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Controlling Climate Change

Since 2015 there have been three UN-sponsored conferences on Climate Change: Paris in December 2015, Incheon (South Korea) October 2018 and Katowice (Poland) December 2018. Paris set the framework; all countries must act collectively if the Earth's temperature by the end of this century can be limited to 2.0 °C above that before the Industrial Revolution 150 years ago. Incheon said 2.0 °C was too much, and all countries should aim for 1.5 °C. Katowice set the ground rules about how these temperature increases could be monitored and implemented. What is noticeable is that no reputable scientist now disputes the phenomenon of Climate Change; this was not the case ten years ago. Incheon raised eyebrows with their headline summaries. For example, (1) global temperatures are currently increasing at 0.2 °C per decade: we are already 1.0 °C above pre-Industrial levels, so could reach 1.5 °C within 25 years, (2) global emissions of CO₂ need to fall by 45% from 2010 levels by 2030 and reach zero by 2050 if we are to hit 1.5 °C, and (3) the runaway greenhouse effect will kick in with disastrous consequences if the temperature rise by 2100 exceeds approximately 3.0 °C.

In mid-2017 I was asked to write the lead article on Greenhouse Gases for the 3rd edition of *Encyclopedia Analytical Sciences*, publish date February 2019. After discussions with Elsevier, this became two closely-referenced articles [1,2]; the first on the science of greenhouse gases and its current situation, the second on what individuals, governments and the UN could and should do, accepting that Climate Change is for real. Both articles, whose timing is prophetic, were published online in autumn 2018. This will be the first generic article on greenhouse gases in *EAS*.

The first article is straight science. The second article is more subjective, and different scientists would doubtless write differently about which issues people should concentrate to mitigate the effects of Climate Change. I concentrated on religion, and wrote how my Quaker (Society of Friends) background and its 'testimonies' on Social Justice, Equality and Sustainability have led me in certain lifestyle directions. This article is probably easier for the non-scientist to understand.

The main conclusion from the first paper is that only one number has changed significantly over the last six decades, the total radiative forcing of all secondary greenhouse gases, caused by an increasing atmospheric concentration of the major component, CO₂. In 1960 the former figure was 1.17 Watts per square metre, in 2013 it was 2.83 (same units), now it is probably slightly higher. The units are unimportant, what is significant is the 242% increase in this number over six decades. Over these years, the CO₂ concentration has increased from 310 to just above 400 parts per million by volume. The other *important* figure, however, has not changed; 80-85% of contributions from greenhouse gases to the overall effect is due to two gases only, CO₂ and CH₄, with the former's contribution being approximately 3.5 times that of the latter. Yes, there are more gases contributing to the greenhouse effect than was appreciated sixty years ago. Yes, some of the finer details of infrared radiative efficiencies and global lifetimes of greenhouse gases are much improved. But these are small effects.

The main conclusion from the second paper is that an individual should wear more clothes and turn down room temperatures, fly and drive less, become vegetarian and so on, but this will have negligible effect because this is just one person's, out of 7.4 billion people, contribution to a global problem. Governments will have to step in and impose policies that, by law, affect every person in that country. Finally, world organisations will need to set world policies, and the UN is the only serious possibility. Possibilities are carbon taxes and levels of world population.

Furthermore, I believe that if Climate Change is not controlled, global migration of people from the low-lying countries of the Southern hemisphere to high-lying countries in the Northern hemisphere will happen on a scale that will make the current migration issues in Europe seem miniscule. After these three conferences, we cannot say we were not warned.

[1] Greenhouse Gases, DOI: 10.1016/B978-0-12-409547-2.14031-4

Elsevier Reference Module *Chemistry, Molecular Sciences and Chemical Engineering*

[2] Global Warming and Climate Change: what can we do, what should we do? DOI: 10.1016/B978-0-12-409548-9.11355-7

Elsevier Reference Module *Earth Systems Environmental Sciences*