A Nelson Mandela Perspective on Global Warming

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Fig. 1(a) Earth as seen from the Moon (b) Earth’s climatic zones (c) An island off Sicily

War is too important to be left to generals, the future of Earth too important to be left to scientists. We should therefore applaud Al Gore, a well-known politician and businessman, and the late Michael Crichton, a prolific novelist, for investigating the impact of human activities on the planet, and for bringing their assessments to the attention of the public. Unfortunately, Crichton in the thriller “State of Fear,” and Gore in the documentary film “An Inconvenient Truth,” reach contradictory conclusions. Gore, in the early 1990’s already, insisted that the man-induced rise in the atmospheric concentration of carbon dioxide is causing global climate changes, that disasters are imminent, and that immediate action is imperative. Crichton came to the opposite conclusion. He asserted that the rise in the atmospheric concentration of carbon dioxide poses no threat whatsoever. How can two highly educated, responsible gentlemen, both of whom assure us that they love and cherish the environment, disagree so completely about a matter as important as the future of our unique planet, the only one known to be habitable?

Gore and Crichton respectively represent the “believers” and the “deniers,” the two large groups that dominate and polarize discussions of global warming and make agreement on a response to threats to planet Earth difficult. For guidance on how to proceed we turn to Nelson Mandela who earned universal admiration for the way he unified his country, South Africa, when it was so divided that it was on the verge of a civil war. To appreciate how he achieved success, we need to know about the differences between foxes and hedgehogs. This is a reference to a line from an ancient Greek poem by Archilochus (7th-century b.c.e.): The fox knows many things, but the hedgehog knows one big thing. To cope with any problem, a hedgehog has one, simple defensive strategy: rolling up into a ball of sharp spikes. A fox on the other hand is circumspect and devises a myriad of strategies to reach his goals. To deal with our immensely complex world, is it best to be as single-minded as a hedgehog, or to adopt the pluralistic approach of a fox? Mandela knew when to be a hedgehog, when to be a fox.

Mandela was a hedgehog when, in 1964, at his court trial in South Africa, he stated that “I have cherished the ideal of a democratic and free society in which all persons live together in harmony and with equal opportunities. It is an ideal which I hope to live for and to achieve. But if needs be, it is an ideal for which I am prepared to die.” After his subsequent, lengthy imprisonment he became president of a country so divided that fear of an imminent civil war led to the emigration of close to a million people, mostly young, white and highly educated. Mandela, to stem this exodus of talented youth, and to unite his people, took advantage of a sports tournament, the Rugby World Cup, held in South Africa in 1995. Politicians routinely use sports for their own purposes, but Mandela faced a formidable challenge because, in South Africa, at that time, rugby was a game of the white elite and as such was a symbol of oppression. (The game of black youths is soccer. To the uninitiated, soccer differs from rugby mainly in being played with a round, not an
oblong ball.) Mandela had to persuade South Africa’s mediocre team to outdo itself, and had to convince everyone, whites and blacks, to support the team. Initially he knew essentially nothing about rugby except that white South Africans are fanatical about it, and that black South Africans detest it. To overcome these obstacles, he adopted the approach of a fox. He took a keen interest in rugby, learnt about the game, its rules, strategies, and star players, and persuaded everyone else to do the same. The white players visited the slums to introduce the blacks to the game, and gradually the blacks started to support the national team. Clint Eastwood’s film *INVICTUS* tells the tense, exciting story of how Mandela succeeded. By democratizing rugby he transformed a symbol of oppression into a symbol of unity. Can science, which to many people, is elitist, esoteric and boring, be democratized? A question concerning the annual global climate changes everyone experiences, the seasons, illustrates how daunting this challenge is.

Why is summer warmer than winter? Twenty-three Harvard University students, faculty members and alumni, all elegantly attired in colorful caps and gowns, were asked this question on a sunny graduation day in Cambridge, Massachusetts in 1986. In a video¹ of this event all but three reply that the Earth is closer to the Sun in summer than winter. One student, after being told that her answer is “incorrect” remarks that: “I’ve never had a scientific background whatsoever … and have gotten very far without having it.” Hers is a valid point. Ignorance of the reasons for the seasons is not a handicap when trying to cope with the seasonal cycle. All we need is an accurate calendar. In general, scientific illiteracy is not a serious drawback when using the products of science – calendars, cell phones, computers etc. Why the concern about scientific illiteracy? What is it that everyone should know about science? What will the benefits be? In the video, the two fellows who precede and follow the girl who knows no science, also make thought-provoking statements. Both have had numerous science classes, but they too give the “wrong” answer to the question about the reasons for the seasons. (One fellow mentions his courses in physics, planetary motion, relativity and electromagnetism.) Something is wrong with the way science is taught. The problem is urgent, now that school children are demanding that their elders take action to counter global warming.

Teachers cringe when students attribute the seasons to the Earth being closer to the Sun in summer than winter, but this seemingly wrong explanation can be an excellent introduction to the powerful methods, and also the serious limitations of science, provided it is treated as a testable hypothesis. Such an approach conveys an important message: science is a method of enquiry that insists on the testing of all assumptions and beliefs, hence its sobriquet “organized skepticism.” The method is powerful. It produced the electronic devices that are now transforming our daily lives, and also inspired the leaders of the Enlightenment and the American Revolution to challenge accepted beliefs and customs. False beliefs prevailed for a while in debates about the shape of the Earth – flat or round? -- but had to be abandoned because of the unquestionable value of accurate maps that facilitate navigation from one part of the globe to another. Is the Earth at the center of the universe? Or merely one of several planets orbiting an average Sun on the outskirts of an average galaxy? The prolonged and passionate arguments that these questions generated were in due course resolved because science explained phenomena such as the seasons and eclipses, and improved the accuracy of calendars. The misnamed last four months of the year -- September ought to be the seventh, December the tenth month – hint at the disputes that preceded these advances. Those quarrels are salutary reminders that, in science, progress is the product of arguments, debates, and a willingness to change our minds when the evidence demands it.

Science is powerful, but nonetheless has severe limitations; it is mute on ethical issues and by itself cannot cope with problems involving both science and ethics. Global warming is such a Tragedy of the Commons² because it has a scientific component – how will rising atmospheric CO₂ levels affect the global climate? – and it also poses wrenching ethical dilemmas: what are the roles of governments and of markets in dealing with this problem? what is the appropriate balance between our obligations to future generations, and our responsibilities to those suffering today, those living in abject poverty? The ethical issues require empathy, compassion and a willingness to compromise, in sharp contrast to the unemotional, objective approach that scientific questions demand. A hedgehog can resolve disagreements about Earth’s shape and location, but
The seasonal cycle is a phenomenon whose occurrence at a time of global warming can nonetheless be important lesson concerning global warming can nonetheless be learnt from the television coverage of the hurricanes: these phenomena can inflict severe damage despite accurate scientific information. Houston is known to be vulnerable to hurricanes because of its proximity to the Gulf of Mexico. Several days in advance of the arrival of Harvey meteorologists provided the citizens of Houston with accurate forecasts of its timing, path and intensity. What happened in Houston demonstrates that the solution to a Tragedy of the Commons requires much more than scientific information. Freedom from regulations and compromises comes at a cost. The cost is far, far lower in the case of Harvey than global warming which affects everyone on the planet. Scientific complexities cause uncertainties in forecasts of climate changes over the next few decades, but uncertainties do not justify inaction. We are playing with fire. Mandela’s advice would be adoption of the strategies of a hedgehog in insisting on justice for all, especially the poor, and of a fox to persuade everyone of the need to try a diversity of approaches. To appreciate what is at stake requires familiarity with the wonders of our amazing planet whose habitability depends on “the ordinary stuff which is our lives, the things people write poetry about – clouds - daffodils – waterfalls – and what happens in a cup of coffee when the cream goes in – these things are full of mystery, as mysterious to us as the heavens were to the Greeks.”

The key to the alleviation of poverty, the highest priority in South Africa and many other countries, is an education whose goals include the acquisition of skills needed in a variety of jobs, and also the building of self-esteem and self-confidence to tackle problems not encountered before. (Apartheid aimed at undermining self-confidence.) The seasonal cycle is an excellent vehicle for such an education, one that
familiarizes everyone with maps and graphs, the tools of science which many people find daunting. The colorful map of Earth’s glorious diversity of climatic zones (fig.1a) surely appeals to all of us, and arouses curiosity, about our location on the map, and about other zones, about deserts and jungles, prairies and savannas, whose varying amounts of rain depend on winds and clouds. Winds harvest water over the ocean and deposit it in fantastically-shaped granaries, clouds that bring us rain which ultimately flows back to the ocean. Some of that water flows through our bodies so that we participate in global recycling. Earth is habitable because of continual recycling, not just of water, but also of O₂ and CO₂ which we inhale and exhale every few minutes. Recycling weaves the diverse climatic zones, and all of us, into a unified mosaic.

A study of the seasonal cycle can make us aware that all living things are interdependent, that “No man is an island.” Seen from the moon, Earth, because of its mosaic of climatic zones becomes a Blue Marble, a fragile space-ship with a precious cargo traveling through inhospitable space. The picture, in fig 1b, evokes strong emotions and moved astronaut Alan Shephard to remark that If somebody had said before the flight “Are you going to get carried away looking at the Earth from the Moon?” I would have said “No. No way.” But yet, when I first looked back at the Earth, standing on the Moon, I cried.⁵ Many people shared those emotions when shown that picture more than 50 years ago. It unified us for a short while, and can do so again. We are on that space ship which, to maintain habitable conditions, receives merely sunlight whose daily and seasonal cycles are the rhythms of our lives. Beats on much longer timescales are implicit in geological records such as the strata in fig.1c that lead to the graphs which tell a most amazing story.

Once upon a time all the continents were clustered around Africa in the super-continent named Pangea. Then, very, very slowly, they started drifting apart. Australia separated from Antarctica, India married Asia, the Atlantic expanded, the Pacific contracted, the Rockies rose, and the Appalachians fell. Dinosaurs ruled for much of this time, until their sudden demise some 65 million years ago. At that time Earth was so hot and humid that there were no glaciers anywhere, but changes in the atmospheric composition -- a lowering of its concentration of greenhouse gases, a consequence of the rise of mountains and the sporadic eruption of volcanoes -- caused global cooling that favored the evolution of exotic mammals, of giraffes, elephants, hippopotami and our ancestors, African hominids. By 3 million years ago both poles had ice-caps. Thereafter glaciers started to wax and wane with an amplitude that grew dramatically. Our species, Homo sapiens, arrived in the midst of those upheavals. We did not amount to much at first, but took advantage of the most recent of the temperate interglacials that separate prolonged Ice Ages, to grow in prowess, and in number, with such astonishing speed that an inadvertent byproduct of our activities -- the sharp rise in atmospheric CO₂ levels seen in fig.2b -- turned us into geologic agents interfering with the processes that make the planet habitable.

![Fig. 2(a)](image)

This graph of temperature fluctuations inferred from sea-floor cores⁶ tells a story about global cooling attributable to the drifting of continents after the demise of dinosaurs early in the Cenozoic. This cooling led, around 3Myr ago (at the red line where the timescale changes) to the onset of recurrent Ice Ages interrupted by brief interglacials. (b) Ice-cores from Antarctica⁷ show atmospheric temperature (blue) and CO₂ concentration (red). Humans advanced rapidly by taking advantage of the temperate climate of the current interglacial, and inadvertently caused the spike in CO₂ concentration at the end of the red record.

We are now Earth’s dominant species, and hence its stewards. From the long-term perspective of fig.2, Earth is remarkably robust. It has always been habitable, despite enormous climate changes that were
associated with the appearance and disappearance of innumerable species. We, *Homo sapiens* progressed with impressive rapidity over the past few millennia, but in doing so have increased our vulnerability to modest, natural climate changes such as an abbreviated or prolonged wet or dry season, and especially to climate changes we are inducing by elevating CO₂ levels. What will the consequences of our actions be? The available answers have uncertainties because global warming increases evaporation from the ocean, bringing into play the versatile and remarkable gas water vapor, a greenhouse gas more powerful than CO₂ that can accelerate global warming, unless it condenses into clouds that reflect sunlight and cool the planet. To predict future global climate changes, scientists have to anticipate the behavior of whimsical clouds. We need to accept that the present is a precarious moment, a time for caution and circumspection.

To have a team capable of winning the soccer World Cup, a country needs eleven excellent players, but to produce that team, every child in the country should have an opportunity to kick a ball. Science, to flourish, similarly needs a broad base of support. To be effective, teachers of science must avoid atomizing “… knowledge into pieces that don’t have a home in a larger conceptual framework. When this happens, we surrender meaning to guardians of knowledge and it loses its personal value.” Lessons in cloistered classrooms need, as complements, opportunities to explore the magic and mysteries of “the ordinary stuff which is our lives, the things people write poetry about…” The seasonal cycle is an excellent vehicle for this purpose, for making everyone aware that we are in a very special place – the only planet known to be habitable -- at a very special time, a precarious moment, in the eventful history of planet Earth. The first step is to treat the “incorrect” statement that Earth is closest to the Sun in summer as a testable hypothesis. Anyone with access to the internet can quickly discover what Copernicus knew ages ago: we are closest to the Sun in January. Next, use the internet to learn that January is winter to some people, but is summer to others. The seasons involve more than distance from the Sun. To explore the matter, exchange with someone in another climatic zone, selfify of yourself and your shadow, taken at the same time of the day over the course of a few weeks. You’ll discover that people in distant parts of the globe, with similar tastes in music and clothes, can have shadows that grow longer while yours grow shorter. All of us celebrate the day our shadows are at a minimum – the start of a new year – or a maximum, an occasion for euphoria in Scandinavia. Those days -- solstices or equinoxes? – have been special for many, many generations. In the distant past our very early ancestors were all clustered around Africa before embarking on remarkable journeys to our current locations. Each neighborhood (climatic zone) has evidence of that journey in the form of rocks, mountains, fossils, plants, birds and other animals. Provide your new friends with a video of what is special about your neighborhood. Earth’s diversity of climatic zones, each with distinctive flora and fauna admirably adapted to its distinctive seasons, makes ours a very special planet whose stewardship is the responsibility of all of us because “No man is an island.”

Earth, when seen from very far away, is merely a pale blue dot, but “That's home. That's us. On it everyone you love, everyone you know, everyone you ever heard of, lived out their lives... every young couple in love, every mother and father, hopeful child, inventor and explorer, every saint and sinner in the history of our species lived there--on a mote of dust suspended in a sunbeam.”

1. The You Tube video “Harvard, A Private Universe” is available from Annenberg Learner
3. Gelles David Weather Channel goes into over-drive, New York Times, 9 September 2017
4. Tom Stoppard Arcadia 1993
5. Alan Shepard, Mercury 3, Apollo