George Powell.

Attention: Chairman
Essential Services Commission
Level 2
35 Spring St
Melbourne Vic 3000


Dear Sir

re Grampians Wimmera Mallee Water, Water Plan.

Your visit to Horsham confirmed my worst fears. They are

- this region has been subjected to the Delphi technique for committing people to a scheme with pre determined outcomes for shorting the people. That is burdening them to a debt against their assets property and rental (income from land use eage)

- With corporations State and Private bodies now driving all sectors of society their is no God given 'commons' left in an economy once based upon such free of fee resources. Water especially piped water will be an economic bond that will destroy equity in ownership of land due to limits (market place) on returns for developed products. Once the water costs upwards graph crosses the product return graph there is

Zero gain.

All-ready the red meat and wool production sector have been told that above 1000 sheep water costs will exceed production returns.

- The planned water price plus C.P.I. increases will be a compounding cost over the envisaged 5 years.

As C.P.I. indexing doesn't include the current Council rates and Water Board costs, both State Corporations, there will be an imbalance. C.P.I. will never reflect the true index to show the cost of living. Water is a consumption cost that won't be stable therefore those with reliance upon C.P.I. adjustments to pensions will always be at a disadvantage.

A regional C.P.I. index including essentials for living Water, Sewerage and Housing would create equity between the rural sector and large urban centres.

- Currently such economic imposts against farm land (equity) with no end to cost increases the potential for investment in farm land is too speculative for family farming dependent upon pipe water with the incumbent costs.

- The population ratio to the cost (debt) impost cannot be sustained without subsidie especially for the poor and aged.

- Land degradation is a product of insufficient disposable income to maintain the bio diversity for soil regeneration. All-ready the dried out wet lands have turned acidic. They, once re wet will/are releasing heavy metals lead, arsnic, aluminium and so on. Contamination of our river systems cannot be easily reversed. Regional degeneration is noticeable. Water price costs will further minimise disposable income for soil refurbishment.

- As an investor I, and my family have chosen to invest outside of this area for at least a decade until the water cost ratio to potential income from (rental) farm land becomes manageable

Yours sincerely

George Powell.

5th - 5th - 2008.

# The Tragedy of the Commons

EDITORIAL

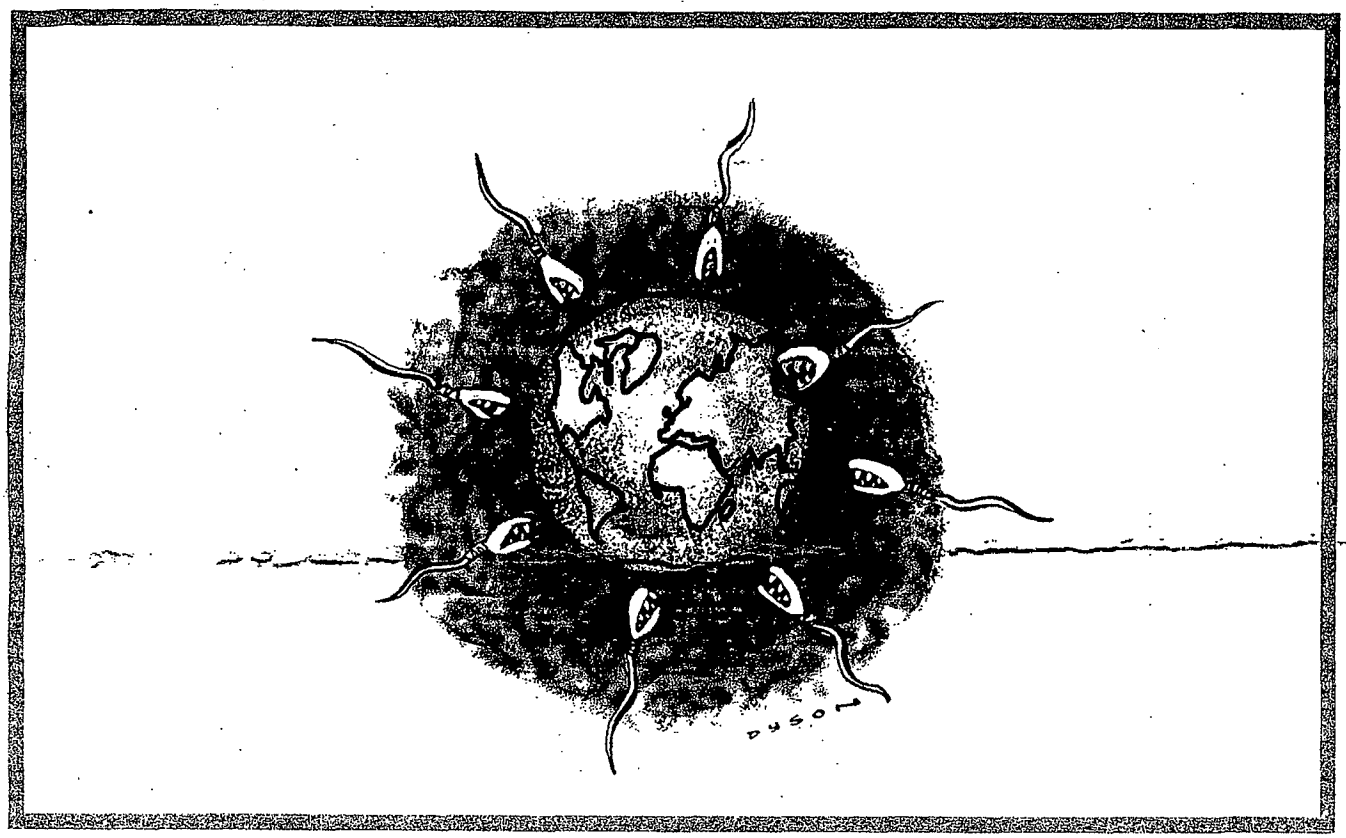
AS GARRETT HARDIN POINTED out in his famous essay, published by the American Association for the Advancement of Science in 1968, the population problem has no technical solution. It requires a fundamental extension in morality. Hardin said four decades ago 'it is fair to say that most of the people who anguish over the population problem are trying to find a way to avoid the evils of overpopulation without relinquishing any of the privileges they now enjoy. They think farming the seas or developing new strains of wheat will solve the problem – technologically' ('The Tragedy of the Commons', *Science*, Vol.162, pp.1243-1248, 13 December, 1968).

It seems that the world is now outside the zone where dealing with the multiplicity of problems associated with rising population is susceptible to a technological fix. A combination of population growth, limits to the supply of arable land, and diversion of food crops to the production of biofuels is resulting in higher food prices. According to *Climate 'Code Red': the Case for a Sustainability Emergency*, published by Friends of the Earth, the price and supply of affordable food is becoming a key indicator of a new phenomenon: a multi-issue crisis of sustainability incorporating food, water, peak oil, extreme weather and global warming. There is also the possibility of a global recession – which for the first time is not amenable to simple credit expansion. Dealing with all these problems involves moral issues requiring changes in human behaviour. Without the necessary changes in human values on which behaviours are built there can be no technological fix to the problems humans now face.

Specifically, the inevitable logic of exponential growth in both population and consumption is now hitting the real limits of global ecosystems and resource availability, as population rises from just over 6 billion now to 9 billion by mid-century. According to Ian Dunlop, formerly an international oil, gas and coal industry executive and chair of the Australian Greenhouse Office Experts Group on Emissions trading from 1998-2000, the situation is not unexpected. It has been forecast for decades going back before the 1972 'Limits to Growth' analysis. In the meantime we have created a political and capitalist system which has proved incapable of recognising it needs the preservation of a global biosphere fit for human habitation. Dunlop argues forcefully (*Climate 'Code Red'*) that our ideological preoccupation with a market economy based on short-run profit maximisation is rapidly leading towards an uninhabitable planet unless there is the development of a global governance framework capable of handling this 'Tragedy of the Commons'.

Hardin's stark message written 40 years ago is even more relevant today. It is worth quoting at length. He points out it is impossible to both maximise population growth and growth in living standards. In a finite world exponential population growth means the per capita share of the world's goods must steadily decrease. Hardin's logic is inescapable:

*If our goal is to maximise population it is obvious what we must do: We must make the work calories per person approach as close to zero as possible. No gourmet meals, no vacations, no sports, no music, no literature, no art ... I think that everyone will grant,*



**Without the necessary changes in human values on which behaviours are built there can be no technological fix to the problems humans now face.**

*without argument or proof, that maximising population does not maximise goods. Bentham's goal is impossible.*

We can define the 'commons' as those resources of the planet which humans are free to exploit without limit. Hardin argues that 'the commons, if justifiable at all, is justifiable only under conditions of low-population density. As the human population increased, the commons had to be abandoned in one aspect or another'.

*First we abandoned the commons in food gathering, enclosing farmland and restricting pastures and hunting areas. These restrictions are still not complete throughout the world.*

*Somewhat later we saw the commons as a place for waste disposal would also have to be abandoned. Restrictions on the disposal of domestic sewage are widely accepted in the Western world: we are still trying to enclose the commons to automobiles, factories, insecticide sprayers, fertilising operations, and atomic energy installations.*

*In a still more embryonic state is our recognition of the evils of the commons in matters of pleasure. There is almost no restriction on the propagation of sound waves in the public medium. The shopping mall public is assaulted with mindless music, without its consent. Advertisers muddy the airwaves of radio and television and pollute the view of travellers.*

*Every new infringement of the commons involves the infringement of somebody's personal liberty. Infringements made in the distant past are accepted because no contemporary complains of a loss. It is the newly processed infringements that we vigorously oppose; cries of 'rights' and 'freedom' fill the air. But what does freedom mean? When men mutually agreed to pass laws against robbing, mankind became more free, not less so. Individuals locked into the logic of the commons are free only to bring on universal ruin: once they see the necessity of mutual coercion, they become free to pursue other goals. I believe it was Hegel who said, 'Freedom is the recognition of necessity'.*

*The most important aspect of necessity that we must now recognise, is the necessity of abandoning the commons in breeding. No technical solution can rescue us from the misery of overpopulation. Freedom to breed will bring ruin to all. At the moment, to avoid hard decisions many of us are prepared to propagandise for conscience and responsible parenthood. The temptation must be resisted, because an appeal to independently acting consciences selects for the disappearance of all consciences in the long run, and an increase in anxiety in the short.*

*The only way we can preserve and nurture other and more precious freedoms is by relinquishing the freedom to breed, and that very soon. 'Freedom is the recognition of necessity' – and it is the role of education to reveal to all the necessity of abandoning the freedom to breed. Only so, can we put an end to this aspect of the tragedy of the commons.*

*— Kenneth Davidson*

ENVIRON-
MENT

# Ecologically sustainable development:
## *will recognition of health risks revitalise the debate?*

TONY McMICHAEL identifies the fundamental link between the health of the natural world and the health of human beings.

*'UNEP's analysis indicates that there is a very strong link between land degradation, desertification and conflict in Darfur. Northern Darfur – where exponential population growth and related environmental stress have created the conditions for conflicts to be triggered and sustained by political, tribal or ethnic differences – can be considered a tragic example of the social breakdown that can result from ecological collapse. Long-term peace in the region will not be possible unless these underlying and closely linked environmental livelihood issues are resolved.' UN Environment Program, 2007.*

THE CONCEPT OF *ecologically sustainable development* (ESD) entered Australia's political lexicon via the Hawke Government in 1989. At that time, almost two decades ago, ideas about sustainability were rudimentary. The inclusion of the adjective 'ecologically' was (potentially) an enlightened move, but the word was inevitably both confusing and provocative. That confusion and contention persists today, even as it becomes increasingly obvious that our ultimate need, as a species, is to sustain the life-supporting capacity of the natural world. That objective should be the real point of 'sustainable development'.

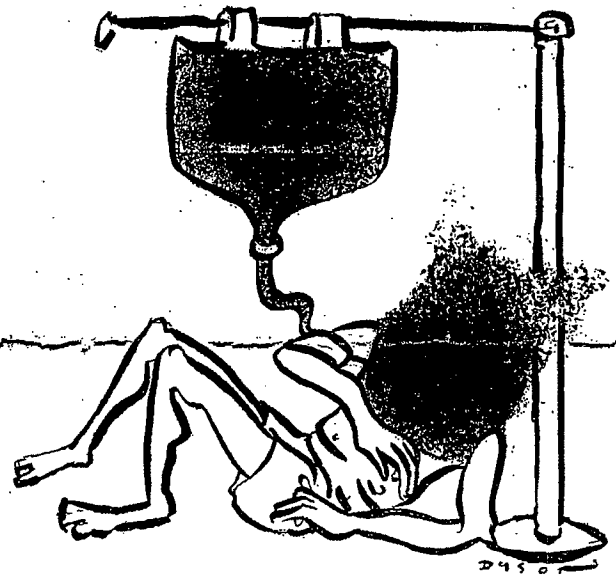
Meanwhile, democratically-elected governments are typically preoccupied with sustaining economic performance and electoral support. The Howard Government's resistance towards climate change, the Kyoto Protocol and emissions targets reflected how governments therefore tend to be in thrall to the 'sustainable growth' expectations of the private corporate sector.[1, 2] Hence, conservative and short-sighted governments readily give priority to sustaining jobs, selective sectoral subsidies, and economic growth ahead of longer-sighted, visionary, policies that would sustain the fundamental source of our wealth and wellbeing – the natural environment and its life-supporting systems. This policy schism persists, despite the growing and widely-accepted recognition that these two objectives need not be incompatible.

Australia's original *National Strategy for Ecologically Sustainable Development* drew on the report of the UN's World Commission on Environment and Development, Our Common Future.[4] That report and the subsequent UN Conference on Environment and Development, Rio de Janeiro, in 1992, promoted a new global agenda in which the process of national development would be attuned to sustaining the biophysical and ecological systems of the natural world. The Rio Conference also drafted the UN Framework Convention on Climate Change, for international cooperative action in curbing greenhouse gas emissions.

In that same year, all Australian state and territory governments endorsed the *National Strategy for Ecologically Sustainable Development*. The strategy's core objectives were:

1. To enhance individual and community well-being and welfare by following a path of economic development that safeguards the welfare of future generations;
2. To provide for equity within and between generations;
3. To protect biological diversity and maintain essential ecological processes and life-support systems.

The Strategy also invoked, as a guiding principle, the precautionary principle. It stated (p.8): 'where there are threats of serious or



irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation'.

During the 1990s, ESD was treated in somewhat divergent and often conflicted fashion by various interested parties in Australia. ESD was adopted by parts of the private sector as an aspirational goal, with a feel-good quality that could also enhance commercial image. Other corporations urged removal of the word 'ecologically', arguing that it both confused and gave undue prominence to the environmental dimension of sustainability. Meanwhile, the *1996 Australia: State of Environment Report* argued that the economy should be understood as a dependent, not an over-arching and controlling, entity. Further, the economy is a sub-set of society's activities and priorities, many of which do not involve economic activity – and, most important, our society-at-large is absolutely constrained by the natural ecology of our planet.[5](Ch10, p. 12)

## Recognition that human health is at risk

There was little in this early discussion about 'sustainable development' that acknowledged a connection to human health. For example, in the first major assessment report (1991) of the UN's Intergovernmental Panel on Climate Change (IPCC)[6] there was scant recognition that this remarkable, global-scale, human-induced environmental change posed serious risks to human health and, ultimately, survival. Within the formal scientific literature there had been scant attention to this relationship and, hence, little stimulus to new directions and content of research.[7] In the IPCC's subsequent three five-yearly reports (published in 1996, 2001, 2007) there has been a steady growth in recognition and emphasis given to the risks to human health from global climate change.

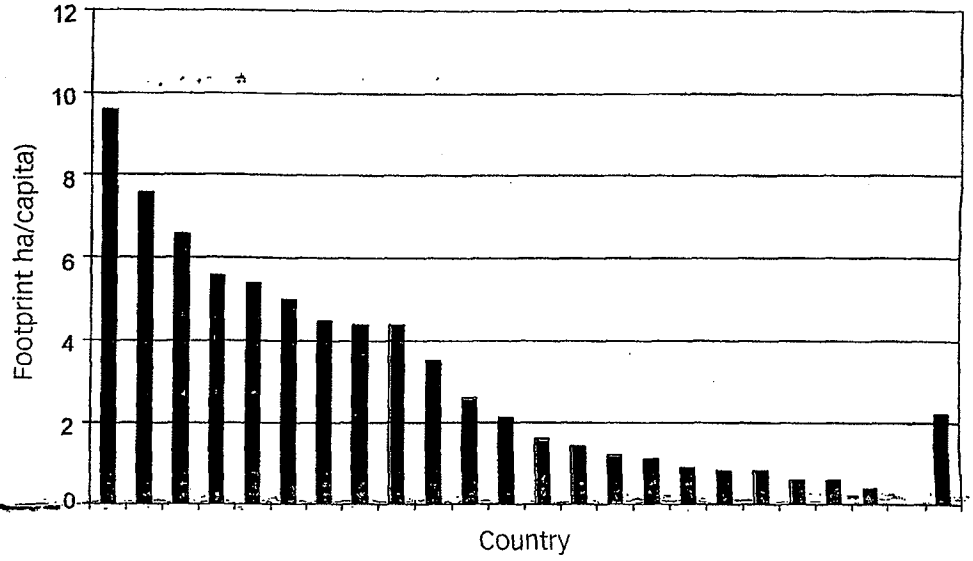
Indeed, since the middle of this current decade there has been a clear upturn in recognition of the fundamental and serious nature of the threats to human wellbeing, health and survival from the various, inter-related, global environmental changes that are the result of human pressures that now exceed the natural capacities of the biosphere. In 2007 the UN Environment Program released its *Global Environmental Outlook 2007* ('GEO-4'), containing a detailed assessment of the state and trajectories of Earth's main environmental and ecological systems.[8] The report conveyed a heightened urgency, including explicit recognition that social stability and human wellbeing, health and survival are at increasing risk from these large-scale systemic environmental changes. It documents the ominous trends in the world's fertile soils (and in many regional agricultural yields), freshwater supplies, coastal and reef ecosystems, fish stocks, concentrations of human-activated nitrogen (mostly from nitrogenous fertilisers and fossil fuel combustion), acidity of the ocean, numbers and stocks of species, and the global climate.

The GEO-4 report listed a range of environment-related indices that had undergone exponential growth, since 1900, reflecting the surges in population size, energy use, material consumption and waste generation. The list includes:

- Global population has grown from 1.6 billion to over 6.6 billion
- Energy use has increased 16-fold
- Industrial production has increased 40-fold, mainly due to growth in developing countries
- Water use has risen 9-fold
- Fish catch has soared 35-fold, >

**FIGURE 1**

**Comparison of the area of productive land surface available per person within selected countries (hectares per capita), circa 2005. This measure is often referred to as the individual's 'ecological footprint'. Australians, on average, currently use three times the world average (6.6 hectares, versus 2.2 hectares). The amount that is actually available, globally averaged, is an estimated 1.8 hectares.**




with major stocks likely to crash mid-century
- Carbon dioxide emissions have increased 17-fold
- Sulphur emissions have increased 13-fold, and other air pollutants 5-fold
- Rates of both deforestation and desertification are accelerating

It appears that we have entered a pivotal decade for decision-making if we are to avert the possibility, indeed probability, that in at least some parts of the world there will be serious environmental crises, conflicts and disasters within a generation.[9-11] That decision-making will be enhanced by recognition and understanding of the scale, type and human consequences of harm that our collective actions are doing to Earth's life-support systems. We have begun to notice, albeit at a rather late stage in the narrative, that the human species is itself at risk[12] – that is, that this exceeding of environmental capacity is much more than a threat to economic activity, infrastructure integrity, tourism and iconic ecosystems and animals.

Assuming that we bring to our decision-making a sense of moral responsibility for the natural world and for the prospects for future human generations, such information about the risks to health should reinforce our motivation to respond. So, how best to assemble and communicate such information?

## Global environmental impact: the state-of-play

Many reputable scientific bodies, both national and international, conclude from the increasingly compelling evidence that we may be approaching a crisis point in Earth's capacities to sustain healthy life. Consider, for example, the dramatic escalation of species extinctions, both plants and animals – now occurring around one thousand times faster than the natural background rate of extinction, and weakening various ecosystems and ecological processes such as pollination [8]. Indeed, the GEO-4 report makes clear that, collectively, we have exceeded the capacity of the planet to supply, replenish and absorb. We are now trading in the red, which is clearly unsustainable.

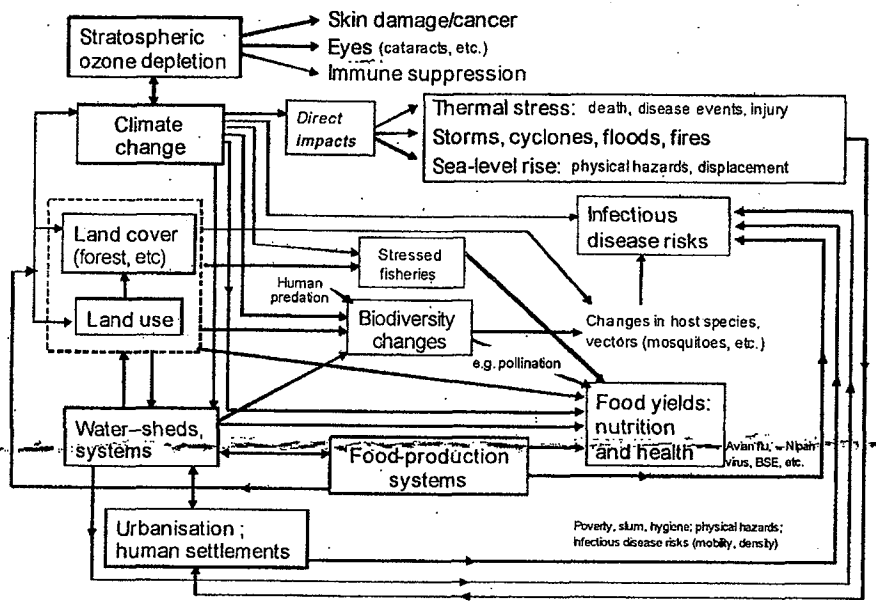
The World Wildlife Fund has recently attempted to estimate how far humankind has ventured into 'the red'. The conclusion is that we are now using global environmental resources at approximately 1.25 times the regenerative and absorptive biocapacity of Planet Earth.[13] While there are currently 1.8 hectares of productive land surface available per person, the global average demand is already 2.2 hectares. That latter figure varies by a factor of ten between the countries with the largest 'ecological footprints' and those with the smallest – see Figure 1.

A similar general conclusion was reached by the exhaustive scientific review and assessment, and the future projections of environmental and ecosystem changes, made by the international Millennium Ecosystem Assessment (MA)[14]. That assessment, conducted during 2001-2005, concluded that:
- Approximately two-thirds of the world's ecosystems have been significantly damaged by human actions in recent decades.
- Continuation of this trend will seriously impair the flow of Nature's 'goods and services' to human societies, comprising: (i) provisioning (e.g. foods, freshwater flows), (ii) regulating (e.g. flood control, and the range and activity of infectious agents), (iii) supporting (e.g. generation of hydropower and geothermal power), and (iv) enriching local cultures (diverse examples include: seasonal festivals, animal migratory events, and totemic species).

The subsequent Health Synthesis Report, a distillation of the health-related contents of the overall MA assessment, summarised the

**FIGURE 2**

**Main pathways by which climate change and other global environmental changes can influence patterns of health and disease in human populations. The impacts on food yields and nutrition and on the occurrence of infectious diseases are highlighted, to show the complex and multivariate nature of the environmental influences.**




evidence from the (as-yet limited) body of research assessing how changes to ecosystems – agroecosystems, biodiversity, coastal ecosystems, fresh water cleansing and flows, etc. – can affect local and regional human wellbeing and health.[15] The tempo of research in this particular domain is now increasing, reflecting the growing awareness of the risks and the urgent need for clearer understanding and policy input.

## Environmental influences on health: a new, systemic, dimension

Modern, predominantly urbanised, societies have been slow to recognise the fundamental significance of global climate change and other associated global environmental changes (GECs). This is not surprising, given how we conventionally think about the health hazards posed by local environmental pollutants: chemical compounds, heavy metals, asbestos, ionising radiation, and others. Those familiar environmental health hazards fit a straightforward view of a local environment contaminated in 'spanner-in-the-works' fashion. By contrast, climate change and other human-induced GECs are qualitatively different environmental health problems. They entail disruptive systemic changes to the functioning of the 'normal works', the system at large.

The recent history of infectious diseases around the world provides insights into how these systemic changes can affect human health. Various GECs (along with other social-economic 'global' changes) have begun to affect patterns of infectious disease emergence, resurgence and spread in recent decades. More than 30 new infectious diseases have been reported since the mid-1970s – an unprecedented rate of emergence of new infectious diseases in humans [16]. The main effects on infectious diseases are shown as part of the constellation of such influences on human health shown in Figure 2.

The increasing tempo of change in patterns of infectious disease occurrence around the world reflects, in large part, the increasing intensity and scale of human activities. This includes: greater mobility of people, intensified trade, increased inter-population contacts, altered social relations (sexual networks, drug use), new commercial technologies, and, on the environmental front, increases in the sheer scale of land clearance, the rate of biodiversity loss, and, now, the emergence of climate change.[17]

The emergence of the viral disease SARS (Severe Acute Respiratory Syndrome) in Hong Kong in 2003 reminded us that we live in a world where microbes freely cross borders, where trade routes and human mobility have expanded, and where densely populated cities enhance epidemic spread. The advent of ('highly pathogenic') H5N1 avian influenza conveyed a similar message: increases in population size and density, intensification of commercial poultry production in SE Asia and southern China, and greater human mobility all combine to amplify the likelihood of new viral strains arising and of their distant spread.[17]

Many infectious diseases are sensitive to climatic conditions. Of particular concern are the vector-borne infections, transmitted via mosquitoes, ticks, midges and other cold-blooded organisms that are very sensitive to climatic conditions.[18] Hence, climate change will almost certainly affect the patterns of occurrence of various infectious diseases, both vector-borne and human-to-human. Globally, malaria, dengue, cholera, and food-borne infections are of particular concern. Recent extensions and outbreaks of these and other related infectious diseases, in association with >

**BOX 1**

## Key conclusions from IPCC Fourth Assessment Report, Working Group I

- Atmospheric concentrations of carbon dioxide, methane and other greenhouse gases are at their highest levels in 650,000 years (the limit set by ice-core samples).
- It is very likely (>90% probability) that human-induced greenhouse gas increases have caused most of the observed increase in global average temperature since the mid-20th century.
- Global average temperatures this century will rise by between 1.8°C (approaching the target 'allowable' increase) and 4.0°C – the range reflecting primarily the uncertainty about future human population size, characteristics, choices and behaviours.
- The temperature increase could be increased by a further 1.5C° because of 'positive feedbacks.'
- Some of the potential human-induced warming has been offset by cooling from other anthropogenic factors (suspended aerosols). Without this inadvertent cooling effect, mean global temperatures would be even higher.

regional warming, suggest that climate change is beginning to influence disease patterns. The advent of climate change underscores the need for a more 'ecological' systems-based approach to understanding of how the interplay of evolutionary, ecological and social processes influences patterns of infectious disease.

The recent emergence of Nipah virus disease, first in Malaysia in early 1998 and subsequently in Bangladesh, illustrates the complex interplay between environmental, ecological and commercial factors.[19] The key species involved in the emergence of this zoonotic (animal-derived) viral disease in Malaysia were: forest fruit-bats, rainforest trees, domesticated pigs, cultivated fruit trees, and humans – along with the virus that was endemic in the bat population. A combination of stresses on the supply of wild fruits in the rain forest – including forest clearing and the dry and fire-prone conditions of the El Nino event of 1997-98 – and the availability of alternative fruit source from the orchards surrounding the intensive commercial piggeries enticed the bats into proximity with the pigs. The pigs became infected with the virus, and duly passed it on to pig handlers. Over two hundred persons were infected with this emerging zoonotic viral disease, and over one hundred of them died.

## Pressures on ocean fisheries

Fish account for a high proportion of animal protein in the world's diet, especially in many developing-country coastal communities. However, since the mid-1980s the total global wild fish catch has been declining. This reflects a now well-documented over-fishing of many of the world's major ocean fisheries. An estimated quarter of commercially exploited marine fish stocks are now seriously over-harvested.[14] The GEO-4 report estimates that commercial pressures on the world's major fisheries have resulted in more than 1400 stocks being fished, of which 240 stocks had 'crashed' by the year 2000. In addition, many areas fished have not returned to maximum catch levels (seen in 1970s and 1980s), despite reductions in permissible catch quotas. Various actions have been taken globally, including stricter enforcement of fishing regulations, specification of marine protected areas of oceans, implementation of ecosystem management and property rights, and the introduction of economic and market incentives.[8]

Meanwhile, alongside over-exploitation by industrialised high-technology fishing fleets, other stresses are building up. As the oceans warm and as various coastal and other currents begin to change and shift, so some fish populations have begun to move.[20] The Eastern Australian current, which runs along the east coast of Tasmania, appears to be undergoing changes that affect local coastal fisheries there. Even more ominous is the gradual acidification of the oceans as more carbon dioxide is absorbed from the atmosphere, forming carbonic acid (as indeed any high school student could have guessed). The calcification processes (the formation of chalky structures) that are integral to the tiny creatures at the bottom of the marine food web – coral, zooplankton, copepods, crustaceans and shellfish – are very sensitive to pH. Scientists estimate that, on current trends, acidification sufficient to impair calcification will occur within 3-4 decades.[21]

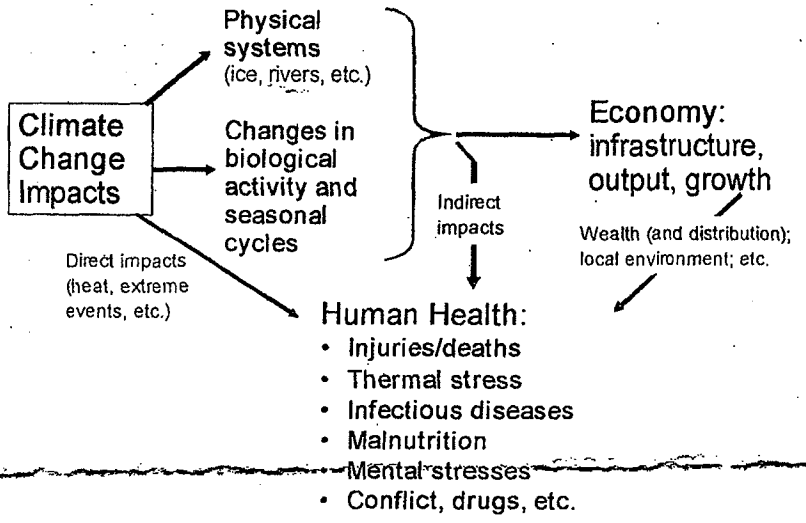
This precarious situation of the world's fisheries illustrates well the complex and multivariate way in which various now-excessive human pressures on natural systems, and the environmental changes that ensue, can combine to pose major threats to components of Earth's life processes and life-support systems.

## Climate change and human health: global and local

The rate of change in the world's climate has accelerated over the past decade.[22] Further, the annual rate of emission of carbon dioxide in this decade is approximately twice what it was in the 1990s, and

**FIGURE 3**

**Diagram of the major domains of impacts of climate change – on physical systems, non-human biological processes and ecological systems, and on human health. Note the interconnectedness between these impacts: all have consequences for human health.**




proportionately more of it is being retained in the atmosphere, as the natural sinks (oceans, forests, etc.) fail to keep up with the extra demand.[23]

The key findings, from the IPCC's Fourth Assessment Report, shown in Box 1, include the conclusion that most of the warming since mid-20th century is due to human actions. [24]

Over the coming century, climate change will cause changes in average temperatures and rainfall, both annually and seasonally. Historical data show that temperatures in Australia have risen by approximately 1°C since 1910.[25] That warming has been uneven, with warmer temperatures observed over inland areas, and least warming over the southeast parts of the country. Rainfall is usually variable in Australia, but trends since 1900 indicate that weak increases have been observed across the country. Since the 1950s, however, trends show rainfall has increased over northwestern regions, but decreased in the east and southwest areas of Australia.

The latest projections of climate change in Australia have increased our understanding of how the occurrence of extreme weather events is likely to change under altered climatic conditions.[25] The CSIRO's main conclusions are:

- Extreme daily rainfall will tend to increase in many areas (though not in the south in winter and spring)
- An increased frequency of drought (as defined on current climate) is likely over most of Australia, especially the south-west
- It is likely that fire danger, including severity, will increase in south-east Australia
- The intensity of tropical cyclones is likely to increase, although the total number of cyclones may decrease
- The number of large-hailstone days may increase along east coast, but decrease along south coast

Global warming may already have begun to displace seasonal rainfall systems, in many mid-latitude regions, towards the poles.[26] This has implications for the occurrence of droughts, and for the location and timing of monsoons. Palaeo-climatological research has shown that the southwest Asian monsoon moved several hundred kilometres northwards during the approximately five thousand years of warming that occurred after the last glaciation, from around 15,000 years ago. There is debate in the scientific literature over the role that climate change may be playing in the severity and duration of droughts in several regions of the world, including south and eastern Australia, India, southern Africa, and parts of southern Europe.[27] However, there appears to be good reason to anticipate that such shifts in rainfall zones will occur over coming decades as warming proceeds.

Recent trends in Australia suggest that this displacement of rainfall systems ('storm tracks') may now be happening. For Victoria and southern South Australia, this raises the prospect that the prevailing winter rainfall system (required for wheat germination) will move southwards over coming decades, drifting increasingly off-shore. The likely consequences of the resultant drying and reduced crop yields for the wellbeing and health of rural communities in affected regions are many. The health risks include mental health problems, water shortages and hygiene, exposures to extremes of heat, dust and smoke, impaired local food production, and exacerbations of health-damaging personal behaviours.

The risks to human health from climate change are a logical part of a wider constellation of impacts on climate-sensitive physical systems (especially ice-sheet and glacier melting), biological processes and rhythms, ecological relationships, and social-economic conditions, summarised in Figure 3. Changes in climatic conditions will inevitably have many effects on human biology, environmental exposures and the physical risks of injury, and hence on health.[28] These effects, as indicated in Figure 3, will occur via direct and indirect pathways, and across >

BOX 2

## Summary of the main health risks from climate change in Australia

- Increased illness events and deaths from more frequent and severe heat-waves, especially in urban environments. Some evidence, from time-trends over the past several decades, points to increasing annual numbers of deaths in association with an uptrend in the annual number of very hot days.
- Increased injury, death and post-traumatic stress disorders from increases in other extreme weather events – esp. floods, storms, cyclones (moving further south), and more extreme bushfires.
- Increased risks of infectious food-poisoning (gastro-enteritis), from salmonella, campylobacter, various temperature-sensitive vibrios, and others. ANU researchers estimate a 15% increase in diarrhoeal disease hospitalisation in aboriginal children in central Australia over the next 3-4 decades.
- Changes in the range and seasonality of outbreaks of mosquito-borne infections – including dengue fever in northern Australia (likely to spread south, down both the eastern and western coasts), Ross River virus disease, Barmah Forest virus disease, and others.
- Fresh-water shortages in remote (especially indigenous) communities, with consequences for hygiene and sanitation.
- Regional increases in the production of various plant-derived aeroallergens (pollens, spores) that cause/exacerbate asthma. Recent research at Macquarie University has identified how this risk has increased and will increase in response to climatic trends.
- A range of adverse health impacts of more severe droughts and long-term drying conditions on rural communities. These include adverse impacts on:
  - Mental health (depression and suicides)
  - Child emotional and developmental experiences
  - Exposures to extremes of heat, dust, smoke
  - Freshwater shortages and hygiene
  - Changes in health-related behaviours (alcohol, smoking, self-medication, local food availability )
- The spectrum of risks to wellbeing and health from the anticipated increase in geopolitical instability in the Asia-Pacific region, due to climate change, and the increase in flow of environmental refugees. Implications for mental health and nutritional problems (refugees), infectious disease risks, and conflict situations.

different timescales. Many impacts (e.g. on agricultural yields and, hence, on nutritional health) will be modulated by the coexistent actions, perhaps interactions, of other environmental changes – as is also shown in Figure 2. The impacts of climate change on local environments, food yields, physical hazards and livelihoods will often also affect mental health and health-related behaviours. The likely main health effects in Australia are summarised in Box 2.

The warming of the Arctic region, with resultant loss of ice (both sea-ice and permafrost), has begun to disturb traditional living, hunting and eating patterns in the Inuit communities of northern Canada. This has resulted in declines in physical activity, a greater reliance on commercially-produced energy-dense processed foods, and a much heightened probability of adverse health consequences, especially obesity, cardiovascular disease and the occurrence of diabetes.

The crucial general point is that global climate change is now affecting more than infrastructure and the economic system. It is affecting Earth's natural life-support systems – and that is the paramount, long-term, danger. The fact that such risks exist serves notice on us that global climate change is a much more momentous process than we originally imagined.

## Achieving sustainability: nature, nurture and governance

As evidence and understanding grow in relation to the effects of climate change on health, so the case for reducing greenhouse gas emissions is strengthened and rendered more urgent. So, then, is the case for cultural, commercial and technological changes that will avert damaging changes to other global and regional environmental systems. However, there are two strong under-currents to be countered.

First, the ideology of neoliberalism has prevailed in high-income countries over recent decades, promoting free-market economic behaviours, individualism, and a consumer culture. Achieving the requisite shift in values and technologies and a willingness to accept 'mutually agreed mutual coercion' within and between populations will require collective effort. Enhanced insight into the dimensions and consequences of the environmental and ecological problems we face will assist that daunting task.

Second, we are, via Darwinian evolution, the inheritors of ancient behavioural proclivities that serve well the amoral self-interested imperatives of individual survival. Altruism and cooperation can