

**The Royal Society of Edinburgh  
ECRR Peter Wilson Lecture**

**Professor John Beddington CMG FRS**

***Global Challenges in a Changing World***

**Report by Peter Barr**

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**Science to the rescue**

*Professor John Beddington, Chief Scientific Adviser to HM Government and Head of the Government Office for Science, believes that science and technology must play a critical role in tackling the many global challenges facing humanity through the 21<sup>st</sup> century – and that the economic downturn is no time to be taking our foot off the accelerator for the investments required...*

Listening to Professor Beddington set out these challenges, you may be forgiven for thinking the future is cancelled. He presents a stark picture of complex, interacting problems, and of transformational changes to be managed alongside these.

- World population is expected to rise from six billion at the start of the century to nine billion by 2050 – an increase of six million people per month, mostly in developing countries.
- Urbanisation will accelerate. Last year, urban population overtook rural.
- More than a billion people live on less than 50p a day.
- Demand for food is projected to increase by 50% by 2030, according to the United Nations.
- World grain reserves are at an all-time low of 14%, down from 35% in 1986, and 75% of the major marine fish stocks are either depleted, overexploited or being fished at their biological limit.
- Demand for energy is projected to increase by 45% by 2030 in a 'business as usual' scenario.
- Demand for water may increase by 30% by 2030. One in three people already face serious shortages in the form of physical or economic water scarcity, potentially forcing more countries to introduce charges and with the possibility of increased tensions and conflicts.
- The acidity of the oceans is accelerating, with Ph expected to drop by approximately 0.4 by the end of the century, due to rising CO<sub>2</sub> emissions.
- Economic migration has increased from less than 80 million in 1960 to around 200 million by 2005.
- The world's mega deltas are particularly vulnerable to climate change, and every year there is already around a 75% chance of one of the world's major 136 port cities being inundated with a one-in-a-hundred-year flood.

Even some of the good news is bad. Beddington highlighted recent research which suggests that banning aerosols may have led to an increase in deforestation of the Amazon rainforest, due to an increase in droughts.

He explained too how economic growth projected for the developing world, lifting millions from poverty, would at the same time increase exponentially the demand for energy, water, food and other resources. More prosperous populations, centred increasingly in mega-cities and aspiring to the lifestyles of affluent Western nations, will require servicing, often by a rural community declining in at least relative terms.

Looming over all of this is climate change – and other unpredictable phenomena such as terrorism and natural disasters. It's no good having a healthy economy if the planet is killing itself – for example, a 5°C increase in temperature would cause a catastrophic rise in sea levels and devastate agricultural production.

Unfortunately, some of our most pessimistic forecasts may not be pessimistic enough, said Beddington. For example, even the worse-case scenario for the rate of Arctic melting turned out to be not as bad as actual observations. Further research and data will be key to understanding whether short term fluctuations or more fundamental trend factors are the cause. In many areas the full impact of the changes being experienced or which are predicted, such as rising sea temperatures, is still not well understood by scientists.

Whilst spending much of his RSE lecture describing the problems, Beddington talked too about solutions. He remains optimistic that science and technology can rise to the challenge, if we have the political will and invest adequately in research and in its effective exploitation. An economic downturn may not seem the best time to argue for increased investment, but Beddington believes that there are profits to be made from the crisis, and that we have no other choice.

Beddington welcomed the inauguration of President Obama, because the new administration is already taking climate change more seriously, including the appointment of two Nobel Prize winners with an interest in climate change to the team of scientific advisors.

Our prospects may look bleak, but Beddington seems to agree with the idea that every crisis means an opportunity. And he is very clear what this will mean: “We need significant investment in science and engineering solutions to complex inter-related issues.”

For example, the developing world will inevitably use its massive coal reserves to generate energy, but new carbon capture and storage (CCS) technologies will not only help cut emissions but also mean profits for the companies who successfully develop and market their solutions. And cleaner electricity and transport are two of the most critical issues.

Reducing emissions by 80% by 2050 in the UK may seem an impossible challenge, but Beddington is confident we can reach our targets by using smart science and technology, especially if there are strong international agreements.

Beddington compared a range of solutions in terms of cost benefits, suggesting that some technologies and policies are more cost-effective at reducing emissions than others. For example, better home insulation would be the cheapest and highest-impact solution, since households alone contribute about 45% to total emissions. Nuclear energy is another “no-brainer” for Beddington, who described it as “break-even” in terms of return on investment, whilst other options such as sugar-cane biofuels generate savings. CCS is still an unproven solution which appears more expensive at the moment, but Beddington believes that it will play a crucial role in substantially lowering emissions from coal in the decades to come. For many

promising technologies, a medium to long term view of the value of investments is needed. Other positive options are re-forestation, combined heat and power plants, biomass and other renewables such as wave, wind and tidal power.

To promote these solutions, we don't just need money and technological innovation but also behavioural changes, said Beddington, helped by incentives. Carbon trading may work at a national level, but individuals need more persuasion.

Increasing food production by 50% in the next 30 years, at the same time as reducing agricultural energy and water consumption and managing pesticides and fertilisers more sparingly, may seem impossible, but there are grounds for hope. Grain reserves are so low that our total reserves are literally at sea at any given moment. But if we could eliminate crop losses and other wastage through the food chain, food production and food security could increase substantially, even on less land with fewer resources. At the same time, Beddington sees genetically modified crops as another key technology option with the potential to make a significant contribution.

Similarly, better water management, such as recycling 'grey water' and improving irrigation using new technologies (including nanotechnology), may mitigate the worst effects of future shortages.

Some ideas, such as 'fertilising' clouds and giant sun shades orbiting the Earth, may seem like pie in the sky, but Beddington has great hopes for fusion power and other breakthrough concepts; for instance, growing algae to increase absorption of carbon dioxide.

He saw an important role too for climate models, to improve progressively our understanding of future climates. He noted at the same time the difficulties in interpreting such models, which, he explained, are inherently chaotic. Even tiny changes in inputs can lead to dramatic variations in results. The models also currently leave "major uncertainties", including potential impacts on monsoons and El Nino phenomena.

Dwelling for a moment on a more administrative aspect of his role, Beddington revealed that every government department has a chief scientific advisor, with the exception of the Treasury.

Just as with the changing economic climate however, there are no quick fixes with science. Asked about birth control, for example, Beddington described how rapid changes in population can have a negative effect on an economy – while many religions oppose contraception completely. Rather than legislating for the bedroom, societies are better off educating women, said Beddington. When it comes to climate change and other global problems, what we need is a much more holistic approach, including better communication and engagement with people.

Finally, asked if it would be "madness" to reduce our investment in science and technology, despite the financial constraints of the credit crunch, Beddington answered resoundingly: "Yes!"