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Born in Glasgow and educated there, he holds a First Class Hons. B.Sc from the University of Glasgow where he also completed his Ph.D. in 1980 on The Meteorology and Climatology of Air Pollution in the Glasgow Basin. He has taught at NUI Maynooth since 1978 and has also taught at a number of universities in North America and Africa. He has also been involved in course design and curriculum development matters at second and third levels. He has served as President of the Irish Meteorological Society 1996-9, Secretary and Editor of the Geographical Society of Ireland 1984-96, Treasurer of the Irish Quaternary Assoc. 1982-5 and chairman of the RIA's Irish Committee on Climate Change 2001-4. Dr. Sweeney has written extensively on climate change and is a contributing author and review editor on the recent Intergovernmental Panel on Climate Change's Fourth Assessment Report.

A Revision of Our Attitudes towards the Natural World is Required

1. Introduction: Climate Change and the Issue Attention Cycle

From being a rather abstract academic concept as recently as a decade ago, climate change has now become an issue which has gripped the attention of society and mobilised the energies of the young. For them it has replaced the fear of nuclear conflagration which dominated the issue attention cycle of the last generation. As with all major environmental issues, a schism exists between the idealism of the young and the pragmatism, some would say cynicism, of their elders. In his book *Global Warming: the Complete Briefing*, Sir John Houghton (2004) reports on a conversation with a senior administrator in the United States who is reported as saying: "We cannot change our lifestyle because of the possibility of climate change; we just need to fix the biosphere." In some ways, this comment epitomises the conviction of many that we can always repair damage done to the environment by some, as yet to be discovered, technological "fix". Nuclear fusion, deep geological storage of greenhouse gases, the hydrogen cell - all offer panaceas in the long term to the problems we have created in the short term and with some justification. Certainly, human development has historically been characterised by an ability to develop

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technological solutions to problems as and when needed. Stone tools, iron weapons, the water wheel, the steam engine, medical breakthroughs, transportation innovations, computer technologies - all have provided platforms for addressing and overcoming particular limitations to human achievement and endeavour. For climate change, however, the lesson of history is that the past is not always the key to the future. People were historically prisoners of climate through its life supporting determination of the annual harvest surplus on which economic, cultural and intellectual advancement depended. Today, climate is at the mercy of people and blind faith that a technological solution is just around the corner is not enough on which to base our present social well-being. Strong leadership from those we elect to represent our concerns is of paramount importance.

2. Global Dimensions of the Problem

In the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007a), a picture of accelerating problems associated with human misuse of the atmosphere is presented. Unequivocal evidence of warming and a 90 per cent level of confidence that the loading of greenhouse gases on the atmosphere to concentrations not experienced for over 650,000 years, is the main driver of recent changes is reported from a synthesis of research from across the peer-reviewed literature over the past seven years (IPCC, 2007a). Together with almost all the nations of the world, the Irish Government have signed off and sanctioned the findings of this report. Among the more significant findings indicative of the quickening pace of global climate change are the following:

- The second half of the twentieth century was the warmest in at least the last 1300 years in the Northern Hemisphere. Temperature extremes have significantly increased in many parts of the world. The oceans have warmed to a depth of 3 kilometres.
- Acceleration in the rate of sea-level rise, melting of glaciers, and reductions in snow cover are now apparent. Summer sea ice extent is reducing by 7.4 per cent per decade and may well disappear in the Arctic by mid century with serious consequences for ecosystems dependent on it.
- Precipitation increases in many temperate regions are now occurring while droughts have become more frequent and more intense in many parts of the tropics.

These observed changes are consistent with model projections and provide confidence that the latter are reliable ways of looking into the future. Inevitably, looking into the future is a risky business and for

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climate change projections this is even more so. It must be acknowledged that uncertainties regarding population, economic and energy growth in the years ahead will always mean that climate change scenarios cannot ever be taken as absolute certainties. Nonetheless, this is not an excuse for inaction since serious impacts are likely in a wide range of areas and sectors (IPCC, 2007b).

- While water availability is likely to increase in high latitude areas, and in some parts of the wet tropics, many of the presently water-stressed areas of Africa are likely to become more drought-prone, seriously compromising their development potential.
- 20-30 per cent of plant and animal species will face a high risk of extinction if global temperature increases above pre-industrial levels go beyond -2°C .
- While food production may increase globally in the medium term due to the fertilising effect of higher CO_2 concentrations in the atmosphere, once temperature increases exceed about 3°C , yields are likely to start declining. In dry parts of Africa this will commence sooner, with any rise above present levels raising the spectre of widespread hunger during drought events.
- Hundreds of millions of people in the densely populated delta regions of the developing world will become more vulnerable to floods and tropical storms. Small island states, especially low lying tropical islands, will also be highly vulnerable.
- Outside of the temperate regions, adverse health effects will be apparent from heat waves, storms, floods, fire and drought as well as changes in water and vector borne diseases. These will more than counterbalance any improvements due to warmer winters in high latitudes.

As with all environmental problems, the burden of climate change falls inequitably on those least able to bear it. It is also evident that the developing world will suffer for a problem not primarily of their making. Richer countries will, in the medium term at least, have the financial and organisational resources to better adapt to the problem though, even in areas such as Ireland, significant changes in climate will be observed.

3. Climate Change Impacts on Ireland

As a result of the work carried out at NUI Maynooth, it can be concluded that July mean temperatures will increase by 2.5°C by 2055 with a further increase of 1.0°C by 2075. Mean maximum July temperatures in the order of 22.5°C will prevail generally with areas in the central Midlands experiencing mean maxima up to 24.5°C .

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Overall increases of 11 per cent in precipitation are predicted for the winter months of December–February. The greatest increases are suggested for the north-west, where increases of approximately 20 per cent are suggested by mid-century. Little change is indicated for the east coast and in the eastern part of the Central Plain. Marked decreases in rainfall during the summer and early autumn months across eastern and central Ireland are predicted. Nationally, these are of the order of 25 per cent with decreases of over 40 per cent in some parts of the east.

These scenarios will have impacts on several aspects of Irish life, though not all of them are adverse. Only two sectors are briefly discussed here.

Agriculture

- For livestock production, the expectation of more frequent summer droughts will require supplementation of grazed grass. Although warmer temperatures would be expected to result in shorter winter housing times for livestock, a trend towards wetter winters may result in problems of poaching and soil damage which may negate this. The balance of grazing season length against winter rainfall will dictate the stored feed requirement, and the actual climate will dictate the choice of forage crops grown. Opportunities to spread slurry or dirty water in winter will be further reduced and increased slurry storage requirements are likely to be needed.
- Maize silage is increasingly likely to replace grass silage, potentially increasing grazing land areas. At the same time, increased production of grain maize is expected. Grain maize yields are expected to increase dramatically in western areas by more than 150 per cent on today's national average value.
- Spring barley yield increases of approximately 25 per cent are likely by 2055 with harvesting time earlier than today.
- For potato, drought stress will be the most important limiting factor determining its viability and it is likely that potatoes may cease to be a commercially viable crop over much of Ireland, though should survive in wetter parts of Donegal.

Water Resources

- A widespread reduction in annual runoff, most marked in the east of the country. All areas will experience a major decrease in summer runoff, particularly in the east of the country. These reduc-

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tions are likely to average approximately 30 per cent over large parts of eastern Ireland by mid-century.

- Winter runoff is predicted to increase. The magnitude and frequency of individual flood events will probably increase in the western half of the country. Seasonal flooding may occur over a larger area and persist for longer periods of time. Areas such as the Shannon basin and turloughs in the west will be vulnerable to these changes
- During the summer months, long-term deficits in soil moisture, aquifers, lakes and reservoirs are likely to develop. It is likely that the frequency and duration of low flows will also increase substantially in many areas. Water supply infrastructure is expected to come under growing pressure particularly in the Greater Dublin Area and the strategic implications of this are profound for a number of areas, particularly spatial settlement strategy. The projected changes in water availability pose potential problems for the dilution of water-borne effluent. With a greater frequency of low flow conditions, additional precautions will be required to ensure that concentrations of water pollutants do not give rise to acute effects.

4. The Environment in the Programme for Government

An impressive menu for action in the area of environment is provided in the Programme for Government (Appendix 1). Only a few are capable of being addressed here though as with all environmental issues, overlapping and hopelessly intertwined issues arise.

- In advance of agreeing an all-party approach on climate change targets, the Government will set a target for this administration of a reduction of 3 per cent per year on average in our greenhouse gas emissions and mandate the Department of Environment, Heritage and Local Government to publish an Annual Report setting out progress on meeting climate change targets.

As one of the world's top greenhouse gas polluters on a per capita basis, Ireland has a responsibility to play its part in addressing the problem. Thus far it has failed to do so, and the radical measures necessary have not been forthcoming. The political will to make the necessary policy changes in how Irish society is organised has not yet been demonstrated. These Carbon Budget proposals are a welcome development. "Business as Usual" has characterised Irish greenhouse gas emissions growth over recent years and globally it appears that we are committed to a likely increase of 3°C as atmospheric concentrations double, probably towards the latter half of the present centu-

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ry. Such an increase is beyond the value of 2°C deemed by the EU as constituting "Dangerous Climate Change". This is where the next big crunch comes. At this point the climate system may become dangerously unstable with non linear increases in impacts, especially in the poorer parts of the world (Figure 2). Large scale events such as the collapse of the West Antarctic ice sheet, the long-term melting of the Greenland ice sheet, the destabilising of the thermohaline circulation and the release of methane clathrates become more probable events, difficult to reverse over timescales of centuries (McElwain and Sweeney, 2007). The prospect becomes bleak, not least for Ireland.

- Make clear provision in Development Plans for environmentally sustainable transport methods.
- Implement all aspects of Transport 21 so that the use of public transport becomes a real option for more and more people.

Transport emissions are the most intractable aspects of the problem and the recent Census results make unpalatable reading. In 1992 Ireland had 227 cars per 1000 people. Today the figure is over 400. CO₂ emissions from road transport have doubled over this period and are likely to rise close to the same level as that projected for carbon credit purchases. Fifty-six per cent of commuters in the Dublin Region now drive to work. Eighty per cent less schoolchildren cycle to school in the Dublin area than in 1991. Even one in three school pupils who live less than a mile from school is driven each day. Small wonder that average bus speeds in Dublin have dropped below 13kph, with comparable figures for London being 26kph, Stockholm 28kph, and Copenhagen 24kph.

- Ensure all County Development Plans are "sustainability proofed".

Tackling this problem requires a determined assault on sprawl. A fundamental review of the land use planning practices is required. Regional Planning Guidelines/Strategic Planning Guidelines have failed to stem the rezoning frenzy and the planning profession has, in my opinion, been demoralised by a lack of support from both within and without the local authority system. The proper implementation of the Strategic Environmental Assessment Directive will go some way towards helping this by forcing plans, programmes and policies to be scrutinised for their resource consumption dimensions more scrupulously. In this context, however, it is perplexing to note that the most important plan of all, the National Development Plan, was not submitted for SEA, a matter on which the EU may yet have the last word.

- Introduce a National Landscape Strategy.

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Private gain versus public and community good is a familiar issue for those seeking to manage environmental resources of all kinds. The Irish Constitution excessively enshrines the right of private property to the detriment of the common good. Land ownership does not imbue the right to do with it what the owner likes any more than ownership of a river bank gives the right to pollute at will. We must move to the implementation of the concept of stewardship in legal terms, hard as that may be for some to swallow. The Irish environment belongs to us all and we all have an interest in its stewardship, especially as taxpayers. Since we do we have an ethical responsibility to leave the earth for future generations in at least as good a state as we inherited it from our forefathers, by not acting now we reduce options for those who come after us and bequeath them damaged goods. This is why sustainable development needs to move from a nebulous concept to a reality in decision makers' minds.

5. Humans as "Subduers" of the Earth

Throughout recorded history, humans have exploited their environment to create an anthropocentric world fashioned to suit their needs for food, shelter, transport and technology. Driving wild game by setting fires undoubtedly helped create and maintain the grassland biomes. Deforestation, for example in Ireland, associated with the medieval monastic settlements, or to remove cover for rebels, or to supply timber needs for Elizabethan naval vessels, was instrumental in the creation of the treeless landscape of much of the island. Only Iceland has less forested area in Europe. Canals, railways, roads, mines, reservoirs, dams and farms fashioned a landscape designed for supporting better the dominant animal of the biosphere. Once part of nature, struggling to overcome its vicissitudes and caprices, technologically advanced humans increasingly became exploiters and dominators of a natural world increasingly geared to meeting their material needs. Nature was tamed.

Most of the earth's resources have been privatised. Utilisation of a resource involves either paying an access cost or conforming to regulatory requirements such as licensing. Water, for so long thought of as part of our birthright, has now been commoditised in most parts of the world. Resistance to the process has been marked - witness the hostile reaction to water charges in Ireland. The atmosphere however remains largely an open access resource. For greenhouse gases, it is effectively a global commons. As with all resources, common resources provide a facility and, if no utilisation cost is involved, tend to get overexploited. This is the root problem of atmospheric pollution either by industrial emissions such as sulphur dioxide or green-

house gases. Regulation of the atmosphere for greenhouse gas emissions is as yet in its infancy with only the United Nations Framework Convention on Climate Change and more recently the Kyoto Treaty providing the first steps towards restricting access and the European Emissions Trading Scheme creating a market in utilisation costs. Still however, the resource provides an individual incentive for most of the world's countries to spread their damage costs over the whole global community.

In tackling the problem of climate change clearly a revision of our deeply ingrained attitudes towards the natural world is required. The anthropocentric view of the natural world has blinded humanity to the obvious fact that far from being above nature we are as dependent on it today as the Neanderthals, though the relationship is more complex. Scientific advances have given us answers to fundamental questions of earth functioning. But these often come in an ethical and religious vacuum. Perhaps the non anthropocentric view of humankind as humble components of a natural web, as espoused by Francis of Assisi, offers an alternative perspective. Humans as stewards of the earth is perhaps the ideology which needs to be inculcated in all of us if we are to have success in tackling the environmental problems facing us, especially that of climate change.

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Appendix 1: Extract from the Programme for Government

Climate Change: A Challenge for the Whole World

As a developed country, as a Member State of the EU, and as a responsible nation in the wider international community, Ireland must play its part in meeting the most important environmental issue facing the world today. Meeting our obligations to the future generations requires all sectors in society to play their part. To ensure this Government will implement a comprehensive range of measures as set out in the new National Climate Change Strategy. This Government believes in the need to commit to a clean and renewable energy future and we commit ourselves to a Green Energy Revolution.

In particular, we will:

- Agree an all-party approach on climate change targets.
- In advance of agreeing such targets, the Government will set a target for this administration of a reduction of 3 per cent per year on average in our greenhouse gas emissions.
- Mandate the Department of Environment, Heritage and Local Government to publish an Annual Report setting out progress on meeting climate change targets.
- Increase the use of alternative energies for generating power in order to ensure that one-third of electricity consumed in Ireland comes from renewable sources by 2020.
- Create new opportunities for our farmers by moving agriculture to a new dual system of food and power production.
- Facilitate the establishment of a new bio-fuel industry in Ireland on the back of this new agricultural production.
- Improve the energy efficiency of new Irish homes by up to 40 per cent or more.
- Introduce a minimum requirement for the use of bio-fuels in State-owned and public transport vehicles. Dublin Bus and Bus Éireann will move their existing fleet to a 5 per cent bio-diesel blend and

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- will achieve a 30 per cent bio-diesel blend in their new buses.
- Make clear provision in Development Plans for environmentally sustainable transport methods.
- Continue to use the taxation system to encourage good environmental behaviour and discourage poor practice, e.g. through re-balancing the VRT and Motor Tax system to reward the purchase of greener cars.
- Complete the phasing out of incandescent light bulbs in favour of more energy efficient compact fluorescent bulbs to reduce our carbon emissions and save on electricity costs.
- Require the public sector to lead the way on energy efficiency with a mandatory programme of efficiency measures including the sole use of energy efficient lighting and heating in offices, schools and hospitals and other public buildings to produce 33 per cent energy savings by 2020.
- Require all street lighting and traffic lighting systems to be energy efficient and replace inefficient systems.
- Require carbon offsetting of all official air travel in support of urban forests.
- Require the mandatory use of bio-fuel mixes in transport fuels and ensure that there is a nationwide bio-fuel distribution network.
- Ensure that the development of renewable energy heating systems is encouraged through targeted grant schemes and facilitated by appropriate planning exemptions.
- Introduce smart electricity meters and ensure that energy produced in the home and at work can be sold back into the national grid.
- Implement all aspects of Transport 21 to so that the use of public transport becomes a real option for more and more people.
- Establish a high level Commission on Climate Change to oversee implementation of the Climate Change Strategy.

Figure 1: Projected temperature changes for Ireland

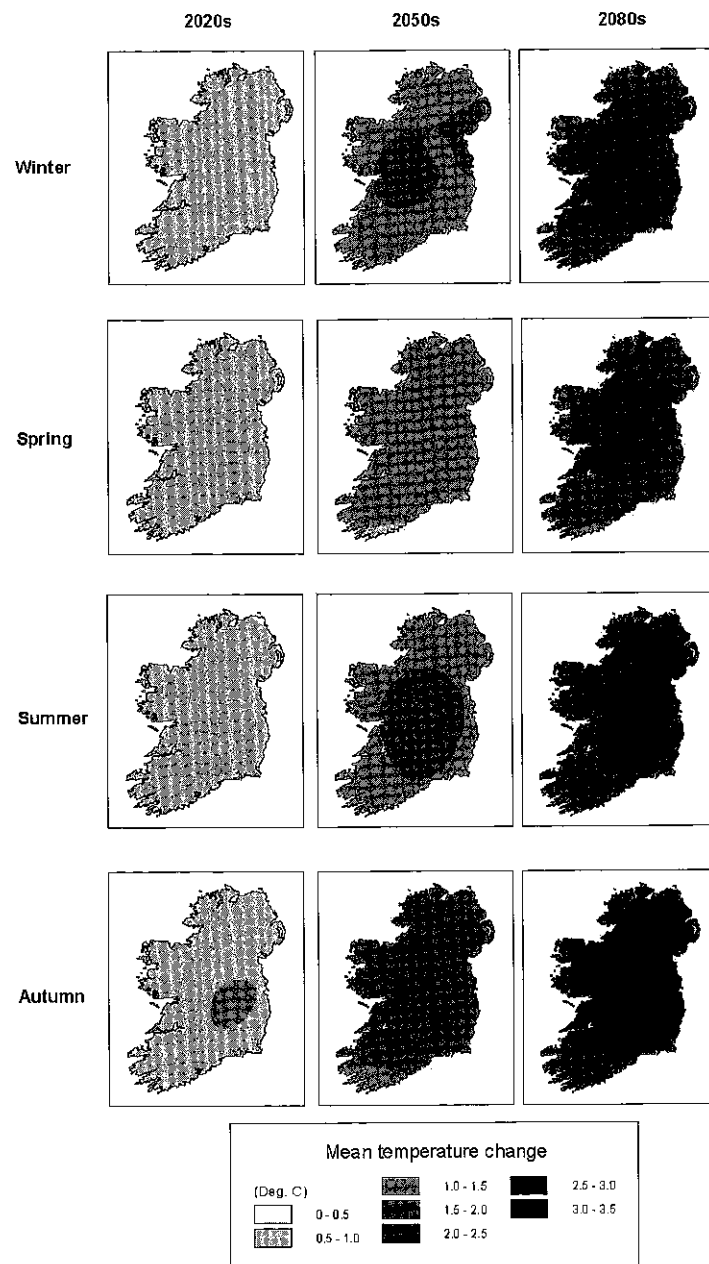


Figure 2. Millions at risk from various hazards in the 2080s as a result of global climate change

