

CLIMATE CHANGE & HEALTH; AN OVER VIEW

Introduction:

“The state of mind determines the state of society and the state of society determines the state of the environment”

Dr. T.V. Muralivallabhan, College Principal, India

Climate change is a reality and is happening now. It will affect every aspect of our lives over the next few decades and way into the future. [1] [3] In Ireland the data indicates that there has been an average temperature rise of 0.25°C per decade in recent decades with a distinct precipitation gradient from north to south, being wetter in the north and drier in the south. [61]

It is not just an environmental issue but has major economic, political, social, cultural, educational, security and of course, health implications. As regards the latter, in 2009, after a year long commission held jointly between The Lancet and University College London, involving many disciplines, the opening sentence of the resulting executive summary is “climate change is the biggest global health threat of the 21st century”. [4]

Climate change is inevitable but its worst effects may still be avoidable, according to Professor Barry McMullin, (Dean of Electrical Engineering & Computer DCU). [8] Mitigation (significant reduction in greenhouse gas [GHG] emissions) is required in conjunction with adaptation to help us cope with the inexorable upcoming changes.

At present, global emissions of GHGs continue to increase, largely due to the “catch-up” effect of developing countries. Because there is a lag period between the release of GHGs and the temperature rise and because the gases persist in the atmosphere for a prolonged time the current burden of gases will continue to cause warming for many centuries. If we continue in a ‘business as usual’ scenario it will inevitably lead to further increasing global temperatures which are already set to top the so-called “safe” limit of 2° C by 2050. [2] This will destabilise the planet’s ecosystems with potentially devastating results for humanity

However, by working together pro-actively, health professionals can - instead of facing the “biggest global threat to health”- turn it into “one of the most significant health opportunities”. [5] [58]

It is vital that we act immediately as there is increasing evidence that incremental adaptation may not be sufficient to avoid intolerable risks. Transformative change may now be required (5AR Ch. 16). [3]

Historical Notes:

John Tyndell (1820-1893), born in Co. Carlow, who became Professor of Natural Philosophy (Physics) in the Royal Institute of Great Britain, and later its Superintendent after Michael Faraday, was the first scientist to show that gases (water vapour, CO₂ and ozone) could absorb heat. Later, Svante Arrhenius (1859-1927) in

Sweden, a Nobel prize winner for chemistry in 1903, wrote a paper in 1895 showing that an increase in CO₂ and water vapour could increase ground temperature - the 'Greenhouse Effect'. [6]

In 1988 the IPCC (International Panel on Climate Change) was formed jointly by UNEP (United Nations Environmental Program) and the WMO (World Meteorological Organisation) due to scientists' increasing concerns about evidence emerging that climate was changing, which was thought to be at least partly due to the release of CO₂ from fossil fuel combustion. [6]

The IPCC is an intergovernmental organisation representing 195 UN member states. It has produced a number of reports known as Assessment Reports (AR), beginning in 1990 (FAR – First Assessment Report) and repeated approx. every 6 years. The most recent is AR5, the first part of which was released in September 2013. The reports are in three sections, produced by three working groups (WG) with a summary for policy makers (governments etc) plus a 'Synthesis Report' for each part. WGI deals with the physical basis of the evidence; WGII deals with the impacts, adaptation and vulnerability; WGIII deals with mitigation. Many thousands of the world's leading scientists in numerous disciplines have been involved in the five reports over the years.

There have also been a number of special reports (8) dealing with specific issues, written by two or more scientists specialising in that particular area.

The Science of Climate Change:

The basic science whereby certain gases in the atmosphere have a warming effect is well understood and has been recognised since the 19th century as mentioned above. Approx. one third of the sun's incoming radiation (shortwave, ultraviolet and visible light) is reflected back into space by the earth's atmosphere and the rest is absorbed by land and the oceans. They in turn give out long wave radiation (infrared) which is absorbed by atmospheric gases - mainly CO₂ (carbon dioxide), methane (CH₄), ozone, water vapour (H₂O) and nitrous oxide - the so called 'green house gases' (GHGs). [6] This effect is an essential prerequisite for a mild, stable global temperature, such as has permitted the evolution of the extensive biodiversity extant in the world today. Unfortunately, the recent increase in concentration of these gases in the atmosphere, due mainly to human activity (burning fossil fuels/deforestation/agricultural practices/production of cement) in the past 150 years, has resulted in an increase in the average global surface temperature. [2]

There are two important points to note about CO₂, the main GHG;

One is that the average global surface temperature is proportional to the atmospheric CO₂ concentration - the higher the concentration the higher the temperature. This has risen in the past century and a half from approx. 280 ppm (parts per million) to 400 ppm last year, an increase of about 40%, and it is still increasing. [2] [7]

The second point is that, once released, CO₂ remains in the atmosphere for a very long period (thousands of years), therefore the CO₂ we release now will remain as a

‘climate forcing agent’ for millennia. [2] The result is that global temperatures have gone up by 0.85°C since 1880 and about 0.5°C of this since 1979 (Professor J. Sweeney NUI Maynooth). [8] The corollary of this is that even if we ceased all CO₂ emissions today the temperature will continue to rise to a predicted 1.5°C by 2050 due to the time lag of temperature response to GHG’s. In Ireland each of the last three decades have been warmer than all preceding decades since 1850. The last 30 year period has been the warmest for the past 800 years (climate is officially measured in 30 year periods). [8] Crucially, the *rate* of warming has been greater than anything that has occurred in at least the past 2.5 million years.

“I think human beings are a failed species - we’re on the way out”

Michael Boulter, Professor of Paleobiology, Natural History Museum, London and University of East London.

Climate Forcing and Feedback:

Forcing refers to cosmic or earth based changes which alter the earth’s temperature and thereby destabilise climate. Feedback may be either positive – causing increased warming, or negative causing decrease warming. Factors include:-

- Changes in earth’s orbit and axis tilt which leads to shifts in geographical and seasonal sunlight - over 20,000 to 400,000 years e.g. the various ice ages.
- Albedo (reflectivity) Increased reflectivity is cooling (negative feedback) but warming means more ice and snow melt therefore less reflective causing increased heat absorption causing more melting = positive feedback
- CO₂ increases (a) natural- warming soils and oceans release more CO₂ and other GHGs which causes increased greenhouse effect = positive feedback.

(b) anthropogenic- burning fossil fuels, farming practices, destruction of forests.

- Aerosols e.g. black carbon (volcanoes, coal burning) - can be deposited on snow/ice reducing reflectivity = positive feedback. Also by blocking incoming radiation may have a cooling (‘dimming’) effect = negative feedback.
- Water vapour is a very important positive forcing agent. The warmer the atmosphere/ocean the greater the evaporation the higher the water vapour concentration.[2]

Tipping Points:

The IPCC has identified certain ‘tipping points’ which could result in uncontrollable, runaway climate change due to feedback mechanisms (see below). In other words instead of a gradual (but historically very rapid) warming, certain factors (combinations of identified risks) could precipitate an abrupt, severe rise in temperature with catastrophic consequences for all global ecosystems. These included:

- Permafrost melt- the release of vast quantities of methane. Also from sea bed methane hydrates in a warming ocean.
- Arctic sea ice loss - loss of reflective snow and ice causing increased heat absorption –the albedo effect.
- Greenland ice sheet melt - increased heat absorption and elevation of sea level.
- Boreal and Amazon forest die back - release of CO₂ and loss of carbon ‘sink’.
- Instability of the west Antarctic ice sheet – additional sea level rise.
- El Nino Southern Oscillation (ENSO) change in amplitude or frequency - increase in extreme weather events. [2]

“An Armageddon is approaching at the beginning of the third millennium. But it is not the cosmic war and fiery collapse of mankind foretold in sacred scripture; it is the wreckage of the planet by an exuberantly plentiful and ingenious humanity”
Professor E. O. Wilson, Harvard University (‘The father of Ecology’)

Representative Concentration Pathways (RCPs)

In order to assist governments and decision makers in planning for the future in terms of mitigation and adaption the IPCC formulated in AR5 four scenarios with varying levels of GHGs (radiative forcing). These RCPs attempt to cater for the complex effects of climate change and don’t just refer to rising temperatures. They are designated by numbers; 2.6, 4.5, 6 and 8.5 which refer to the radiative forcing in W/m², the lower number representing a reduction in forcing and the upper representing a business-as-usual scenario leading to profound devastating effects on the ecosphere, including humanity. [2]

2°C Limit:

As mentioned with the “Copenhagen Accord” (see below) politicians settled on 2°C as the limit for acceptable warming. However, many scientists think this is far too lenient. Kerry Emmanuel of MIT (a leading authority on hurricanes) states that “any number much above 1°C involves a gamble”. Thomas Lovejoy, former Chief Biodiversity Advisor to the World Bank said, “if we are seeing what we are seeing today at 0.8°C, 2°C is simply *too much*”. James Hansen of NASA, arguably the world’s most prominent climatologist, has said that 2°C is “actually a prescription for long term disaster”. Author, journalist and climate researcher Bill McKibben wrote “Political realism has bested scientific data” (June 2014). [10] According to World Energy Outlook 2012 if existing fossil fuel resources were burnt it would release 2,860 Gt (gigatonnes) of CO₂, about three times the global carbon budget required to keep the temperature below 2°C. [11]

It therefore follows that fossil fuels, despite the protestations of ExxonMobil, Shell etc. and the coal industry, are basically outmoded and the billions of dollars invested in buying resources and in exploitation are essentially wasted, including those invested in hydraulic fracturing (‘fracking’) for ‘unconventional’ hydrocarbons. In a

report titled “Unburnable Carbon 2013” from the London School of Economics and Carbon Tracker (a London based NGO) it was concluded that burning known resources of fossil fuel is incompatible with meeting the 2°C Copenhagen Accord target. Therefore, investing in fossil fuel companies is not only contributing to the potential destruction of the planet’s ecosystem but is unwise financially. The International Institute of Applied Systems Analysis (IIASA) [62] point out that if the \$500 billion per annum spent on subsidies for the fossil fuel industry was diverted to pay a portion of the estimated \$1200 billion investment per year required to fund development of ‘clean’ energy infrastructure, it would make the international community’s task much easier. To this end investors and institutions are now beginning to divest from fossil fuel stocks. Stanford University in the US has just got rid of its coal stocks. Students at Harvard and Washington Universities are protesting, trying to force the hand of their authorities to do likewise. [12] At the recent BMA representative AGM a motion was passed supporting the BMA’s transfer to “100% renewable” electricity supplier and to transfer investment funds from energy companies that rely on fossil fuels to those that provide renewable energy. [13] The World Bank and private investors are refusing to fund unabated coal burning facilities [14] and even the US is at last showing some signs of a ‘Damascus road conversion’ with President Obama’s legislation requiring coal burning power stations to limit CO₂ emissions. This will have the effect, hopefully, of preventing the construction of new facilities. It has also been reported that China is limiting construction of new plants in some areas.

“Rapid technological advances in renewable energy are stranding carbon investments; grassroots movements are building opposition to the holding of such assets; and new legal restrictions on collateral flows of pollution - like particulate air pollution in China and mercury pollution in the U.S.- are further reducing the value of coal, tar sands, oil and gas assets.” Al Gore, ex US vice president June 2014 [14]

Despite the fact that coal is well known to be the most polluting (in terms of both CO₂ and particulate air pollution) [3], the use of coal in Europe is actually increasing, mainly due to cheap imports. [15] There is increasing pressure from environment/health groups within Europe to try to persuade the European Commission to introduce Emissions Performance Standards (EPS) for coal fired power stations, initially new ones and later existing ones. The UK has already introduced limits (450g CO₂/ kWh) and the European Investment Bank uses the same criterion for its funding. [17]

The good news is that according to the European Environment Agency (EEA), the official EU environmental watchdog, the EU as a whole has exceeded its targets for GHG emission reduction. [18] However, the Irish EPA has said that our GHG emissions will remain stable until 2020 which will be 5-12% below 2005 levels when we are obligated to reduce emissions by 20%. The major reason for this failure is the emissions from agriculture (predicted to increase by 15%) and transport (predicted to increase by 9%). Dr Laura Burke, Director of EPA said that we need to make changes urgently to “indicate rapid decarbonisation of energy and transport and the adoption of sustainable food production, management and consumption systems”. Dr Eimer Cotter, Senior Manager EPA, stated that “we need to translate our national commitment into action on the ground if we are to deliver the required emission

reductions”. [19] Unfortunately, the government scheme “Food Harvest 2020” is leading us in the opposite direction by proposing non eco-based intensification and should be scrapped or modified substantially. The IPCC AR5 indicates that climate related impacts are already reducing crop yields in some parts of the world; a trend that is projected to continue and worsen as the temperature rises. [3] A recent paper (Westhoek et al) published by Science for Environment Policy (the EU Commission) investigated the effects of a 50% reduction in beef, dairy, pork, poultry and eggs in diets of the EU 27 and filling the deficit by cereals. The results show that the demand for animal feed would drop from 520 million tonnes to 285 million tonnes. This implies that 30 million tonnes of cereal would become available for humans and imports of soy bean meal would be reduced by 75% with the co-benefit of improved population health. Moreover 23.7million hectares of land, previously used to grow fodder, would be freed up for other uses. [20]

Effects of Global Warming:

We are thus now committed to a warming world, but how much? How quickly? And with what effects? The IPCC has attempted to answer these questions in their five reports over the last twenty five years.

Worryingly, as the evidence mounts and the sophistication of the climate modelling improves, the predictions and warnings have become increasingly severe. Allowing for the fact that the reports have consistently *underestimated* the spread and severity of effects, and because IPCC reports are based on published peer reviewed papers from around the world and the complexity involved in the reports, there is a time lag of 3-5 years vis-a-vis the original research. [21] In other words even AR5 is essentially already out of date which may be important given the ever increasing pace of CC.

In 2007 the AR4 defined 2°C (3.6°F) as the maximum temperature rise compatible with a reasonable chance of maintaining stable ecosystems and human social systems. [9] This 2°C limit was confirmed politically in Copenhagen (COP15) in 2009 (The Copenhagen Accord) and again in Cancun (COP16) in 2010 which detailed that the increase was to be relative to preindustrial levels. [22] Many experts believe that even this level of warming is technically dangerous. There is also a growing consensus that without immediate, drastic cuts in carbon emissions this limit will be exceeded. [21] The effects will primarily be physical and environmental (ecological) with knock-on effects on all human systems, including healthcare systems. [3]

Sea Levels:

Melting ice and snow will contribute to sea level rise along with thermal expansion of water due to heating. The Greenland ice cap melt will be the major source of excess water in the short term along with mountain glaciers. [3] There has recently been strong evidence that the west Antarctic ice sheet that heretofore had been thought to be a low risk for melting, is in fact becoming unstable. [21] [23] [This would add an extra 3.4m to global sea level rise in addition to the most recent estimate of the order of 1m by the year 2100. These estimates assume in part a linear relationship between warming and sea level rise but it has been agreed that in a business-as-usual scenario (BAU) of CO₂ emission there could be a non-linear response of multi-metre sea level

rise this century. [1] [21] AR5 of the IPCC summarises without giving actual predicted levels *“that it is very likely that there will be an increase in the occurrence of the future sea level extremes in some regions by 2100, with a likely increase in the early 21st century. The combined effects of Mean Sea Level (MSL) rise and changes in storminess will affect future extremes”*. [3] In Ireland, sea level has risen by 10-20 cm since 1890 and a rise of approximately 0.5 metres is considered likely during the period 1990-2100. [61]

Ocean Acidification:

The oceans are becoming more acidic due to the absorption of excess CO₂ causing the formation of carbonic acid. This is already affecting the shells (calcium carbonate) of various marine species, including coral reefs, which suffer from bleaching due to warming and this could cause major problems for more than 500 million people in tropical coastal areas. [3] [21] According to Donald Penman et al. the oceans are estimated to absorb about 1/3 of excess carbon and the pH has gone from 8.2 to 8.1 (25% increase in acidity) and is predicted to fall to pH 7.8. [23]

Biodiversity Loss:

Biodiversity is essential for a healthy environment. In turn this is essential for human health. There are many ongoing chronic threats to biodiversity including overpopulation; overharvesting of resources; invasive species; land use changes (agricultural practises); overuse of artificial fertilisers (nitrogen); chemical contamination of the biosphere; deforestation; extremely high electromagnetic radiation levels, GM plants and the direct effects of excess CO₂ on plant growth and development. Most of these factors are contributing to a global reduction or extinction of species ongoing over many decades. There is evidence that the global ecosystem as a whole is approaching a ‘state shift’ - a tipping point- on a planetary scale, as a result of human impacts that could be abrupt and irreversible. Barnosky et al. (2012) University of California at Berkley. [60]

Climate change is likened by many health professionals to an acute illness on a planetary scale which, particularly over the last 30 years, is compounding the chronic pre-existing illness as above. [4] In AR4 (2007) the IPCC estimated that if there is global warming above 1.6 °C, 9-31% of species will be committed to extinction. If average temperatures rise to 2.9°C, 21-52 % of species will become extinct. [1]

There have been at least 5 mass extinctions in the past, based on paleontological evidence and many scientists are now saying that we are in the midst of the 6th great extinction. The IPCC AR5 of 2013 reports that because of the numerous biological variables affecting biodiversity it is extremely difficult to predict outcomes accurately in specific areas. [3] The most vulnerable habitats in Ireland include sand dunes, lowland calcareous grasslands, raised bogs, turloughs and upland lakes. An increase in the decomposition of bogs will also occur.

Extreme Weather Events:

A warmer atmosphere holds more moisture and also increases evaporation in dryer areas leading to worldwide flooding events and droughts in certain areas. Modelling predicts that as CO₂ increases such extremes will become more severe and more frequent in most parts of the world (Seager R. et al 2012). [21] [25] We are already beginning to see evidence of this, even in Ireland, although owing to natural variability in our weather it is not always possible to determine whether a specific event is directly related to climate change. Warmer oceans also produce the conditions for stronger hurricanes/typhoons and warmer land for tornados of which we have seen numerous examples in the last few years, particularly in the US and the Far East. [3] [21] In Ireland, lengthier heatwaves and rainfall events in winter, and more intense downpours in summer are projected. At the same time, an increase in the propensity for summer droughts is indicated, particularly for the south and east. [61]

Shifting Climate Zones:

There is wide natural variability in annual temperature changes but in the last thirty years there is evidence that isotherms (lines of a given average temperature) have moved pole-wards at a typical rate of 100 km per decade and also upwards in elevation (Hansen et al 2006). [26] This is far in excess of any possible natural rate of change. Flora and fauna are responding to this with e.g. threequarters of marine species shifting their ranges by as much as 1000 km pole-wards (Poloczanska et al 2013). [27] Hence the reported appearance of many warm water species off the coast of Ireland.

These large ecological changes are disruptive for the biosphere and have the potential to cause difficulties for *all* species in affected areas. This may cause local extinctions due to the rapidity of the warming and also to geographical factors e.g. cold-adapted mountain species and polar bears in the arctic. (AR5 Chapter 2) [3]

Health and Social Wellbeing Impacts:

“Climate change threatens the basic elements of life for people around the world- access to water, food production, health and the use of land and the environment”
Executive Summary Item Review - Economics of Climate Change, UK
Government released October 2006 (The Sterne Report)

- Direct via extreme weather events; heat waves; floods and droughts; storms, hurricanes, typhoons, fires; all causing deaths, illness, injuries and infrastructural damage.
- Indirect through ecological disruption (natural systems)

Changing infectious disease patterns; food and water born diseases; air pollution causing increased mortality and morbidity.

- Indirect mediated through human social systems
Social disruption; forced immigration; conflict; undernutrition and starvation; breakdown of social structures, food production/distribution and infrastructure damage; security considerations relating to all the above. [3]

Most research on health effects of climate change relate to effects caused by warming to the so called 'safe' limit of less than 2°C global average. More recent research quoted by the IPCC indicates that there are doubts about whether this limit can be maintained (Anderson and Bowes 2011). The IPCC report states that "it can be assumed that the increase in many important climate related health impacts will be greater than simple linear increments" (IPCC AR5). [3]

Food Security:

The impacts of climate change on agriculture/horticulture has the potential to cause the most severe and widespread impacts on health globally. Although warming temperatures and higher CO₂ concentrations may initially promote plant growth other factors such as water stress and higher temperature extremes can quickly damage crops. It is predicted that for each degree of warming yields of corn in the US and Africa and wheat in India will drop by 5-15%. [3] If temperatures rise by 5°C most regions of the world would experience yield losses and global grain prices could double (US National Research Council 2012). In Europe, according to the EU official environmental organisation the European Environmental Agency (EEA), one third of food is wasted, two fifths during processing and two fifths of the remainder is thrown away at home (on average in 27 EU countries). [28] Interestingly the National University of Ireland at Galway (NUIG) have just initiated for next semester a one year MSc course utilising an international model on 'Climate Change, Agriculture and Food Security (CCAFS)'.

In view of the potential significance of the food security issue, Dr Colin Sage University College Cork who has extensively researched the subject, has prepared the following brief overview for inclusion.

Definitions of food security

"Food security exists when all people at all times have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life." (FAO et al 2012: 57)

Food security is often understood as comprising four pillars: availability (supply), access (discussed below), utilization (the body's ability to metabolise food nutrients, which might be impaired by illness) and stability (without periodic or seasonal shortfalls in the provision of food).

An understanding of *entitlements* has become a vital part of a social vulnerability approach which recognises the differential impacts of environmental, economic and other risks upon individuals, households, communities and regions. This approach breaks with past preoccupation with the arithmetic of food supply and human numbers in order to identify those who are most vulnerable to food insecurity and to better understand the basis of their survival strategies; that is their ability to cope with

various forms of uncertainty whether chronic or on seasonal, periodic or irregular time scales. Moreover, recognising the influence of external factors (such as climatic or economic shocks) on local food provisioning systems reveals the nested interconnections that link the food security of individuals and households to the global level.

Impacts of climate change

Regional scenario-building exercises using general circulation and statistical crop models point to a growing divergence between high and low latitudes in terms of agricultural output. Within the tropics there is particular concern for the effects of higher temperatures, with resulting heat stress on crops, animals and farmers; changing precipitation patterns, disrupting established cycles of rain-fed farming and associated livelihood activities; rising sea levels that will not only cause inundation of coastal farmland but trigger saline intrusions of freshwater aquifers; and increased likelihood of extreme weather events, such as drought and floods that will not only directly impact agricultural production, but destroy physical infrastructure affecting food storage and distribution. While any one of these aspects of climate change exert greater stress on food provisioning arrangements at local and regional level, it is anticipated that in practice there are likely to be dynamic interactions between these different variables creating greater turbulence and food price volatility on global markets (World Bank 2012).

For example, changes in temperature and in the amount, timing, and intensity of rainfall can result in reduced yields and lower overall levels of food production. This leaves households with inadequate amounts to sustain their consumption needs until the next harvest, and/or sell into local and regional markets. This decline invariably exacerbates price fluctuations which are likely to be transmitted into national urban food markets. Here access to food will be determined by the ability to pay higher prices and, depending on how these price rises occur alongside changes in income, can make existing food secure populations vulnerable to food insecurity in the future. It may be possible to make agricultural systems more resilient to climate change effects by changing farming practices, for example from staggering planting dates to practicing water conservation methods such as using mulches or rainwater harvesting techniques. The introduction of more heat or drought tolerant varieties of existing crops, or replacing those with new crop species, may also be an option but may have profound implications for household labour and other resources.

Improving access to food will not automatically result from increased agri-commodity production especially under the prevailing model of highly mechanised, large-scale, high-input farming that dominates throughout the developed world and is being promoted as the solution for the South. This model currently produces enough food to feed the world, yet almost one billion are hungry. Such technologies do not enhance the human right to adequate food (De Schutter 2011).

Rather, improving access to food under climate change will require public investment in strategies for community based adaptation. This will include on-farm experimentation utilising locally developed seeds and knowledge; better water management practices involving rainwater harvesting, storage and use; soil moisture conservation and other techniques. Yet building local resilience to climate change must be accompanied by institutional efforts at multiple scales in order to ensure

individual, household and community entitlements are secured in order to improve access to food.” (Aug 2014)

The bottom line for global warming is the *cumulative* emissions of GHGs (UNEP February 2014). In order to limit warming to less than 2°C it is essential that the total emissions must stay below 800 GtCe (gigatonnes Carbon Equivalent). The total already emitted between 1870-2011 is 550 GtCe, so sustained reduction is essential. [21] [29]

The present CO₂ atmospheric concentration as mentioned is 400 ppm and that is increasing at a rate of 2ppm/year. [2] There is considerable scientific opinion that it is insufficient to reduce emissions, that it is necessary to reduce the atmospheric concentration to 350 ppm. [20] To date CO₂ reduction has proved politically impossible and thus there are efforts to compensate for this inaction by focusing on other GHGs which are shorter lived e.g. methane, fluorocarbons, nitrous oxide and particulates such as black carbon (soot). In recent years non CO₂ GHGs have provided about 20% of the increase in total GHG forcing (Hansen et al 2013). [20]

Noted US journalist author and climate researcher Bill McKibben commented “In a rational world policy makers would have heeded scientists when they first sounded the alarm 25 years ago. But in this world, reason, having won the argument, has so far lost the fight. The fossil fuel industry, by virtue of being perhaps the richest enterprise in human history has been able to delay effective action, almost to the point where it is too late”. [29]

“Climate change is a market failure on the greatest scale the world has ever seen”
Ian Roberts, Professor of Epidemiology and Public Health, London School of Hygiene and Tropical Medicine

Since the 1970’s global warming has caused over 140,000 excess deaths per annum, costing US\$ 2.4 billion according to WHO estimates. Weather related disasters result in 60,000 deaths per annum. Malnutrition and undernutrition currently cause 3.5 million deaths/year; Diarrhoeal diseases cause 2.2 million deaths/year; all these are predicted to increase with rising temperatures with women and children, the poor and the old, mainly in developing countries, bearing the brunt (WHO Climate Change and Health 2013). [30]

In Ireland, by mid to late century, a significant decrease in groundwater storage will increase the risk of severe drought. A decrease in soil moisture may have serious implications for agricultural practice, and irrigation will be essential in most areas where potatoes are grown. Demand for water will also increase, as a result of warmer temperatures and an increasing population. In addition, the levels of soil nutrients may be altered.

Response to Climate Change:

In the face of ever increasing evidence of the risks faced due to climate change what has been the response of officialdom?

Despite innumerable conferences, seminars and symposiums, and considering the increasingly detailed data from the scientific community, one would have to say that the overall response has been inadequate. There has been much talk and little action. A good part of any progress that has occurred has been made through the advocacy work of civil society organisations i.e. institutions like universities, scientific societies, trade unions and environmental NGOs. It has been suggested that democratic governments by their nature are not fit for purpose in terms of making the necessary decisions regarding climate change mitigation and adaptation.

This issue is unprecedented in human history and so responding adequately requires serious consideration of profound ethical and political issues. IPCC AR5 reports that “socio cultural and cognitive behavioural contexts are central to decision making”. They suggest that translating knowledge into necessary action can be blocked by normal psychological mechanisms viz. that risks and threats are in the future (temporal), and/or are located elsewhere (geographic), and/or experienced by others (social) and/or are uncertain. Thus it is essential that the facts are presented in such a way as to circumvent these mental ‘blocks’. [3]

International Efforts:

These have been led by the UN (UNEP) with the development of the UN Framework Convention on Climate Change (UNFCCC) at the UN Conference on Environment and Development (the Earth Summit) in Rio de Janeiro in June 1992. Its objective was “to stabilise GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system”. It provides a framework for negotiating specific international treaties (protocols) that may set legally binding limits to GHG emissions. As of March 2014 it has 196 signatories (‘parties’). In 1997 the Kyoto Protocol was formulated which sets binding emission levels for developed countries. A conference of the parties (COP) is held annually and as mentioned previously at COP 16 in Cancun, Mexico (2010) it was agreed that future warming should be limited to less than 2°C above preindustrial levels. The USA did not sign the Kyoto Protocol and Canada withdrew from it in 2012. At COP 17 in Durban, South Africa in 2011 a “A Platform of Enhanced Action” was agreed stating that a new treaty to replace Kyoto would be adopted in Paris in December 2015 (COP21) to be implemented in 2020. [31]

Pending the hoped for agreement on GHG emissions in Paris UNEP are focusing on a number of climate mitigating and adaption programs mainly for developing countries and now based on an ‘ecosystems approach’. [32]

The WHO (an agency of the UN) have been researching the health effects of climate change since 2008 and advocating mitigation/adaption. Dr Bettina Menne (Program manager for Climate Change, Sustainable Environment and Green Health at WHO Europe) at the recent UN international conference in Bonn commented, “the recent IPCC report shows that we are already on the path to climate change and a growing range of related health effects. However we can still decide on the future we want for our children - now is the time for action, in reducing GHG emissions and creating a more sustainable and equal world”. [33]

This year alone there are six major international conferences focusing on climate change and sustainability. Starting with the World Economic Forum in Switzerland in January 2014, other highlights are the WHO organised first conference on Health and Climate Change in Geneva in Aug 2014 [34] and a special UN Conference on CO₂ reduction for governments, businesses and industry leaders in New York in September 2014, called by the Secretary General. [35] These are all aimed at producing a positive outcome for the above mentioned COP 21 in Paris in September 2015, following the disastrous non-results of the Copenhagen (COP 15) conference in 2009.

Last month (July 2014) Mary Robinson, because of her outstanding dedication to advancing just and gender-informed climate change action through the ‘Mary Robinson Foundation - Climate Justice’ and her previous work in the Great Lakes Region of Africa and as UN High Commissioner for Refugees, has been appointed UN Special Envoy for Climate Change. The Secretary General in welcoming her appointment stated that he shared her sense of urgency for action on CC. [36]

EU Response:

“Climate change is a defining challenge of our time”

Manuel Barroso, President EU Commission, January 22nd 2014

“Climate change is not a battle it is a world war that will last for many years”

Stavros Dimas, EU Commissioner for the environment, 2004-2009

□ The EU has long been a driving force in international negotiations on climate change and was instrumental in the development of the UNFCCC and the Kyoto Protocol. EU leaders have committed to transforming Europe into a highly energy-efficient low carbon economy. Under Kyoto the EU15 (member states prior to 2004 - including Ireland) have committed to reducing *collective* emissions to 8% below 1990 levels by 2012. As mentioned, monitoring indicates that we overachieved on this target. Most new member states have similar targets. New targets have now been approved i.e. 20% reduction below 1990 levels by 2020, to be implemented by a package of binding legislation. The EU has further indicated its willingness to increase this emissions reduction to 30% if other developed and developing countries undertake their ‘fair share’ of reduction efforts.

In the recent Climate and Energy Policy Framework for 2030 the Commission proposes a further reduction of 40% below 1990 levels by 2030. [41] For 2050 EU leaders have endorsed the objective of reducing GHG emissions by 80-95% as part of the effort by other developed countries to reduce emissions by a similar degree. [37] The key to all these actions is that they must occur simultaneously in all economies throughout the world with appropriate pro rata reductions in developing countries. Industry, above all else, demands a ‘level playing field’ hence the complexity and difficulty in achieving consensus.

The EU is also setting targets through legislation to increase renewable energy production by 20%, to increase energy efficiency by 20% (the 20:20:20 program) and to reduce emissions from new cars and vans. Currently the Commission are proposing even higher targets of 27% renewable energy and 30% energy efficiency to be agreed by governments by Oct 2014 at the latest. It has been agreed that at least

20% of the €960 billion budget for 2014-2020 will be spent on climate related actions based on the ECCP (European Climate Change Program). [38]

The EU is also the world's leading donor, assisting developing countries to combat climate change.

Incoming president of the EU Commission, Jean-Claude Juncker, has enunciated 10 political priorities. The third one is “developing a new European Energy Union, switching suppliers for cheaper energy, prioritising renewable energy and energy efficient buildings with a binding target” - all aimed at reducing emissions.

To illustrate that it is feasible to produce the required energy without using fossil fuel or nuclear energy the Centre for Alternative Technology (CAT) in west Wales has developed a detailed integrated program, titled ‘Zero Carbon Britain’. By combining all available technologies in a balanced way for energy and heat production, changes in agricultural practise and moderate dietary and transport shifts, they have clearly demonstrated that solutions to the climate crisis already exist - it is a question of urgent action. This plan has been submitted to the Westminster parliament. [39]

Irish National Response:

“We have now reached a limit where we can say that a key prerequisite for further development - the natural functioning of the earth's system as we know it - is at risk”
Owen Gaffney, International Geosphere-Biosphere Program (IGBP), Tyndall Conference Dublin, September 2011.

One could be excused for thinking that any efforts made by Ireland to respond to global warming are going to be a mere pinprick in the greater scheme of things. This is not the case. There is the question of moral, ethical and political solidarity to consider, not to mention our obligations under EU and International law. Ireland agreed our Kyoto targets in 1998 and 3 main policy measures were adopted - a carbon tax, halting the use of peat for electricity generation and converting Moneypoint to gas. Unfortunately only the first was implemented and this was in 2010 - too late to meet the 2008-2012 targets. [40]

Kyoto obliges Ireland to reduce GHG emissions accordingly or risk heavy fines. It is also bound by EU legislation and directives. The overall EU objective as reconfirmed by the Council in February 2011 is to reduce EU wide emissions of GHG by 80-95% by 2050 as compared to 1990 levels. [41] The National Economic and Social Council (NESC) developed a detailed policy framework in 2012 to achieve this. It was essentially a long-term socio-economic vision for effective transformation to a low carbon economy - it was a “re-focus on the whole government and societal agenda”.

The four Key Factors identified were:

1. Electricity generation
2. Built environment
3. Transport
4. Agriculture

A draft National Low Carbon Roadmap was produced to add further detail. [42] Minister Hogan (March 2014) stated “economic development and low carbon transitions are not mutually exclusive and can be programmed in parallel provided we advance in an informed and sensible course”. However, the problem is we seem to be going backwards, not advancing. We still have Moneypoint power station, the largest single CO₂ source in the state, but as a Category I facility its emissions are ‘covered’ by the EU Emissions Trading Scheme (ETS). Turf is still being burned for electricity generation in large quantities and there are still extensive areas of drained bogs which are emitting significant amounts of CO₂.

The built environment is governed by EU Directive on the Energy Performance of Buildings (EPBD) and SI (Statutory Instrument) 243 of 2012. We also have Part L of the Building Regulation (Conservation of Fuel and Energy), the National Energy Efficiency Action Plan (NEEAP) and the National Renewable Energy Action Plan (NREAP). All these policies could be very helpful but like most environmental plans policies and legislation they remain on the shelf or tend to be honoured in the breach rather than the observance - a case of too little, too slow. It has been noted that the government’s Energy Policy makes no specific commitments and funding for Warmer Homes and other ‘retro-fits’ have been slashed in the past three years.

As previously mentioned the Irish EPA is predicting a 15% increase in Agricultural emissions and a 9% increase in transport emissions; the former largely thanks to the industry led Food Harvest 2020. It would appear that the government and civil service have little concept of the severity and urgency of the situation facing us.

Response of International Health Professionals/Health Services:

“Our planet is losing its capacity to sustain human life in good health. Signals about what human activity has done to the environment have become increasingly shrill”

Dr. Margaret Chan, Director General WHO, Geneva, May 2014

The health care industry and professionals have been slow to recognise the dangers associated with climate change. Indeed the IPCC did not highlight health effects until 2007, when the AR4 devoted a chapter to it. Civil society organisations (universities, research centres, environment and health NGOs) fairly quickly took the scientific evidence on board, including IDEA (Irish Doctors Environmental Association) and ISDE (the International Society of Doctors for the Environment) and began advocating for action. In April 2009, WHO indicated it’s recognition of the reality by dedicating the Annual World Health Day to “Protecting Health from Climate Change”. In May 2009 the Lancet and University College London published the aforementioned “Managing the Health Effects of Climate Change”. [4] In October 2009, the WMA (World Medical Association) published the “Declaration of Delhi on Health and Climate Change” [52] and later that month the “Prescription for a Healthy Planet” was issued jointly by HEAL, HCWHE and CHC (The Climate and Health Council). It was presented formally to the EU Commissioners for Health and for the Environment in Brussels. [44] A good updated overview (April 2014) by a group of well respected and representative international NGOs titled ‘Climate Change: Health Impacts and Opportunities’. [5]

Health Care Without Harm is a non-profit coalition of hospitals, health care systems, local authorities, research and academic institutions and environmental and health NGOs currently with 500 members in 53 countries. It has offices in North America, Buenos Aires, Manila and Brussels. Their aim is to try to educate the health care industry, governments and policy makers by advocating for a healthy environment as a pre-requisite for human health with a major focus on climate change. [43]

At the UN climate change conference in Bonn in June 2014 there was a WHO side event to explore recent findings on climate change and health. Nick Nuttall from the UNFCCC highlighted that engaging Health Ministers is imperative to achieve a binding satisfactory outcome for the Paris 2015 discussions (COP21). David Warrilow from the Department of Energy and Climate Change in the UK noted that health ministries are the key to providing a link between governments and the populace. The representative from the Ministry of Environment and Physical Planning in Macedonia considered that health was *the most relevant and comprehensible aspect of climate change* for most people. This meeting created four single overarching communication outcomes (SOCO):

- For European policy makers: Mitigate GHG emissions to obtain immediate health gain (7 million deaths per annum from air pollution globally according to WHO – in developed countries this is mainly due to coal burning power stations).
- For local governments: Make cities sustainable and climate resilient.
- For climate change negotiators: Integrate health into all UNFCCC negotiations.
- National and European policy makers: Integrate climate change into all health policies. [33]

The health sector itself paradoxically is contributing significantly to climate change. Through the products and technologies it employs, the energy and resources it consumes, the waste it generates and the buildings it constructs and operates it is accelerating a trend which in turn undermines public health. According to HCWH European hospitals consume 300KW thermal and 100KW electrical energy /m²/hour. Approximately 15,000 hospitals utilise 10% of GDP and produce 5% of all CO₂ emissions. According to the UK's NHS Sustainable Development Unit (SDU) the NHS (one of the largest employers in the world) emits 32 million tonnes of CO₂. This is equivalent (Mt CO₂e) per annum to ~25% of total public sector emissions. They aim to reduce this by 24% by 2020. [45]

The RCGP (Royal College of General Practitioners) believes that GPs have a role in raising awareness in relation to climate change and health, as well as promoting appropriate lifestyle choices and that this should be seen as part of a *wider duty of care*. The RCGP, who are signatories of the DOHA Declaration of Climate Change, Health and Wellbeing (COP 18 2012), have said that “doctors and other health professionals can provide a powerful example to others in reducing carbon emissions and promoting a healthy, sustainable future”. [46]

In continental Europe, German and Scandinavian health services tend to be very progressive in terms of carbon emissions and sustainability. In Germany BUND-

Berlin (equivalent to Friends of the Earth) have developed an ‘Energy Saving Hospitals’ scheme, applicable nationally. In the past 11 years, 35 hospitals have been awarded energy saving certificates. This has resulted in a combined CO₂ reduction of 54,000 tonnes, saved 17,000 MWh of electricity and 130,000 MWh of thermal energy with a cost reduction of €8.2 million per annum. [47]

Skane Regional Hospital in Malmo, Sweden is an example of a good co-ordinated approach to ‘greening’ a hospital. They have examined logistics and transport and have formulated a green travel plan for patients and staff. They aim to be 100% fossil fuel free by 2020 by simply revising infrastructure and re-organising facilities to maximise walking and cycling, with an estimated saving overall of €375,000 per annum as well as an improvement in staff health. Their motto is BMW- Bus, Bike, Metro, Walk. Another issue studied here was waste reduction by changing from disposable to re-usable sharps containers (RSC). This movement was started in the USA and Australia in 1996 and is in use in thousands of hospitals worldwide but uncommon in Europe (2012). Life cycle analysis (LCA) must be examined and carefully controlled. In Skane University Hospital 30 tonnes of plastic to landfill per annum was reduced to zero; 5,000kg of cardboard was reduced to 116kg and GHG production was reduced by a factor of 6, equivalent to an 84% reduction in carbon footprint. [48]

Australia, which has already been severely impacted by climate change (increased wild fires, droughts, storms and floods), has a very active and well organised medical, environmental and public health NGO (Doctors for the Environment Australia) which is fighting to overcome the regressive climate policies of the current administration. [49] They have produced some good literature; leaflets, posters (for surgeries) etc and in association with the Australian Conservation Foundation (ACF) have produced a “Green Clinic Guide” giving 10 simple inexpensive tips to save energy, reduce carbon emissions and save money. [50] The Climate and Health Council, an international not-for-profit organisation set up in London in association with the BMJ (British Medical Journal) by health professionals to educate and advocate for action on climate change has listed 5 ‘win-win’ tips to help people “to improve health, save carbon and save money”.

They are:

- “Keep warm, keep cool, keep well” Insulation in just 10 households could save 100,000 tonnes of CO₂ in one year.
- “One meat free day a week”, Improves health and if everyone in the UK did this, the CO₂ emissions saved would be the equivalent of taking 5 million cars off the road.
- “Walk, cycle at least once a day”, If everyone in the UK made one less car journey a week it would save 7 million tonnes of CO₂ emissions.
- “If you have to drive, be a safe driver”, If everyone stuck to the speed limits almost 1 million tonnes of CO₂ can be saved.
- “Create safe green spaces”. This will act as a carbon ‘sink’, promote physical and mental health and helps to protect from flooding and heat waves. [52]

IDEA in collaboration with FEASTA, has played a pivotal role in highlighting innovative ideas generated outside the UNFCCC process by NGOs, think tanks and universities from developed and developing countries, as well as by governments, on the architecture of the climate regime.

IDEA and FEASTA solicited support from UNFCCC, UNEP, UNHQ, NY, the EU Commission and governments to support a project that could offer a range of alternatives in dealing with the climate crisis.

Having got the go ahead from Yvo de Boer, Executive Secretary UNFCCC and Achim Steiner Executive Director of UNEP, our (IDEA) international advisor, during a 3 year period,¹ met with a broad spectrum of government delegates, NGOs, EU Commission Officials, other UN and International organization officials, Major Groups and other stakeholders to gain support for the development and publication of a report which would offer new and alternative proposals for tackling climate. This eventually lead to the publication of the report Building The Climate Regime: Survey and Analysis of Approaches (UNEP/WRI) The report is a review of more than 130 proposals developed by governments, NGOs, academics, and other stakeholders to build a regime which will deliver effective mitigation and a level of action consistent with the objectives of the UNFCCC.

The report outlines five key issues that have been major topics of debate in the process and proposals are grouped in accordance with the issues addressed:

- 1) Options under the UNFCCC to increase ambition.
- 2) Options outside the UNFCCC to increase ambition.
- 3) Means for Sharing the mitigation effort under the UNFCCC
- 4) Performance on Mitigation
- 5) The Legal Form of a Future Climate Agreement

IDEA has acted as a catalyst in ensuring that human health and wellbeing issues are being considered as essential to achieving sustainable development.

For the past five years, at international fora IDEA in collaboration with ISDE and others has emphasized the link between the environment and human health.

Response of Irish Health Services/Health Professionals:

It is clear from the above examples that there are numerous strategies by which health services could assist in mitigating and adapting to climate change, rather than contributing to it's advancement. The Institute of Public Health in Ireland and the Irish Doctors Environmental Association both signed 'the Doha Declaration on Climate Health and Wellbeing' (COP18 Doha 2012). By way of making a start the HSE has created the National Health Sustainability Office (NHSO) in 2013 to act as a focal point and to connect with other relevant government agencies, such as Sustainable Energy Authority of Ireland (SEAI), the Office of Public Procurement (OPP), the Office of Public Works (OPW) and the Department of Communications, Energy and National Resources (DCENR). [54] This indicates that there is some official recognition of the multi-sectoral effects associated with climate change. The first national seminar on Sustainable Health Systems , "Making it Happen", was held in May 2014 in Dublin. Mr Tony O'Brien Director General of the HSE addressed

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the meeting and pointed out that the health service was one of the largest consumers of energy in the state. [55] In fact, the focus of the meeting appeared to be on the financial savings to be made from energy conservation/efficiency, food waste and water management. Interestingly, the ‘elephant in the room’ does not appear to have been mentioned as such; but of course all the actions proposed would be of benefit in the context of climate change.

Irish hospitals are beginning to take sustainability/ecological issues on board; Connolly Hospital, Dublin, Sligo Regional Hospital, Galway University Hospital and Cork University Hospital are all examples. [64] Judging by information available on line the focus at this point appears to be on waste minimisation and recycling, both very important of course, but there is a serious need for a broader approach, for specific action plans along with specified time frames and with an overriding sense of urgency.

The Department of Health is reported to have reduced overall energy consumption in Hawkins House by 9% since 2007 (Irish Medical Times 6/6/14). [57] This is a good start but totally inadequate in terms of overall requirements and in relation to savings made in health care buildings and hospitals throughout the world. Much more investment is needed in retrofitting and future-proofing all facilities and the National Health Sustainability Strategy needs to be published and activated immediately.

There is no evidence that the Irish College of General Practitioners (ICGP) has noted climate change, although the World Association of Family Doctors (WONCA) [58] held a symposium (Basel 2009) and a workshop (Prague 2013) on it with regard to health effects. They have requested that their members sign the Doha Declaration on Climate Change (2012) and plan to develop a power point presentation and information leaflets on ‘Greening the Doctors Office’. [59]

The Royal College of Physicians in Ireland (RCPI) were prescient in 2009 when the annual James Smiley lecture was titled “Climate Change and Health: the Role of Occupational Medicine”. Evidence of any consequences from this has not been found. No relevant information was found on the appropriate web sites for other health professionals e.g. the Irish Nurses Organisation, the Irish Society of Chartered Physiotherapists.

Actions

“By making choices that reduce GHG pollution and preparing for the changes that are already underway, we can reduce the risks from climate change, our decisions today will shape the world our children and grandchildren will live in.”

United States EPA 2014

There are only two options:

1. Do nothing and continue contributing to planetary ecosystem demise.

OR

2. Take steps to ameliorate the situation; Colin Butler, Professor of Public Health, University of Canberra Australia has written “Doctors have a duty of care to think ahead, to think in a precautionary manner and to sound warning in the interests of their patients, whether as individuals, a population or the whole planet”. Editorial to forthcoming book ‘Climate Change and Global Health’ – personal communication.

Individual Actions:

- Self educate - websites, literature etc.
- Join an environmental group - joint action is more potent. The Environmental Pillar of Social Partnership is composed of 28 environmental NGOs (including IDEA) with direct access to government.
- Join the ‘Green Homes Program’ www.greenhome.ie
- Measure your carbon footprint and/or your ecological footprint. (Google)
- Consider ‘active travel’, car sharing, public transport.
- Reduce air travel – Skype/videoconferencing is being increasingly used. Holiday nearer home.
- Aim for paper free surgery/office
- Make opportunities to talk to patients re CC
- Erect posters in waiting rooms
- Buy locally sourced food and support local markets

Organisational Actions

- Sign the Doha Declaration on Climate Health and Wellbeing www.climateandhealthalliance.org or [63]
- Sign up for the EPA ‘Green Healthcare Program’
- Hospitals: join ‘Global Green and Healthy Hospitals’
- Engage with the government to advocate for urgent effective action on climate change - particularly with the Minister for Health (as suggested by WHO and others).
- Advocate for a separate Ministry of Energy and Climate Change. c.f. UK
- Move towards climate-friendly meetings/conferences e.g. upcoming WHO global conference on health and Climate Change this month in Geneva – to be a “Green” conference with:
 - CO₂ efficient transport
 - Using electronics instead of paper
 - No plastic water bottles
 - Less meat in the cafeteria
 - Improve built environment factors/practices
 - Improve waste management
- Highlight the risks of CC in all meetings, conferences and in all professional journals along with the positive steps that can help to reduce risks.
- Hold meetings at venues accessible to public transport, biking, walking.

Websites:

www.globalfootprintnetwork.org : Good general info and data on ecological footprints from personal to global.

Energy Saving Hospitals Project: www.energysavinghospitals.org Good for hospital energy reduction.

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ACRONYMS/ABBREVIATIONS

BAU	Business as Usual
BMJ	British Medical Journal
CAT	Centre for Alternative Technology (Wales)
CCAFA	Climate Change Agriculture & Food Security
COP	Conference of the Parties
ECCP	European Climate Change Program
EPA	Environmental Protection Agency
ETS	Emissions Trading Scheme (EU)
EU	European Union
Gt	Gigatonnes (1000 million)
GtCe	Gigatonnes Carbon equivalent
IDEA	Irish Doctors Environmental Association
ISDE	International Society of Doctors for the Environment
KWh	Kilowatt hours
LCA	Lifecycle Analysis
MtCO ₂ e	Million tonnes CO ₂ equivalent
NEEAP	National Energy Efficiency Action Plan
NESC	National Economic & Social Council (Ireland)
NGO	Non Governmental Organisation
NUIG	National University of Ireland in Galway
PPM	Parts per million
RSC	Re-usable Sharps Containers
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
WHO	World Health Organisation
WONCA	World Organisation of National College & Academies of GPs

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