrum of grassroots, citizen-led, community initiatives sustain the movement toward the Great Transition against the backdrop of climate change, resource depletion, and economic instability. Purposeful groups of friends and neighbors mitigate these converging global crises by engaging their communities in environmental education and actions that increase local self-reliance and resilience. They catalyze re-localization of economies and low carbon lifestyles by innovating, networking, collaborating, and replicating proven strategies, respecting the deep, fractal patterns of nature, and diverse cultures in their localities. "Transitioners" work with deliberation to

create a fulfilling and inspiring local way of life that can withstand the shocks of rapidly shifting global systems."

In other words, despite the unsettling and discouraging view, Patricia has hope. As people of hope, what vision do you see? What big and little shifts can we make to bring this vision into focus?

—Richard Rose

(For more on frame-shifts, Annawadi, and the Transition movement, see the end notes.)

Can Technology Alone

Counter the Impacts of Population Growth & Climate Change?

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Richard L. Rose, Ph.D. Science Education, is a retired teacher and administrator of science programs in Fauquier, Loudoun, and Alexandria Public Schools in Virginia and Marymount University who has done research on science education and the population genetics of *Crassostrea virginica* (in *Estuaries 7(2), June, 1984*). His book *Frameshifts (2011, two volumes)* is a fictional treatment of the transition required to move from a consumer culture to a sustainable culture.

Robert Rose is a software architect who has worked for 20 years with technology teams building a variety of applications including dozens of business solutions, educational software and online teaching resources, in-home elder care management software, nerve monitoring software, and population health bioinformatics using HIE data.

Abstract

In discussions related to CO_2 emissions and the impacts of climate change and population on the only practical life sustaining planet that we know of, the fallback position for defenders of status quo, is to rely on technology to compensate for these impacts via increased efficiencies, newer green technologies and birth control methods. This paper demonstrates that, absent changes in population and consumption trends, even massive technological progress, no reductions in CO_2 emissions (and in related global warming effects) are possible under even under unrealistically optimistic assumptions. This work points out the importance of addressing population growth and consumption on actually a higher, or at least an equal footing as technological development. The link to use the ***online carbon dioxide estimator model*** *is:* http://cognizantsystems.com/CO2.html

Introduction

Climate change, associated with global warming is the biggest threat that humans face. The conversation about how to address this threat usually centers on countering it with advanced technologies, smart systems and efficiencies. But does technological innovation have the biggest impact in this equation, or do other factors such as population and consumption play an equal or bigger role? The authors perceive great reluctance, even among scientists, to talk about these additional factors. In fact, discussion related to controlling or reducing population, via non draconian means, seems to have become a forbidden topic. This important part of the discourse on climate change mitigation is covered herein. A brief discussion of the nature of technology and population growth follows, after which a simple model is presented to estimate how these factors jointly affect (for simplicity) just CO_2 emissions.

1. Technology

Science has advanced to an amazing level. We have studied the basic components of matter (and yes have even observed the famous god particle, the Higgs Boson) and our knowledge of the Universe has increased at an exponential pace so much so that we can "observe" planets around other stars, know the distribution of galaxies etc. Yet, there is much to be learned and we are constantly surprised by our observations. Our powers of analysis have not answered important questions such as how small quantum and large bodies work under a unified law, whether there actually is dark matter and energy and why. We seem to be amazing at linear logic and yet we know from our observations that the Universe is full of deviations from our logical assumptions. Our minds and technology have limitations. It is important to remind ourselves that scientific truth is provisional and that we are also limited by the laws of nature. Rather than thinking of science and technology as a means to *overcome* nature, we should instead think of them as means for *smartly working within* the laws of nature, as we remain fully aware of the limitations of what we should and should not do.

Technology also has additional practical limits and considerations that affect its role in this important quest for combating climate change:

1. It takes a significant amount of time to develop, introduce (solve practical issues associated with breakthroughs) and scale up new technologies. The time period is usually in the range of a few decades. For example, it took many decades before we were able to have a reasonable range for electric cars; the passenger jet plane had many issues that had to be solved even after introduction –recall the breakup of the British passenger plane due to its non flexing structural member; issues with nuclear power reactors. Other technologies that really are just improvements on older versions can occur much faster, however breakthrough technologies take longer.

2. Our fundamental knowledge has so far resulted in technologies that are severely limited by the Second Law of Thermodynamics. Case in point, our automobiles have dismally low efficiencies if the efficiencies are defined based on the calorific value of the fuels and our solar cells have efficiencies of less than about 25% based on the solar energy inputs.

3. Breakthrough technologies occur rarely and we cannot rely on such breakthroughs in the time frame of our current crisis, which has already begun to raise sea levels and temperatures of the atmosphere and ocean.

4. Unfortunately, our technology development is also hampered by the seemingly inherent limitation of our species – our tendency to act in a short term and self interest-driven mode. As a result, we have actually reduced fundamental research. The bulk of our spending seems to be on the development of consumer goods and technologies that help produce such goods.

5. The investment requirements for new technology development are a significant barrier, which is magnified by the defense of the investment made in older technologies. Their less efficient products become cheaper with time (the producers already have a higher volume and are willing to make less profits on such mature technologies as their investments have already paid off) and thus more attractive in our current economic systems. Thus current economic systems themselves may retard the development of new technologies.

6. Political systems also seem to be geared against making the required long term sacrifices necessary for us to replace older technologies, thus acting as a brake on the introduction of new technology.

7. New and efficient technologies often cause humans :(a) to consume more because the products appear convenient, cheap, and easily "thrown away," and (b) to increase our population. This has been happening since the first agricultural revolution and the subsequent mechanization of industrial agriculture. Population growth has also been enhanced by the medical sciences which have increased life-spans, and reproductive period.

Jaisinghani [1] in his book, "Homo sapiens – An Appraisal of Modern humans", has discussed in detail these limitations of technology and how it is impacted by our political and economic systems. These limitations of technology must be kept in mind as we address the CO_2 emission forecasts below.

2. Population

Human population has exploded over the last 2,000 – 10,000 years, as shown in *Figure 1*. Considering all the critical shortages and catastrophes that normally control an animal population's growth rate, this graphic shows an unprecedented rise. One can observe that the European Black Plague, the flu epidemics and the World Wars don't even create blips on the population curve and the population continues its exponential increase.

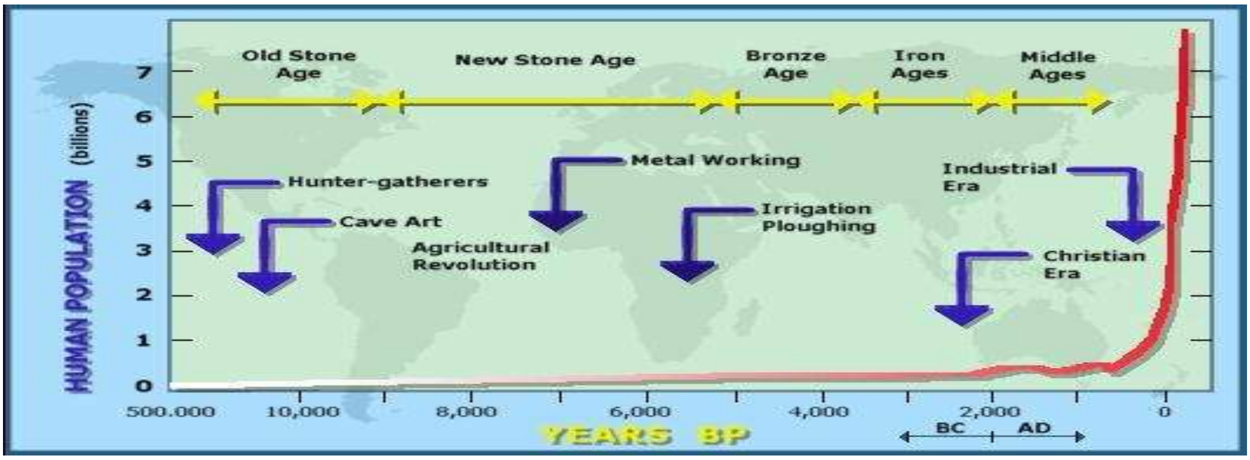

Figure I - Human Population Explosion with milestones. Courtesy University of Michigan.

The biggest threat the planet and human existence faces is from the actions of humans themselves. As long as our population was low (estimated at about a million ten thousand years ago) we were like every other species living off the land and moving along to new lands as we exhausted the resources on a parcel of land. However, our way of life, as our population has grown threatens our long term existence, because it entails desertification, toxic pollution, climate change, and habitat degradation. As a species we are not notably astute in responding to long term imminent threats. We camp out on volcano rims or keep fishing until the fish are gone or the tsunami arrives.

Jaisinghani[1] has taken these issues personally, however. In his book, *Homo Sapiens: An Appraisal of Modern Humans,* he takes into account pollution, population pressures, climate change, consumption, agricultural crises, increasing shortages of water and other minerals, and the imponderable forces of governance and economics. Jaisinghani also assesses humans' collective behavior and risk analysis when faced with long-term concerns. The record is not encouraging. He remembers his boyhood in Bombay (now Mumbai), a populous city of parks and access to the countryside.

> *The India that I lived in 50 years back does not exist. It has been wiped off the map and only exists in my mind. To me, except for the food and some cultural aspects, it has been transformed into something else. The population has gone from half a billion to 1.2 billion and culturally and physically the country has been transformed by technology and by the population—far more in the last 30 years than in the past 250 years. Indian society has transformed from a philosophical, non-materialistic and spiritual-based agricultural society that looked at our current existence as a small stepping-stone on the path of life. It is now largely a materialistic society, more materialistic than the U.S. . . . The country seems to be bursting at the seams. All one has to do is stand at a street corner and observe, while being continuously bumped by the stream of pedestrians at all times of the day . . .* (pp.121-122)

Jaisinghani's book also suggests some preconditions for addressing the accelerating degradation of the human habitat, the most important being to lower population growth rate, which drives consumption, greenhouse gas emissions, and depletions and degradations of all kinds. He does not advocate draconian regulations, it should be noted. While some decrease has been noted in the population growth rates for some countries, they are not “brakes” of sufficient magnitude to address such accelerating problems as greenhouse gas emissions.

The issue of population is complex. Not only are our numbers exploding, but our habits are changing for the worse. Our life styles have become sedentary and we are consuming more food and all kinds of goods. Even worse, , we are dumping more and more garbage and refuse and releasing toxic chemicals in the land, sea and atmosphere. Our habits include things that one does not expect from an intelligent species, such as contaminating critical resources of water and land, increasingly in short supply. Yes, we have a super intelligent large brain, but we often seem to be governed by our short-term, self-interested, primate instincts. Our primate instincts helped our survival and growth as long as our numbers were low. As our population has expanded they have become detriments.

Currently , at 7.3 billion people, the Earth is able to support about half of them living in a decent humane manner, while the other half live in abject poverty, lack of fundamentals such as clean water, food and sanitation. As we continue on this path and continue to emit carbon and affect global warming and climate change, the impact on the poor increases disproportionately. The ratio of humans living in humane conditions as compared to the global population decreases. So the important questions we need to critically pose are:

- What is the carrying capacity of the planet such that most humans can live in humane conditions?
- Can we continue to ignore the future impacts of climate change and our polluting effluents just so that we can provide more for the “other half”, the poor today? Will this not backfire as sea level rise, water pollution, fresh water shortage and loss of agricultural land make it more difficult to provide a basic decent sustenance for the other half? Is not the carrying capacity of the planet limited by climate change and the planet’s health itself?
- On a temporary basis, will the “haves” make sacrifices so that the “have nots” can live a little better? The alternative step of further industrialization, exploitation, and pollution of the environment seems moribund. Will humanity be able to confront the issues of eco-justice as it tries to address the complexities of population, consumption, technological development and their impacts on climate? These are not the kinds of questions science asks, but they are the questions scientists and engineers must ask if we are to successfully stop the runaway freight train that is global warming.

Clearly the carrying capacity of the planet is limited by the scenarios of climate change and CO_2 emission.

Paul and Anne Ehrlich[2] considered this question in *Population, Resources, Environment: Issues in Human Ecology*. They defined total environmental *impact* as the product of population size and impact per capita, where impact could be measured in such terms as rates of water consumption, waste production, and greenhouse gas generation, global temperature change, and so on. They made the point that the multiplicative power of exponential population growth drives total impact. In other words, various measures to affect individual impact, such as reduction of consumption, while desirable, do not appreciably affect the growth of total impact. They point out that "no technology can completely eliminate the impact of a given amount of consumption." (p.261) As for trying to define the carrying capacity of the Earth, one must somehow sum the total impacts of multiple factors in relationship to human health and well being. This is a different kind of problem than dividing arable land area, available water, or available coal by the population number. The Ehrlichs pointed out that the determination of an *optimum population size* is ultimately a moral and social calculation. The carrying capacity is better conceived as a chosen environmental setting that will support the many desirable ways of life followed by humans over the planet. Key considerations are health, economy, equity, well being, education, and preservation of desirable cultural patterns.

More people translate into more CO_2 emission and climate change. But there are other negative impacts of high population and high population density. Increases in population density are associated with higher crime, more poverty and disease, pollution, and a general breakdown of social structures that have been the fundamental pillars of civilization. Human life and empathy lose value and all higher aspects of human existence seem to take a back burner to survival. In Jaisinghani's [1] book, India is used as an example of what happens when the population of *Homo sapiens* goes out of control. He compares the India of today (1.2 billion people) to the India he grew up in (500 million) and points out that such growth is happening everywhere. For example in the same time period the US population grew from about 160 million to about 360 million. Thousands of years of a non-materialistic Indian culture has been transformed to a highly materialistic society in just decades. Clean water and air are now a rarity. Water tables are being tapped out (and the same is happening in the US and indeed worldwide). Yet most Indians think they have made progress as they are able to now afford technology gadgets, even as they ignore the fact that there is no room to walk on the streets of their mega metropolises, and that even breathing the air is dangerous. While to a certain extent pride in technological progress is understandable, it is difficult to understand how it is really progress when the number of people living in abject poverty keeps increasing. Each year 10 million Indians enter the job market and yet, given the land, resource and logistic limitations, there is no reasonable way to have enough growth to employ these people each year. Even if the environment were completely ignored, it is doubtful that enough economic growth can take place to enable jobs for this ever increasing number of people. Can India continue to ignore its explosive growth in numbers and simply overcome the logistical limitations by technology and economic growth?

In this paper, we shall focus on a narrower issue. We shall consider the impacts of advanced technology development, population and consumption of goods, with the aforementioned limitations and trends in mind, on CO_2 emissions. A simple analysis, based on certain assumptions, will be used to calculate the projected CO_2 emissions, under different scenarios. The assumptions used actually favor the prediction of lower emissions. For example, we do not consider the loss of CO_2 sequestration as a result of deforestation which tends to increase with population growth and agricultural demands. It is important to remember that it is reasonable to expect more climate change to occur if the CO_2 emissions are not curtailed. And with climate change come:

sea level rise, loss of coastal lands, rainfall changes, storms and other events which adversely affect not only Homo *sapiens* but on all species on this planet.

CO_2 Emission Model and Results

Efforts to forecast worldwide emissions of CO_2 continue to offer value since these emissions cause global warming and have been continuing to increase for many years. Any forecast must consider different types of parameters including those which are:

1) known and unchangeable, such as the CO_2 emission levels for past years as it relates to the increased use of technologies causing these emissions.
2) unknown, such as the positive and negative impacts of future technological advances that we can only imagine.
3) within our collective control to determine, such as population growth rate, level of energy consumption, and implementation of green energy solutions.

Forecasting this is difficult, but here our intent is to show the effects of technology, population and consumption under assumptions that are actually favorable to lower emissions. And this can be done rather simply, albeit the scenarios used here may be subject to considerable debate. The model proposes to use the most significant parameters to calculate a rough estimate of worldwide CO_2 emission levels in 2050. As a first marker in this race for survival, the emission level in 2050 is a good gauge for understanding what we need to accomplish. By trying out different values for parameters in the third category (above), one can create different scenarios to track possible future emission levels from various changes made today. The calculations involved are simple:

1. Based on 2014 data of CO_2 emissions and world population, we can calculate the per capita CO_2 emissions. The amount emitted is 35.9 Gt[3] which comes to about 5 GT per billion people in 2014.
2. We then assume under various scenarios the relative (%) increase/decrease of per capita consumption which is assumed to be directly proportional to the per capita CO_2 emission in 2050.
3. Similarly, we assume, under limitations discussed previously, the relative of percent advancement of technology that can reduce CO_2 emissions on a per capita basis, noting that throughout per capita is actually per billion people.
4. We then assume the population under various scenarios in 2050 using prior estimates and studies.
5. Knowing the population and the per capita (increase/decrease due to consumption and decrease due to technology advancements) emission we can then calculate the total emissions in 2050.

This model is limited by its assumptions, which as we have pointed out result in lower CO_2 emission predictions. These are:

a) It does not take into account methane and other green house gas emissions.

b) It does not take into account bovine emissions, (agricultural animal source CO_2 emissions due to digestion of food) which will rise proportionally with population unless we consume less meat.

c) Sequestration source losses (such as losses in forest cover etc.) will also increase as population increases. This is too complex to take into account in this simple model.

The results of the model with 5 scenarios are shown in *Figure* 2.

Figure 2 - Impact of Technology, Consumption and Population on Carbon Emissions and Global Warming, 2050

	BASE - 2014	**Scenario 1** Likely current trend - 50% increase in per capita consumption	**Scenario 2** 25% increase in per capita consumption	**Scenario 3** CO_2 Emission Reduction on War footing	**Scenario 4** Realistic Urgency
Per Capita CO_2 EMISSION 2014 basis	5.12	7.50	6.25	6.25	6.75
Population, billions	7.00	9.00	9.00	8.50	8.75
CO_2 Emissions sans technology impact	36.9	67.5	56.3	53.1	59.1
Technology Impact % Efficiency and Green Energy	0	35%	35%	45%	40%
Total CO_2 release Gt/yr	36.9	43.9	36.6	29.2	35.4

2014 Status

In 2014[4] 7 billion people released 35.9 Gt of CO_2 at a rate of about 5.1 Gt per billion people.

Scenario 1 – Current Trend Based Projection

In this scenario we assume that the population increases to 10.5 billion, and the per capita consumption of energy and resources increases by 50% (thus causing a 50% increase in per capita emission prior to factoring in technology impact) . This emission is reduced by 30% due to technology improvements (due to more renewable energy, higher product efficiencies and other advances such as in transportation etc.). This seems to be the current trend – this is discussed below.

<u>Population</u>: Most present day estimates are that our population will reach 11 to 12 billion before the end of the 21st century! This takes into account the main factors affecting our population: fertility, mortality, initial population, new birth control technologies and time. By 2050 most average estimates (these estimates are compiled and summarized by Jaisinghani[1] in Chapter 3 of his book) are about 9 billion people. It should be noted that this

is the most probable projection and it could be slightly higher or lower depending on the optimism applied in the projections.

Resource Consumption: Consumption of all resources per capita is increasing rapidly not only in developing countries, where the standards of living on an average must come up, but also in developed countries. Jaisinghani[1] has summarized the work related to increasing per capita consumption of resources and waste disposal in Chapters 3 and 4 of his book. Although there are no general projections available for growth in consumption of *all* resources, the trends are clear; driven by the growing industrial strength of the high population countries like China and India (and the fact that consumption of resources are not decreasing, but actually increasing, in the developed world) a 50% increase in per capita consumption, albeit debatable, is not an unreasonable estimate of the current trend. Additionally, there is actually a trend to encourage more and more consumption (consumer spending) in order for job growth that is necessary as the population expands.

Technology Advancement: This includes technologies that increase efficiency and new technologies that are yet to be developed. Considering the obstacles to technology development discussed earlier, and the projection period of 36 years, it is unlikely that given the current state of politics and economic systems, that technology will enable us to reduce the per capita emissions by more than 30%. Consider the following facts to understand why this 30% technology factor is reasonable:

1. The US Energy Information Administration 2016 report[5] covers projections for renewable energy sources for electric power (but they include hydroelectric power which has severe environmental downsides to it and is limited in its growth potential*): "Renewables account for a rising share of the world's total electricity supply, and they are the fastest growing source of electricity generation in the IEO2016 Reference case (Figure 5-4). Total generation from renewable resources increases by 2.9%/year, as the renewable share of world electricity generation grows from 22% in 2012 to 29% in 2040 (Table 5-2)"*. Note that hydro electric power makes up about 80% of the "renewable" energy in 2012 and projected to be about 50% of "renewable" in 2040. We do not consider hydro electric power to be truly renewable due to its severe impact on the environment and other species and the fact that our rivers are running dry in many parts of the world. However, hydro electric power does not directly produce CO_2 and so even with this DOE projection, 35% in electric power from renewable in 2050 may be the trend. Additionally, this DOE report also considers wood pellets as a renewable energy source. In our opinion this should not be consider renewable especially when one consider sequestration and land use loss as a result of using forest resources.

2. Governments throughout the world are spending less on fundamental research (and and non defense research in general) and this does not forebode well for development of new technologies. Jaisinghani[1] summarizes R&D spending statistics in his book (Chapter 4) by country and by technologies. Corporations are spending more and more resources on consumer goods and gadgets and not much on new technologies that can address these severe climate change threats.

3. Politically, it is difficult for governments to focus on long term solutions such as requiring the use of more efficient technologies, especially as the income gaps

between the rich and poor have increased; requiring use of efficient appliances, autos etc. affect the middle class and poor to a greater extent.

4. The movement towards transportation efficiency, electric automobiles and mass transit systems is not very encouraging. As fossil fuel prices are down these transportation components seem to have been put on the back burner.

This scenario based on current trends shows that our CO_2 emissions will increase to almost 44 Gt per year, even though our technology has advanced to enable a 35% reduction in CO_2 emissions on a per capita basis. This clearly demonstrates that the current approach of environmental groups focusing on just the development of technology and implementation of green energy will, *in a practical sense,* not be enough to even maintain existing emissions; these groups should simultaneously demand that governments provide more incentives and aid for having less children worldwide and for a move towards less consumption (and growth) in the developed world. Without these two additional goals there is little chance of stopping this runaway train we call global warming.

Scenario 2 – Limited Consumption Increase

One could argue that we could limit the increase in per capita consumption of resources, especially in the developed world and still have just enough growth for the underdeveloped world; it is difficult to imagine how we can have a world without wars and instability if the teeming population of the developing world does not have a significant increase in their standard of life i.e. more per capita consumption. In this scenario we assume that the per capita emission (prior to technology adjustment) only increases by 25%. *This may be unrealistically optimistic as the under developed countries need massive growth*. The population and technology factors stay the same as in Scenario 1. With these conditions, the total amount of CO_2 released remains essentially the same as in 2014.

Scenario 3 – Highly Optimistic; CO_2 reduction on a war footing

In this scenario we assume that the species Homo sapiens comes together and decided TODAY to put CO_2 reduction on a war footing and we do everything possible (within logistical restraint) to get our emissions down by 2050. Somehow all governments get the message that this is of critical importance to the survival of the species and life as we know it today. We accelerate our technology factor to increase to 45%; we somehow curtail our population growth to 8.5 billion and our consumption portion of CO_2 release increases only to the difficult to achieve level of scenario 2. These are practical limits given that there are less than 34 years to go before 2050 comes around. Under these circumstances, yes, we can reduce the CO_2 emissions to about 29 Gt per year and given another 100 years or so we may be able to stabilize the climate. Can we do this? Can we develop as a species to change our short term self interest behavior?

Scenario 4 – Realistic with Urgency

If everyone gets on board with the concept that we a) must address the population growth (limit it to 8.75 billion in 2050), b) reduce consumption (per capita emission factor to 6.75) in the developed countries i.e. they must be willing to make larger sacrifices having primarily caused global warming, and c) technology implementation and growth must be accelerated (emission reduction factor to 40%), then scenario 4 represents the results that could *realistically* be achieved, noting that even this is not going to be easy. In this scenario we can slightly reduce emissions to 35.4 Gt (keeping in mind that this estimate does not include loss of sequestration factors etc). Will this result in the stopping of the runaway freight train and can this allow our polar ice caps to recover? Maybe after a lot of time.

Summary

Clearly any realistic approach to achieve CO_2 reduction and stabilizing our climate must simultaneously address all three aspects, population, consumption and implementation and development of green technologies. Education and leadership are critical to achieve any significant reduction. A war footing path towards this must include (see also Jaisinghani[1] for a more detailed discussion of the path) :

- The reorientation of environmental and other advocacy groups. These benevolent groups must stop pursuing narrow objectives such focusing ***only*** on children's issues, green energy or species protection or forest deforestation. ***Simultaneously***, at every occasion they must talk about other factors since all these factors interrelate.
- We must all do everything to remove the taboo associated with population and non draconian population reduction. All governments should adjust their tax and other policies to encourage population reduction; no more tax deductions beyond one child for example.
- Just as we prepare environmental statements for new development projects we must prepare population assessment statements for all policies and laws. If a policy will not encourage population reduction then it must be altered to do so.
- A change towards non growth economies in developed countries is a just and fair, but extremely difficult (almost impossible) requirement. After all it is the western developed world that has released the most carbon cumulatively since the industrial age. They therefore must bear the major burden of the sacrifices required. Without these sacrifices, we cannot achieve reduction in consumption. And yet we are faced with the dilemma of allocating more resources to half the world population that lives in disparate conditions. The only way to achieve lower consumption is to accept the condition that we are willing to live in a world in 2050 with more than half of humanity living in extreme poverty and also with the associated wars and diseases that will penetrate into western societies; no wall will stop this scourge.

Perhaps the reader disagrees with these scenarios and conditions we have put forth here. In that case the reader is invited to design their own scenarios using our online web CO_2 estimator: http://cognizantsystems.com/CO2.html

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1. Jaisinghani, R. (2015). *Homo sapiens - An Appraisal of Modern Humans.* Manchester, UK: Siri Scientific Press.

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3. Carbon Dioxide Information Analysis Center, Environmental Sciences Division, Oak Ridge National Laboratory, Tennessee, United States. http://cdiac.ornl.gov/GCP/ 2016.

4. cf. Global Carbon Project, http://www.globalcarbonproject.org/carbonbudget/15/hl-full.htm#pathways, 2016.

5. International Energy Outlook, 2016, US Dept. of Energy report: DOE/EIA-0484(2016) I May 2016

6. For more on Annawadi slum, see Katherine Boo's *Behind the Beautiful Forevers.*

7. Patricia Boyce Simms is a facilitator for Movement Building in Solidarity @ www.geo.coop