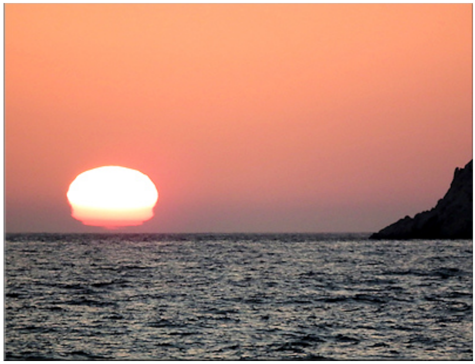
Climate Change

Things that may interest you

- The main greenhouse gas is water vapour. It increases with temperature and warms the climate, but cloud formation reflects heat back into space, so its effect is mixed.
- Current majority scientific consensus estimates that greenhouse gas emissions could rise by 70% by 2050, leading to more intense weather events, glacier and permafrost melt, flooding, sea-level rise, rainfall, biodiversity and cropland loss, and other environmental pressures.
- Global warming is not a foregone conclusion: there are unknowns and, while the balance of accepted evidence points toward warming, some factors (ocean cycles being one) are insufficiently researched. Forecasting is also always a matter of estimating probabilities.
- Around 21.5m people have been displaced by climate change since 2008 (UNHCR).
- The estimated range of possible global temperature rise by 2100 is 2° to 6°C. Current assessments reckon a 3°C rise is most likely. The richer nations of the global North are responsible for 70% of CO_2 emissions while they bear only 18% of global costs.
- By 2040, one in four children worldwide will be growing up in water-stressed areas.
- Despite the Paris Climate Change Agreement of 2015, a problem for global monitoring is that many nations massage and falsify the figures they submit – so the agreement is in effect undermined and its implementation is endangered.



Climate change – especially the possibility of *runaway* climate change – is one of the big global risks of our time. Whatever climate sceptics might assert, climate change is happening. But questions remain: *what drives it*, *how strong is each driver*, *how will it develop* and, particularly, *what should we do about it?* Final answers will be known when future decades actually arrive. Until then we rely on scientific models and forecasts, unfortunately shaded with fear, hope, politics and sectoral interests. The science is not as settled as many assert, but it has advanced nevertheless.

This is not solely a question of global warming – it concerns increasingly extreme climate trends, harsher weather events (storms, floods, droughts), atmospheric turbulence, varying regional impacts and the ecological, social, economic and political consequences that arise from all of these.

Global debate focuses greatly on climate change, while the complete spectrum of global issues and their interdependencies is thus easily obscured and downplayed. Poverty, pollution, population, ecosystem degradation, economics, climate change and everything else are totally connected – for example, the more that there are extremes of poverty, wealth and inequality, the more that there is ecological degradation and climate change.

Within the field of climate change there is a need for much more research, including investigating the comparative heating effect of CO_2 and other greenhouse gases, and a range of complex environmental feedbacks, the influence of clouds, ocean currents, solar cycles or even man-made electromagnetic and nuclear radiation. Some scientists do research them, but they aren't usually invited to dine at the climatological top table and are often inadequately funded.

Then there is the first-nation or shamanistic perspective in which *Gaia* is seen as a living being in possession of intelligence and feeling, grieving and balking at its treatment by humans. The atmosphere, the most fluid and responsive part of our planetary system, responds by becoming critically unstable, imbalanced and turbulent – it gets angry and upset. This perspective does not accord with scientific logic, yet it makes sense nevertheless, and these are changing times in which we need to see things broadly. Perhaps there's a message here.

Anthropogenic global warming (AGW) theory holds that man-made greenhouse gas emissions are leading to observable climate change and warming. The main greenhouse gases are water vapour, carbon dioxide, methane, nitrous oxide, ozone, CFCs and HFCs. They originate from industry (17%), power generation (21%), waste disposal (3%), land use changes (10%), buildings (10%), fossil fuel drilling, mining and processing (11%), agriculture (13%) and transport (14%).

Increased greenhouse gas emissions are expected to:

- raise Earth's average temperature – this varies regionally, most close to the poles;
- influence the patterns and amounts of rainfall – floods and droughts, critical in some areas;
- diminish permafrost, ice and snow cover – reducing freshwater supplies and heat reflection;
- raise sea levels – variably, since tidal seawater piles up unevenly in different places;
- increase ocean acidity – harming oceanic life, coral reefs and ocean processes;

- increase the frequency, intensity and duration of extreme weather events;
- affect ecosystem characteristics, such as vegetation, extinctions, topsoils and so on; and
- increase threats to human wellbeing, food supply, water sources, economies and infrastructure.

In AGW theory, the extent of future change depends on how much we reduce CO_2 emissions, and there is a long time-lag between emissions reductions and CO_2 sinking. This said, it is not clear exactly how much CO_2 is actually a driving force in climate change. Emissions, still rising, are understood to lead to increased stress in already stressed areas, affecting water supplies, soils, agriculture, forestry and marginal climates. Richer countries can buy their way out of such problems but they can't do so forever, while poorer nations face climatic changes they cannot easily handle. This affects richer nations' food supplies, inward migration and global stability – especially if it affects pinch points such as the shipping lanes passing between unstable Yemen and Somalia.

The World Bank reports that keeping global temperature rise below 2°C by 2100 will require $3.5tn a year in energy sector investments until 2050 (world GDP in 2017 was $126tn, or 2.7% of GDP). Natural disaster impacts cost $520bn annually, forcing some 26m people into poverty each year. Up to 2030, the world will need to spend $90tn on new infrastructure, mostly in middle-income and developing countries. There are around $19tn in gains from such transitioning, but efforts should not be limited to short-term and gainful activities. The full price is incalculable but the full costs, in terms of raised prices and taxes, shortages, disasters and disruption, will outweigh the benefits.

Uncertainties

There are uncertainties around climate change. IPCC rates its confidence as 'likely' (66%) that 'most' global warming since 1950 has been due to human-caused greenhouse gas emissions. Some scientists argue that computer models have overestimated the role of greenhouse gases, ignoring oceanic effects or a solar magnetism-related warming cycle that peaked around 1980-2005 which may turn cooler around 2020-60, then warm again later in the 21st Century. So there is debate.

A range of proposed factors might affect climate change. These include enhanced carbon capture by plants as greenhouse gases increase (since they and the added warmth encourage plants to grow); growing production of aerosols and biosols (pollution, dust and bio-particles) that reflect and disperse heat and generally increase cloud cover; changing human land-use patterns (particularly stripping the land for city growth, agriculture and deforestation); ocean currents (which could be changing); natural longterm terrestrial and solar variability cycles (generally overlooked); and regional phenomena. All of these can tip the balance either way, some reducing and some increasing warming, with complex and largely unknown effects. A few scientists reckon Earth could actually go into a cooling phase, perhaps even suddenly.

The weight of scientific opinion ranges against these other hypotheses, yet it would be wise to research all options without prejudice and also to define adaptive resilience projects not only in CO_2-related global warming terms but to encompass wider possibilities. This is not a simple binary question of correct or incorrect theories – it is one of interrelationships and proportions, the number of factors at play and how they affect each other. Media and politicians prefer the formula to be simpler, and some scientists, perhaps to their eventual detriment, try to make it so, but it is not.

We are in uncharted territory. Current theories hold up in the opinion of many and in the context of the data and climate modelling that has thus far been used. But uncertainty suggests it is wise to spread bets and widen strategies. One key issue is the way humans have weakened the global ecosystem, thus reducing the natural moderating, balancing and cleansing effect of ecosystems.

From a resilience and contingency planning viewpoint, two issues are crucial: *weather events* and *climatic extremes*. On the ground, things change and big decisions are made as a result of these, since they impact critically on people and local systems. While it is probable that CO_2 causes and amplifies such events and extremes, CO_2 makes up only about 0.041% of atmospheric constituents, out of a total of 3% of greenhouse gases. If a small constituent has such a big effect, it is also plausible that other small influences have an effect. The main greenhouse gas variable is water vapour and, in the longterm, the quantity of water vapour can be influenced by environmental restoration, reforestation, rewilding and new agricultural and urban planning practices.

Weather events and extremes have a definitive effect on humanity and nature. An area can revive from one disaster if the impetus, the people, the knowhow and the resources are there, but multiple instances such as repeated droughts or storms, or a disaster combined with a conflict or bad politics, can leave permanent and pivotal consequences – emigration, biodiversity loss, land abandonment, local economic downturn and downward spirals of deterioration. So weather events and extremes have ways of drawing lines and making a critical difference.

The depletion and fragmentation of bioregions by human activity reduces their capacity to respond to changing climatic circumstances. This affects nature's resilience and responses to climate change, and it affects humanity too, and its own resilience to change and misfortune. An all-round approach to human resilience is needed, to help societies and economies adjust to *whatever* trends and threats come their way. A society's own capacity to handle bad harvests, floods, droughts and storms, economic fluctuations, refugee influxes, pests, diseases and conflict will become deciding factors affecting each locality's future. Climate indirectly affects many other things, from water tables and food supplies to socio-political stress and refugee numbers – it can cause wars to erupt, though it can also stimulate fact-facing, reform and an overdue dawning of sanity, by precipitating social and political issues and bringing realism and change.

Business and governmental interests prefer to work with climate mitigation more than with adaptation and resilience-building. That is, the emphasis is on preventing or reducing climate change rather than adapting to it, while both are relevant. About 95% of international funds go toward mitigation policies such as emissions reductions – which also happens to provide business with profitable enterprise. Adaptation and resilience should receive much more.

Geoengineering (solar radiation management), a strong intervention, is also potentially profitable to the corporate and military sector. One risk with geoengineering is that it could independently be adopted by several countries or actors without global control, carried out for a variety of narrow and even contradictory reasons such as improving a particular country's climate, favouring certain interests or even conducting weather wars, regardless of how it affects wider global systems. Solar radiation management, never done before, also risks affecting the world's climate too much or too little, or impacting certain countries disastrously (such as India and its monsoons), or causing massive pollution or public health issues, or having all sorts of unintended outcomes. Theoretically, it is a quick fix, but it is a very risky option – and, *who decides, and on behalf of whom?*

Meanwhile, adaptation, involving water and soil conservation, forest and biodiversity protection, natural-capital building, and changes to social habits, city design and agricultural practices, gives less opportunity for corporate profit, but longterm it has the biggest all-round effects and payoffs.

Policy focuses mainly on climate change when *everything*, from toxins to governance to corruption, needs cleaning up, and an all-round buildup of ecosystem capital is a priority. This will take time, but the least regrettable way to address climate change is to attend to these less-profitable, more system-changing, socially-engaging, naturally-reinforcing options. Forward-thinking change is needed in all departments of life, and this means systemic change.

The world has not yet fully understood the extent of change that is necessary. Here lies a serious problem. Recent years have seen CO_2 production levels flat-lining, but much of this comes from energy conversion from coal to gas – a half-solution. The West has pioneered many positive ecological and climate-related measures, yet it is hamstrung politically by resistance from its own vested interests and its electorates, who are happy with change as long as it doesn't affect them. This situation suggests that the initiative for full systems-realignment will rest probably with China, India and the developing world.

Climate diplomacy

In 1988 the UN convened a special working group, the IPCC, which made its first report in 1991, leading to the Kyoto Protocol of 1997. Kyoto's main thrust was the subsidised deployment of renewable energy technologies coupled with energy efficiencies in developed countries, allowing for developing countries to increase their use of fossil fuels temporarily. Kyoto successfully reduced emissions in EU, USA and Japan by its target of 12%, measured from 1990 levels, but there was a relocation of energy-gulping and polluting industries to China, India and elsewhere, where emissions rose rapidly. Though marginally helpful, Kyoto was an example of a high-level political measure that sounded good while yielding insufficient and mixed results.

In the 2015 Paris Agreement, emission reduction targets were replaced with wider goals intended to restrict warming to a 2°C rise in temperatures. It committed to substantial emission reductions by 2025 yet, despite this, carbon emissions will still rise by 2.2% per year up to 2025. Growth of renewables will just about keep pace with energy-demand growth. The 2°C scenario envisages a 60% emissions reduction from 2013 levels by 2050, and at current rates we will not achieve this. Progress was made at Paris, but enforceable guarantees were not written into the agreement: signatories are yet to ratify it and their capacity to circumvent its details puts the agreement at risk.

Uncertainty over the role of CO_2 in global warming means that, even if emissions are halved by 2050, it might reduce the driving force of CO_2 only marginally – CO_2 decays slowly over centuries. It is eaten up quickest by growing plants: adaptation of human systems and enhancement of biological activity in all global ecosystems are at least as important mitigation measures as emissions reductions. Much-vaunted carbon-capture technologies are yet to materialise. Deeper systems changes are studiously avoided by policymakers, but systems change might become a critical, no-choice issue in future decades.

Where nature could in the past adapt to climatic change, it is now constrained in its adaptability. It faces a double hit from growing population (with rising demand for land, resources and water) as well as from the changing climate. While we wean ourselves off fossil fuels, current inadequate mitigation strategies will bring only marginal relief to poor and vulnerable communities. Today’s economic development strategies insufficiently address resilience and adaptation, and in some respects they increase climate vulnerability and contribute to the growth of emissions. There is a need for much more joined-up and cross-disciplinary thinking.

Truly to address and adapt to climate change, much more needs to be done. It is forecasted that, with just a 2°C temperature rise, 25%

of the Earth's land surface will be liable to persistent drought and desertification. But climate change is not the only factor affecting drought: dryland growth arises from overgrazing, deforestation, urbanisation and population growth, farming practices, water withdrawal and land clearance, all of them exacerbating climate impacts and also influenced by them. Attention to all of these areas is needed as much as to emissions reductions.

As things stand, the future does not look good. Many regions will experience net loss (such as the Philippines from repeating typhoons or the Sahel from deepening droughts) and those regions that gain (such as northern climes becoming milder) will nonetheless be affected by periodic, at times serious climatic extremes and weather events. The good news is that climate change might be a deciding factor that galvanises global systems change, forcing us to deal with a wider range of issues affecting nature, climate and human life. It might force humanity to take more of a whole-systems approach, the best bet for transitioning toward global resilience and sustainability.

It would help if climatologists avoided character assassination and labelling scientists who question climate assumptions, models and data as 'deniers'. Some of these questioning scientists indeed are politically motivated, but others are sincere, credible researchers with valid views. Consulting the world's farmers and sailors might help too. The science on AGW contains uncertainties and thus a range of reasonable theories should properly be examined – the stakes are too high for errors.

"*The only function of economic forecasting is to make astrology look respectable*", said economist J K Galbraith, and the same applies to the natural sciences. Yet we must still try. The bottom line is that greenhouse gas-based global warming is happening and there is no wisdom in complacency, but other factors might be at play too, which could modify current forecasts of future temperatures. It is reasonable to say that climatic instability will get worse, that there are things we can do to reduce its impacts, and that things need to change in every department of life. Then it is a matter of human will – and wont.

Useful links

World Bank climate change economic overview. http://www.worldbank.org/en/topic/climatechange/overview

Current greenhouse gas concentrations, CDIAC. http://cdiac.ess-dive.lbl.gov/pns/current_ghg.html

Historical Overview of Climate Change Science, IPCC. https://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-chapter1.pdf

Climate Change: a summary of the science, Royal Society, 2010. https://royalsociety.org/~/media/Royal_Society_Content/policy/publications/2010/4294972962.pdf

UNHCR and Climate Change, UNHCR, 2015 (*about climate refugees*). http://www.unhcr.org/uk/protection/environment/540854f49/unhcr-climate-change-overview.html

Climate Change and Health factsheet, WHO, 2017. http://www.who.int/mediacentre/factsheets/fs266/en/

Health and Climate Change, The Lancet, 2015 (*report*). http://www.thelancet.com/climate-and-health

When I Talk about Climate Change I don't talk about the Science, Andrew David Thaler. http://www.southernfriedscience.com/when-i-talk-about-climate-change-i-dont-talk-about-science/

Ten Solutions for Climate Change, Scientific American, 2007. https://www.scientificamerican.com/article/10-solutions-for-climate-change/

Meet the Green who doubts 'the Science', Spiked, 2010 (*article*). http://www.spiked-online.com/newsite/article/8979