



## Extinction: What it Means to Us

Lord Martin Rees (Cambridge University)

It's a privilege to speak here today. But I do this with diffidence. That's because I'm a physicist – trying to understand only the inanimate world. Much of this still baffles us. But it should be an easy task, compared to the complexities of living things and their ecologies. It's biologists, ecologists and social scientists who face the most daunting intellectual challenges. Those are the disciplines represented at this meeting.

You may think that, as an astronomer, I worry about asteroid impacts. I do, but not very much. It was such an event 65 million years ago that many think did in the dinosaurs. But the probability of such a catastrophe is one in 100,000 each century – no bigger now than it was in the remote geological past.

The effects that should worry us more are catastrophes induced by humans – whose probability is now far higher – and is rising fast.

The Earth has existed for 45 million centuries, but this is the first time when one species, ours, is so empowered that it can determine the planet's future – the first when technology could enable us all to live in fulfilment. Or – to take a darker view – the century where our follies could foreclose the immense potential for further evolution. We're deep in the anthropocene.

The choices and decisions we make today will resonate at least into the 22nd century – and if we get them wrong, we'll bequeath future generations a bleak future. We surely need to look ahead – and horizon scan – further than most politicians and planners do.

In particular, if our despoliation of nature causes mass extinctions – by neglect, by error, or by malign intention, then, to quote E.O. Wilson, "it's the action that future generations will least forgive us for".

Our focus at this workshop will be to address the threats that stem from humanity's ever-heavier collective 'footprint' on the planet – which is depleting resources, impoverishing ecologies, changing the climate. And also we should address the threats stemming from misuse of biotech or other powerful technology.

Even with a cloudy crystal ball there are two things we can predict decades ahead:

- The world will be more crowded.
- And it will have a changing climate.

A word about these two trends.

Fifty years ago, world population was about 3 billion. It's now 7.3 billion. But the growth is slowing. Indeed the number of births per year, worldwide, has levelled off. Nonetheless world population is forecast to rise to around 9 billion by 2050. That's partly because most people in the developing world are young. They are yet to have children, and they will live longer. The age histogram in the developing world is becoming more like it is in Europe.

Experts predict continuing urbanization – 70% of people in cities by 2050. Even by 2030 Lagos, San Paulo and Delhi will have populations above 30 million. To prevent megacities becoming turbulent dystopias will surely be a major challenge to governance. As it will be to ensure that rural populations aren't left behind.

Population growth seems currently under-discussed. That may be partly because it's deemed by some a taboo subject – tainted by association with eugenics in the 1920s and 30s, with Indian policies under Indira Gandhi, and more recently with China's hard-line one-child policy. And because forecasts of mass starvation have proved premature. Up till now, food production has kept pace – famines stem from wars or maldistribution, not overall shortage.

Can 9 billion people be fed? We'll be hearing from experts at this workshop. But my layman's impression is that the answer's yes. Improved agriculture – low-till, water-conserving, and perhaps involving GM crops – together with better engineering to reduce waste, improve irrigation, and so forth – could sustainably feed that number by mid-century. The buzz-phrase is 'sustainable intensification'.

But there will need to be lifestyle changes. The world couldn't sustain even its present population if everyone lived like Americans do today— each using as much energy and eating as much beef.

But none of us need live as profligately as that. Indeed, all can, by 2050, have a good quality of life – provided that technology is developed appropriately, and deployed wisely. That should be our message – in Gandhi's famous mantra – Enough for everyone's need but not for everyone's greed.

Population trends beyond 2050 are harder to predict. They will depend on what people as yet unborn decide about the number and spacing of their children. John Bongaarts and others will be discussing this later.

As we'll hear, if families in Africa remain large, then according to the UN that continent's population could double again by 2100, to 4 billion, thereby raising the global population to 11 billion. Nigeria alone would by then have as big a population as Europe and North America combined, and almost half of all the world's children would be in Africa.

Optimists remind us that each extra mouth brings also two hands and a brain. Nonetheless the higher the population becomes, the greater will be all pressures on resources, especially if the developing world narrows its gap with the developed world in its per capita consumption. And the harder it will be for Africa to escape the 'poverty trap'.

And, as well as rising population, there's a second firm prediction we can make – the world later this century will be warmer.

Climate change will hit hardest those who have contributed the least to its cause. Heat stress will most hurt those without air conditioning, crop failure will most affect those who already struggle to afford food, extreme weather events will most endanger those whose homes are fragile.

Unlike population trends, climate policies certainly aren't under-discussed, even though they are under-acted-upon.

It's still unclear just how fast the climate will change – how much the climatic effects of rising CO<sub>2</sub> are amplified by associated changes in water vapour and clouds.

But despite the uncertainties, most would agree that under 'business as usual' scenarios we can't rule out, later in the century, really catastrophic warming, and tipping points triggering long-term trends like the melting of Greenland's icecap.

But even those who accept this assertion have diverse views on the policy response. These stem from differences in economics and ethics – in particular, in how much obligation we should feel towards future generations.

Economists who apply a standard discount rate (as, for instance, those in Bjørn Lomborg's Copenhagen Consensus do) are in effect writing off what happens beyond 2050 – so unsurprisingly they downplay the priority of addressing climate change in comparison with shorter-term efforts to help the world's poor.

But if you care about those who'll live into the 22nd century and beyond, then, as economists like Stern and Weizman argue, you deem it worth paying an insurance premium now, to protect those generations against the worst-case scenarios.

So, even those who agree that there's a significant risk of climate catastrophe a century hence, will differ in how urgently they advocate action today. Their assessment will depend on expectations of future growth, and optimism about technological fixes. But, above all, it depends on an ethical issue – in optimizing people's life-chances, should we discriminate on grounds of date of birth?

Consider this analogy. Suppose astronomers had tracked an asteroid, and calculated that it would hit the Earth in 2080, 65 years from now – not with certainty, but with (say) 10% probability. Would we relax, saying that it's a problem that can be set on one side for 50 years – people will then be richer, and it may turn out then that it's going to miss the Earth anyway? I don't think we would. There would surely be a consensus that we should start straight away and do our damndest to find ways to deflect it, or mitigate its effects.

A word now about other threats to the environment that come from new technologies.

Here we can't make firm forecasts decades ahead – smartphones, for instance, would have seemed magic only 20 years ago. So we can't conceive what advances might emerge by 2050.

Technology should be our friend. Without applying new science, the world can't provide food, and sustainable clean energy, for an expanding and more demanding population. These advances will offer inspirational challenges for young scientists and engineers.

But we need wisely directed technology. Indeed, many of are anxious that some, especially biotech and robotics, are advancing so fast that we may not properly cope with them – and that we'll have a bumpy ride through this century.

And there are portents.

The new CRISPR – cas9 gene-editing technique – is hugely promising for eliminating harmful genes in humans . And 'gene drive' programmes are being promoted as a method wiping out species – mosquitos that carry diseases, even parasitic imported species like grey squirrels in Britain. But surely caution is in order here. There's a risk of disturbing ecological balances.

These technologies will need regulation, on prudential and ethical grounds.

Back in the early days of recombinant DNA research, a group of biologists met in Asilomar, California, and agreed guidelines on what experiments should and shouldn't be done. This seemingly encouraging precedent has triggered several meetings to discuss the much more powerful recent developments in the same spirit.

But today the research community is far more broadly international, and more influenced by commercial pressures. What I find scary is that biotech involves small-scale dual use equipment. Indeed, biohacking is burgeoning even as a hobby and competitive game. I'd worry that whatever regulations are imposed can't be enforced worldwide, any more than the drug laws can – or the tax laws. Whatever can be done will be done by someone, somewhere. Regulating the huge facilities in the nuclear arena is a doddle in comparison.

Let's recall what's meant by sustainable development.

The Bruntland Commission in 1987 introduced this phrase It was defined as: "development that meets the needs of the present – especially the poor – without compromising the ability of future generations to meet their own needs".

There seems no scientific impediment to achieving a sustainable and secure world, where all enjoy a lifestyle better than those in the 'west' do today. We can be technological optimists.

But the intractable politics and sociology – the gap between potentialities and what actually happens – engenders pessimism. Politicians look to their own voters – and the next election. We downplay what's happening even now in far-away countries. And we discount too heavily the problems we'll leave for new generations.

Our responsibility – to our children, to the poorest, and to our stewardship of life's diversity – surely demands that we don't leave a depleted and hazardous world.

Here the great religious faiths can be our allies. The Catholic Church, for instance, transcends normal political constraints – there's no gainsaying its global reach, nor its durability and long-term vision, nor its focus on the world's poor. And that's why the Holy Father's Encyclical on climate and environment was so important. It had huge resonance and smoothed the path towards a consensus at the Paris climate conference in December 2015

Partha Dasgupta, along with the climate scientist Ram Ramanathan (who sadly can't be at this workshop), achieved great leverage by laying the scientific groundwork through the Study Week on climate and environment.

So, in summary, the pressures of rising populations, climate change, and the risks of misusing powerful technologies will aggravate the type of devastation that this workshop is about – loss of biodiversity.

But let's remind ourselves why this matters. We're clearly harmed if fish stocks dwindle to extinction. There are plants in the rain forest whose genes may be useful to us. But there's a spiritual value too. To quote E.O. Wilson again 'At the heart of the environmentalist world view is the conviction that human physical and spiritual health depends on the planet Earth ... Natural ecosystems – forests, coral reefs, marine blue waters – maintain the world as we would wish it to be maintained. Our body and our mind evolved to live in this particular planetary environment and no other'.

But even this is too anthropocentric a focus – those who call themselves 'environmentalists' would proclaim that biodiversity, the intricate variety and beauty of the natural world, has intrinsic value over and above its benefit to us humans. And of course the Encyclical affirmed that humans had a duty of care towards the rest of God's creation.

We all surely want to 'sign up' to this goal. But there's a big problem in achieving it. – basically because our secular institutions – despite their global range – don't plan long-term enough.

Those who built St Peter's Basilica and Europe's great cathedrals thought the world might only last another thousand years – and they knew of nothing beyond Europe. But despite these constricted horizons, in both time and space – despite the deprivation and harshness of their lives – despite their primitive technology and meagre resources – they built huge and glorious buildings they never lived to see finished –and that uplift our spirits centuries later.

What a contrast to so much of our discourse today! Unlike our forebears, we know a great deal about our world – and indeed about what lies beyond. Technologies that our ancestors couldn't have conceived enrich our lives and our understanding. Many phenomena still make us fearful, but the advance of science spares us from irrational dread. Unlike our forebears we know that we are stewards of a precious 'pale blue dot' in a vast cosmos – a planet with a future measured in billions of years. – whose fate depends on humanity's collective actions this century. So it's shameful that our horizon is shorter than theirs.

Spaceship Earth is hurtling through the void. Its passengers are anxious and fractious. Their life-support system is vulnerable to disruption and breakdowns. There's too little horizon scanning to minimize long-term risks.

The stakes are high. And the threats are real. It's a wise maxim that 'the unfamiliar isn't the same as the improbable'

And I give the last word to a secular sage – the biologist Peter Medawar:

"The bells that toll for mankind are ... like the bells of Alpine cattle. They are attached to our own necks, and it must be our fault if they do not make a tuneful and melodious sound".