Tony Fry

Living in a Changed Climate

Climate change, as a 'product' of global warming, does not just mean things are getting hotter, but rather that the whole climatic pattern of hot/cold, wet/dry, low wind speeds/high wind speeds is changing. Climate change, and its causes, has received a great deal of scientific attention and been subject to extensive research. However, the claims about the causes of climate change have generated an enormous amount of controversy, rhetoric, campaigning, international conventions and more.

There is now a consensus among the scientific community, most recently expressed by the United Nations Committee on Climate Change, that climate change is here, and the speed of its development cannot be explained by recourse to theories of 'natural causes.' After more than a decade of analysis, projections and attempts to curtail greenhouse gas emissions, the actors in this drama are now facing two discernible failures. First, is the failure to gain international agreement on adequate action to curtail greenhouse gas emissions. Second, is the less publicised, but equally significant failure to initiate adaptive measures to mitigate the effects of climate change.

Informed professionals, corporations and governments need to take initiatives, such as designing and constructing buildings, plant and products that can reduce the emissions that cause global warming and can also deal, in whole or part, with whatever climate change eventuates. This paper is neither a study, report nor product of scholarship, rather it presents the EcoDesign Foundation's orientation to working on the problem of climate change. It comes out of a reflection on the Foundation's efforts and experience in 'sustainable architecture' and 'renewable energy' over the past decade, and recognises a need for far more critical activity in these areas. The paper will strive to bring a number of new perspectives into focus, and in so doing, seek debate, criticism and hopefully solidarity.

The context

While a changing climate is an intrinsic part of our planet, over the last few hundred years and especially over the last 120, direct and indirect human activities have significantly altered the speed of change and the nature of the process. The result has been an unprecedented increase in global warming over a very short space of time — due to a continuous build up greenhouse gasses in the atmosphere. Unlike 'natural extreme emissions events' human activity increases emissions as a constant accumulation without any recovery periods. Unless the current trend of global expansion of production and consumption of fossil fuel energy is significantly curtailed, then irrespective of the geopolitics of 'development and social justice' the situation will worsen. The degree to which this problem can be countered by weak regulatory measures, 'no-regrets actions' or by compensatory means (like the sequestration of carbon dioxide in plantations of fast growing

trees) is, at best, practically, culturally and scientifically questionable. Actual solutions will come at a cost, and unavoidably will involve major reductions in the use of non-renewable energy. Clearly for such 'solutions' to be possible, global developmental directions, economies and cultures have to fundamentally alter. In this setting, advancements in social justice are not an effect of development but a prerequisite for its remaking.

We approach this complex situation, without disappearing into the complexity, from two contextual perspectives.

First, there is a need to far better understand that while climate change is exacerbated by industrial society *this is fundamentally by driven* human activities, especially as world population grows, urbanises and the demand for manufactured commodities from a globalising consumerist society ever increases. In this scenario, the reduction of non-renewable energy is just one factor in the reduction of the impact of human actions.

From what has been said, it follows that while population figures are often cited they can mislead, as figure 1 shows.

▼ **Human world inhabitation:** from over 50, 000 years plus to the year ➔	**1900** ➔	**2000** ➔	**2050** ➔
▼ **Human population growth** from ➔	1.6 billion ➔	6.0 billion ➔	8.5 billion ➔
▼ **Impact population** = number of people x level of consumption from ➔ (**note:** consumption level figure is an indicative global mean of wealth/poverty)	**Consumption: 1 person at the year 1900 levels = n**	**Consumption: 1 person at the year 2000 levels = n x 50**	**Consumption: 1 person at the year 2050 levels = n x ?**
▼ **Impact population**	**1.6 b** x **n** ➔	**6.0 b** x **n** x **50** ➔	**8.5 b** x **n** x **?** ➔

Figure 1. IMPACT POPULATION PROFILE

Clearly, unless there is a major reduction in the growth of the 'impact population' the problem of climate change will worsen. As indicated, it is a problem that cannot simply be 'contained' within the physics, chemistry and biology of the climatic system. In coming decades, the geopolitical, economic, cultural and psychological manifestations of climate change will become more apparent and will require a far more coherent, inter-related mix of strategies and measures for reduction, prevention and adaptation.

Second, climate change became a public issue mainly through the efforts of concerned scientists. While appropriate, this also brings problems.

Dominantly, science and technology are viewed as the means of providing solutions (by, for example better defining and monitoring the problem and responding to it with the likes of carbon sequestration, 'clean' fuels, 'sustainable building design and construction', improvements in the performance and uptake of renewable energy, increased energy efficiency and so on). What, however, has not begun to be adequately contemplated is that the complex inter-related consequences of climate change will generate massive social, cultural, political, economic and health problems. These problems will become evident in many ways, such as — growing numbers of environmental refugees (from floods, drought, heat, cold, lack of food and water); in the climatic inappropriateness of many traditions of building and dwelling; in conflicts, of various scales over desertification, fresh water resources and fertile soil; in failing agricultural economies (exacerbated by what will become inappropriate farming methods and nutritional health problems); and in the numerical increase and geographic spread of vector and non-vector delivered tropical diseases (because of climate change, sub-tropical regions are expanding, as are their populations).

Against the backdrop of geo-physical global impacts, climate change will have profound geopolitical, cultural and psychological consequences *and* pose major threats to global security — this because of actual and perceived threats to the ability of human populations to sustain themselves, and much else upon which they depend.

While the environmental impacts of climate change are slowly starting to be comprehended via the study of global warming and associated data, as well as, more problematically, 'extreme weather events', there is far less knowledge being developed on the enormous consequences of climate change and measures needed to deal with them. The regional map of climate will alter, which in turn will reconfigure: international political and security relations; population migration and ways of life; cultural forms and value systems; the fabric of the built environment; social organisation; economies; public health; natural resource management and more. It follows that there is a pressing need to:

- raise awareness about the more complex picture of climate change
- create cultural strategies that broaden the constructive responses to climate change beyond scientific and technological approaches
- develop adequate design responses to the situation.

It is extremely important to grasp the complexity of the situation as well as to be engaged practically. Design practices (planning, architectural, industrial and communication) have a large part to play, but design responses have to be informed by an understanding that bio-physical, economic and social ecologies are all interconnected. A brief example will make this more apparent.

As is well known, a number Pacific Islands fear the threat of rising sea levels (projected as 50cms in the next 50 years). However, well before the landmass is flooded, the islands' shallow lens of fresh water will become salinated. Not only will the loss of fresh ground water affect the island's ecosystem but there will also be short and long term economic impacts, alterations in external perceptions of the region, changes in local food production, plus shifts in the disposition, mood and psychology of the populations. Modifications to human settlement patterns will follow — the islands are likely to be depopulated a long time before they are flooded. It follows that the more complex picture of causality needs to be created. This cannot come from the way climate change is currently presented, with its focus on highly visible climatic events and often questionable projections. More adequate ways of thinking the future are needed.

Clearly, debates on climate change have raged, and will continue to do so. It's likely that action to reduce impacts will stumble on for the foreseeable future in the ineffectual manner to which we have become accustomed. What we aim to focus on here, design for climate change, is not about campaigning, although it could well incidentally trigger public interest and awareness. Certainly, it has not received any media attention yet, and, as already indicated, what this issue aims to do is inscribe understanding and action across a broad band of professional practices.

Elemental Design

What now follows is a short review of how 'sustainment design' thinking can approach the complexity of climate change and how this can inform what design is constructively able to do.

What climate change designs and what has to be designed.

Climate change is mostly sought to be understood through atmospheric and terrestrial thermal measurement and modelling. This is the correlated to emissions of various gases, (most notably carbon dioxide as well as nitrogen oxides, methane and chlorofluorocarbons) that accumulate and retain heat within the atmosphere. Comparative measurement spans, for example, differences between changes in land and sea temperatures; current and historical core samples from polar ice caps; and, temperatures at various levels of the atmosphere. Observed changes in weather patterns, the frequency and nature of extreme weather events are also significant sources of data (although the attribution of 'planetary structural' versus 'artificially inducted' cause is extremely difficult to prove empirically when dealing with dynamic systems, with most detectable shifts in patterns being circumstantial, rather than conclusive, evidence). Beyond the direct focus on climate, there is also much research on impacts like coral reef bleaching, reductions in biodiversity, alterations in freshwater catchment and the relation between the spread of sub-tropical zones and tropical diseases. However, again the relation between global warming, as cause, and specific effects is still being explored. The relationships are frequently suggestive, contentious or unable to be empirically demonstrated.

Whatever the status of 'the provable facts of causes of climate change', what is beyond doubt is that events are occurring that have to be dealt with, but which are just not being sufficiently recognised or addressed. Most overtly, this would include:

- what, where and how we build
- dealing with the increasing level of risk associated with existing, and now climatically inappropriate, built environments
- the need to alter farming methods in many parts of the world
- locating and culturally reconstituting large numbers of environmental refugees.

More indirectly, but equally important, is dealing with the impacts of climatic and environmental change on the perceptions and mood of populations at large. And, more specifically — how we dress, what we eat, the amount of time we spend indoors or outdoors, how often we are exposed to extreme weather events, and what levels of anxieties are associated with them. These are but a few of the things that will become more apparent by degree. The process has of course started — beach culture in Australia has dramatically changed since the arrival of a massive hole in the ozone layer, which has exposed the population to much higher levels of ultra-violet light and markedly increased the risk of skin cancer. Likewise, and for the same reason, the population in Southern Chile is instructed to stay indoors on days when UV levels are high. More directly, and at the causal end of the problem of emissions, the air quality in many of the world's mega-cities is so bad that respiratory diseases are becoming more prevalent and again people are regularly told to stay indoors.

While current levels of knowledge, in terms of climatic behaviour, are growing, the ability to view the complexity is not. Knowledge on longer term implications of climate change — geophysical, meteorological, environmental and socio-cultural, is still very underdeveloped. How to design and 'engineer' environmental adaptation, and enable appropriate cultural change, is an even bigger challenge that has to be met.

However, and more specifically, design for change needs to be informed by critical thought which realises that whatever we make, especially as built forms, is always en route to the future as a determinate force.

The failure to adequately grasp the futural impact of what we design and bring into being has been a major flaw in modern design and world making. Future design action will require, for example, when conceptualising a building with an expected life of say 100 years, to design for whatever are the current conditions but also, expected changes in those conditions, This might mean providing structures better able to withstand high wind speeds, hail impact, large volumes of rain for extensive periods, or equally a building able to cope with great temperate fluctuations, protracted droughts or very high volumes of snow. At the same time, such buildings have to be designed so that they do not make major constructional or operational

demands, especially upon energy generated from fossil fuels, which would themselves add to greenhouse gas emissions problems, thereby 'fuel' the climate change problem.

Changing the way we design and construct the built environment in response to climate change will alter the way we live and work. From a long history of striving to conquer the environment by creating conditions of environmental independence (such as fully serviced systems buildings) we now find ourselves in a reverse situation — the revenge of the environment. We now have to respond as change is imposed upon us, at a level we cannot ignore. Such a situation creates a major need for a communication and cultural strategy, with a focus on appropriate design actions. Constructive action to engage the impacts of climate change now needs to proliferate at all levels from the individual to the governmental. At this point let's be more explicit by presenting five kinds of things that 'Design and the Coming Climate' might engage. This could be considered as prompt toward such designing. What will be said under the following five headings can be applied to the circumstances of both established industrial and newly industrialising nations.

1. Climate change in a changed climate

The word climate is used to name and define established patterns of weather created by the interactions of sun, wind, rainfall, water, tides, humidity, temperature, atmospheric conditions and the terrestrial topographic form of particular geographic regions of the planet. But it is also used, metaphorically, to characterise the atmosphere, the mood, the ambience, *the climate* of a social or business situation (for instance, it might be described as relaxed, tense, excited, stimulating, hot or cool). At the same time, as anyone who has experienced say a wet season, a long dark winter, endless hot still days will know there is often a direct relation between physical climate and the socio-cultural atmosphere, mood or ambience. It is no coincidence that we apply terms like sunny, gloomy, dull, changeable to both the weather and the disposition individual people and cultures. Actions follow from particular relations of people, place and climate — we use shade, light, colour, sound and materials with particular characteristics to manage this relation by creating desired effects, moods, ambience.

Basically, not only have climate and culture been structurally linked across the history of humanity but one can say the formation of a culture (the way it builds and lives, its sources of food and diet, its rituals, its dress and so on) has always been climatically determined. Put at its simplest, climate is a primary designing determinant of a culture.

It is against the background of what we could call the anthropology of climates that we should view the changes to which we will have to respond. This means: (i) taking actions to reduce the impacts of human and industrial activity on climate, (ii) adapting to climatic change as weather patterns alter (iii) adapting the

environments we create so they are appropriate to a changed climate, and (iv) modifying how we constitute psychic-cultural climates so we may deal with change.

The non-scientific community, the design community, in its broadest sense, needs to acknowledge that climate change will change the mood of people at large and at the same time, the mood of the community needs to be changed towards the situation — the latter needs to prefigure the former. A disposition towards a questioning, observing, enquiring, understanding, thinking, exploring and acting responsibly needs to be designed by intensifying the will, mood, *climate* to do these things.

2. Climate change and the existing designed environment

The built environment (industrial, commercial, institutional and domestic buildings) contributes to greenhouse gas emissions and thus global warming, mostly because of its energy-inefficient design and construction. Engineered supplements (mechanical services) rather than solving this, mostly compensates for or conceals it. Certainly, for new buildings, good design, selecting the right materials and establishing communities of informed users can make many, and in some case in some geographic locations all mechanical services redundant. A great deal of heating, cooling and ventilation can be, in whole or part, 'passive'. At the same time existing structures, and almost all new ones, have not been designed or built to deal with a climate other than that which currently prevails. This means that as the climate changes a great deal of the existing built environment will be in a condition of growing risk, inefficiency or both. This situation also converges with population growth and trends toward rapid urbanisation in many parts of the world. Increasingly there will be more people in more places less capable of withstanding extreme climatic shifts and events (this will be as much a consequence of population density as of a climate event). The history of droughts, earthquakes, floods, landslides, hail storms, heat-waves, tornadoes/hurricanes/typhoons, tsunami already shows that the worse the standards of building construction the higher number of injuries and fatalities.

As climate changes existing 'standards', as well as notions of 'current best practice', will become increasingly redundant. In some places, if rainfall becomes much higher, then guttering, stormwater and land drainage systems will fail to cope with the added volumes of water. The ground upon which building stands is then likely become waterlogged for extensive periods, and, depending upon geological conditions, could mean building foundations becoming unstable.

Examples of failing standards abound — it is already clear that most roofs in places like Australia are not able to withstand the kinds of hail storms that the country is already getting on a regular basis — the Sydney 'hailstones the size of tennis balls storm' of 1999 destroyed thousands of roofs (leading to a great deal of water damage) and was the most expensive claim event for the insurance industry in Australia's history

(which included the total levelling of the City of Darwin by Cyclone Tracy in 1974). Alternatively, in terms of earthquakes, it has been known for a long time that building standards being poorly applied or ignored (e.g., Turkey 1999; El Salvador and India, 2001) dramatically increases the destructive force of such events. It is not only a matter of increased intensity, but that we are heading for a condition of disjuncture between structures, locations and climate: buildings built for dry conditions finding themselves in a wet climate; ones in low wind speeds areas being exposed to storms with very high winds; or buildings constructed for a temperate region becoming subject to extreme heat for extensive periods.

Two conclusions are evident. First, many existing built forms will become more and more inappropriate to the emerging climate. Second, a massive amount of the current built fabric will have to be retro-fitted to cope with climate change. This, in turn, poses questions about the state-of-knowledge in this area. There are also implications for cost and opportunities that span, materials, technologies, landscape and the cultural ramifications of such change.

3. Design, climate change and adaptable new structures

Architects and building designers now need to be conceptualising new buildings, especially substantial ones with design lives that can accommodate transition through various climatic regimes. This means designing a building in response to various change scenarios back to the present, with ease-of-retro-fit capability. Buildings will also need to be commissioned with their specific climate change strategy inscribed into the facility management, so that the appropriate action will be triggered at the right time. Whole-of-life design will require a fine balance between over-designing and over-pricing the initial life of the building versus overloading building operation and retro-fitting costs. Demand assessment and system sizing for operational energy, water supply, collection or drainage will require specifications that can accommodate future climate change response needs or that can facilitate ease of upgrade. Likewise, building orientation and passive thermal performance may need designing for ease of adaptation, for example by having the ability for significant amounts of shade to be added or removed from a facade.

Building owners and users will need to comprehend this changed design scenario is likely to effect the viability of a building over time, this both economically (its market and insurance value, as a reduced risk building, would need to be quantified and projected), socio-culturally (as a place to live and/or work that takes the well being of the occupier/user into account for the entire life of the structure) and as sign (of responsibly in the face of change with branding potential).

4. Climate change and future architectural, product and visual environments

While buildings that can deal with current and expected climate change circumstances need to be conceived it is also important to contemplate structures that are able to deal with conditions well beyond what is likely

to be experienced in the short term (say 50 years). There are two reasons for doing this: first, in practical terms it something that will be needed to be learnt; and, second, putting images of such buildings into circulation (as viable realities rather than as utopian fictions) can contribute to making the implications of climate change less abstract. This needs to be coupled with arguments that make it absolutely clear that it is myopic in the extreme to have faith in technology alone solving the problem, when we see overwhelming evidence that technology will go on adding to the problem (three examples instantly come to mind: information technology is driving up energy demand, larger aircraft and increased air travel are on the way, and more consumer durable goods are now being manufactured than ever before — this for ever larger and rapidly growing markets).

Some of these future structures will, for instance, have to be much better anchored to the ground, be stressed to better able to withstand very high wind speeds and the impact of flying debris, have a thermal capability of dealing with extreme and rapid swings in external temperatures (and without the use of a vast amount of energy to create a stable building micro-climate). Likewise, occupants may be unable to leave buildings for extensive periods (making food storage and the ability to take indoor exercise a priority). They may also exist in external conditions far more hostile than is currently experienced (extreme heat, cold, high winds and dust from denuded landscape).

The world will start to look a very different place, and this is an image that begs to be contemplated.

5. Design for a changed climate and what it itself designs

There is still very little realisation that whatever we design and make, including, but not just, the built environment, is not only travelling toward a future but constituting it. In so doing it travels back towards us — as with global warming, we live in the still *emergent* consequences of our own and others actions (this includes greenhouse gas emissions that can have an atmospheric life 50 to 200 years). What we build now is thus decisive — it decides, in part if we will reduce or increasing the impacts of the way we live and work; if the form of the future we are moving into will increase or reduce our ability to create communities of change; or if what we build expresses or negates values that communicate a desire, and will, to materially address climate change as an extant condition.

Subject to differences of place and circumstance, designing for a changed climate is much more than an architectural and engineering exercise. It means designing for what has, or is, changing in very broad terms (including the context of damage and destruction), and finding ways that, whenever possible, turn negative circumstances (like more rainfall or stronger winds) to positive advantage. Consider this scattering of ten quite different suggestive examples of innovations that could be prompted by specific changes of climate in particular places:

— delighting methods for indoor mega-structure farming;

— new thermally controlled, and fully enclosed, forms of protective clothing for extreme wet, sun/heat, wind, dust, with monitoring devices to warn and instruct a wearer in high risk settings;

— new products to repel the more numerous, larger and more dangerous tropical insects from both people and animals

— new materials to absorb moisture/resist fungal growth, sustain high impacts, insulate from/resist heat, reflect light and absorb heat

— regimes of work and leisure in large indoor bio-simulated artificial climates

— webbing and bracing structures to protect tree plantations from wind damage

— new ways to create and tend gardens in places where normal outdoor planting would not survive emergent patterns of weather

— new high wind area super-turbine generators

— new solar-thermal power stations in newly hot regions

— new low impact/ high yield aqua-farms

Some of these innovations, in some form, may happen. Some are already underway. Their degree of desirability will be circumstantially relative. They do, however, if only by inference, make something else evident.

An approach to a changed climate solely based on architectural, engineering and product innovations will be both inadequate and impossible for many of the poorest nations — many of whom, if the forecasters are correct, will be exposed to its worst excesses. Design for a changed climate means, in this context, a modification of mostly existing methods of building construction, agriculture and industry from within the country by a cadre of local expertise. This will only arrive by the creation and transfer of inter-cultural transfers knowledge (such education would have to be 'on the ground' and supported by political and economic structures superior to the mix of governmental and non-governmental organisations — the politics of this issue is of course another debate in its own right). However, extrapolating from this last comment — one could say that the educational implications and demands of climate change in general, and design for a changed climate in particular, requires a fundamental shift in education per se.

Learning how to live with climate change needs to arrive at primary school as a life skill. In secondary school it needs to be brought into the way in which many subjects, like geography, environmental studies, economics, technology and design, are taught. At a tertiary level (higher education, further education and

training), in the humanities, sciences and technical areas, climate change needs be understand as precipitating a fundamental shift in the material and cultural worlds we occupy. Questions of how we perceive our world, how the current state-of-affairs has come about, what we think, what we now do, need be employed to reassessment of every discipline and its future. It matters not if one is studying hotel and catering management, law, welding, Asian history, medicine, bricklaying, architecture, real estate management, international relations, plumbing, metallurgy, forest management, philosophy, computer science or building construction — and much more — there are vast areas of thought and practice to moderately or dramatically change, there is so much to learn and teach.

The more we delay, the worse the situation, and harder the task.

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There is but one thing to emphasise in conclusion — the challenge to be faced in terms of the sustainment of the people, cultures, ecologies of our planet is staggering, and can only be done by a profusion of very different kinds of actions, large and small. The more people and nations avoid taking this action, and continue to invest in securing the status quo, the harder further away we get from even starting the job of designing for a changes climate (in all its senses). Writ large, what climate change tells us is that the form of the future in increasingly in our hands. In this situation, design for a changed climate becomes a primary expression of accepted responsibility.

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Tony Fry is Director of the EcoDesign Foundation, an international consultant on design, sustainability and education. His most recent book is *A New Design Philosophy: An Introduction to Defuturing* published by UNSW Press, Sydney, 1999.