Natural England Commissioned Report NECR030

# Global drivers of change to 2060

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NATURAL ENGLAND

# Foreword

Natural England commissions a range of reports from external contractors to provide evidence and advice to assist us in delivering our duties. The views in this report are those of the authors and do not necessarily represent those of Natural England. They are intended to provoke discussion about possible futures, and are not formal predictions. They do not represent the policy or strategy of Natural England or SAMI Consulting (St Andrews Management Institute).

## Background

The world in which we live and work is constantly changing and evolving – the precise nature of the future that actually unfolds is inherently uncertain. Surprise is inevitable.

Natural England needs to be aware of the wide range of potential circumstances that could affect its operations to deliver its goals for the natural environment and the benefits it delivers to everyone.

For this reason and as a tool to aid thinking and stimulate new ideas about the future, a set of scenarios – stories setting out a range of possible pictures of the future – that are plausible and represent the breadth of possible circumstances have been developed.

This report provides a synthesis of global drivers of change that represent the most significant trends, factors and pressures that could affect the natural environment to 2060. Some factors should be regarded as wild cards – highly improbable events but with significant impact should they happen.

By focusing discussions on the major factors likely to affect the natural environment at a series of scenario creation workshops held in January 2009, the findings directly influenced the creation of basic storylines for Natural England's scenarios.

Containing information grounded in evidence, this report provides an underpinning base for Natural England's scenarios work. The findings will also be used to develop our wider futures thinking.

Two related scenario reports are also available online :

- Natural England Research Report NERR031 '*England's natural environment in 2060 – issues, implications and scenarios*'. This describes how the future could unfold; the factors that might shape the future; how we might live; and the implications for the natural environment.
- Natural England Commissioned Report NECR031 '*Scenarios compendium*'. This describes what other scenarios exist and how ours complement/plug gaps that these do not.

The authors would like to thank the numerous Natural England staff and external stakeholders who contributed and reviewed material.

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**Keywords** - Natural resource conservation, sustainable development, climate change, biodiversity, scenarios, environmental change, drivers of change, futures

**Further information**
This report can be downloaded from the Natural England website: **www.naturalengland.org.uk**. For information on Natural England publications contact the Natural England Enquiry Service on 0845 600 3078 or e–mail **enquiries@naturalengland.org.uk**.



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# Project to assist Natural England develop a set of scenarios for England's Natural Environment to 2060: Global Drivers of Change to 2060

## Global drivers of change to 2060 – Summary

**The fourteen global influencers summarised below are described in alphabetic order to stress that they are not in order of importance, urgency or certainty.**

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| **Climate Change**<br><br>Uncertain impacts and responses | Climate change will have both physical and social impacts. This driver is going to act both through the direct impacts of changing climate but also the way in which people respond to its challenges.<br><br>Physical changes expected by 2060 include sea–level rise and coastal vulnerability; higher temperatures and ocean acidification. These are relatively well predicted over a timescale of 50 years.<br><br>More uncertain is how people will respond (over the next 50 years) with associated knock–on effects. Uncertainty regarding the future rate, type and eventual magnitude of change is a big issue. |
| **Converging New Technologies**<br><br>Promise and perils | It is expected that converging technologies will bring about tremendous change in the future; providing new products and services, enabling human personal abilities and social achievements; and reshaping societal relationships.<br><br>***Nano:*** The range of applications is endless – super soldiers and athletes; change in manufacturing and food production; and the blurring between life and the inorganic world.<br><br>***Bio:*** Advanced genetic techniques are used to generate desired traits in plants, animals or micro-organisms and, ultimately design entirely novel forms of life.<br><br>***IT:*** Information technology will spread from silicon into bio– and nano– carriers, and become pervasive. |
| **Demographics**<br><br>Growth in Africa and most of Asia | The human race is increasing and is rapidly migrating to urban centres. The global population (currently 6.8 billion) is expected to peak at around 10 billion before the end of this century. Pressure on resources must increase, and ecosystems and the services they provide are under threat. Most growth will come from lifespan; by 2060 the population will everywhere be much older than it is now. |
| **Energy**<br><br>New technologies and diverse supply | The world is approaching peak global oil and gas production whilst demand especially from the emerging economies is increasing rapidly.<br><br>The cost of energy may increase in the medium term and is likely to remain high, depending on the speed of development of alternatives to fossil fuels. The scarcity and cost of energy will drive energy efficiency across all industries and change many aspects of our way of life, transport being especially impacted.<br><br>By 2060 global energy supply is likely to be far more diverse than currently with fossil fuels playing a less important role. The energy mix will be made up of both existing low carbon technologies and new technologies. |

# Project to assist Natural England develop a set of scenarios for England's Natural Environment to 2060: Global Drivers of Change to 2060

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| **Food Security**<br><br>Will supply rise to meet demand? | As population and wealth increases global demand for food is growing faster than global supply.<br><br>There are various long–term factors which will drive up the food supply, and other limiting factors that may reduce it. This tension is made more complicated by short–term supply–demand cycles, and natural variation in weather patterns and yields. |
| **World Economic Power Shifts**<br><br>Economic and cultural dominance of China and India | China and India will continue to grow faster than Organisation for Economic Co-operation and Development (OECD) countries. With huge populations, their economic influence will grow as GDP per person rises. Economic power leads to political, social and ethical dominance in subsequent decades.<br><br>By 2025, China may well have overtaken the USA in GDP. By halfway through the "Pacific Century", China will be the new economic superpower, with India coming up behind; and the geopolitical landscape will have changed. |
| **Governance**<br><br>All levels attempt to reduce risk | The world is seen as an increasingly dangerous place. International, EU, national regulation will increase to attempt to reduce risks. It may be that regulation will be undertaken by local governments on behalf of international organizations.<br><br>There is the potential for a "Clash of Civilisations" as demographic changes and shifts in economic power have political repercussions. |
| **Health and Wellbeing**<br><br>Global spread of lifestyle diseases | Health in the developed world is under threat due to preventable lifestyle disease. In the developing world diseases once thought of as being a developed–country problem are rapidly increasing due to a globalisation of lifestyle, urbanisation and increasing affluence. |
| **Infectious Diseases**<br><br>Disease goes global | Infectious human and plant diseases are on the increase; globalisation has increased the spread of otherwise local diseases.<br><br>Old diseases are becoming resistant to current control techniques, social changes are promoting sexually transmitted diseases. Climate change is making humans, plants and animals more susceptible. |
| **Marine**<br><br>Acidification, pollution and over–fishing | The oceans are getting ever more polluted. Plastics and plastic particles are a growing problem and acidification of our oceans is a critical issue, as the absorbed carbon dioxide exhausts our oceans' ability to buffer the excess amount in the atmosphere.<br><br>The oceans provide protein for hundreds of millions of people through fish. If fish populations crash due to acidification, pollution or over–fishing, the consequences could be disastrous. |

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| **Mobility**<br><br>Human movement continues to increase | • People like to travel, and the amount of travel increases as other forms of communication grow. All transport vehicles and associated infrastructure and control systems will be "intelligent."<br>• Most travel world–wide will be for leisure; virtuality being used for business contacts.<br><br>Migration will also increase as globalisation encourages labour mobility, and populations shift following war, environmental degradation or climate change. |
| **Money, Wealth, Economy**<br><br>Faltering growth | By 2060, the 2008/9 crunch (or perhaps the 2008–2015 long depression?) will be a distant memory. Technology will not have slowed down, so we will all be wealthier, in the sense of being able to do more and more clever things with fewer person–hours of work on our part.<br><br>But this wealth may not translate into being able to command ever greater quantities of natural resources, because the supply is constrained.<br><br>There may well be new models of economic activity, such as the possibility of a different model of manufacturing based on localised production, or variations from the current free–market Western paradigm. |
| **Resources**<br><br>Global scarcity | Economic growth and the associated growth in consumption among emerging economies is resulting in a worldwide rush for resources. Water shortages are particularly likely to lead to conflict and issues over food security.<br><br>Simultaneously there is a growing recognition that resources need to be used efficiently; that 'waste' is a valuable resource, with new processes and legislation being developed to reduce material inputs and increase reuse and recycling. |
| **Values and People**<br><br>Generational shift and complexity | Millennial and post–millennial children will be raised and educated in an environment of pervasive, immersive information and media technologies based on open source architecture and a worldview underpinned by paradigms of chaos and complexity. Global levels of education will continue to rise.<br><br>Even as the cultural difference between countries will reduce, national cultures will become internally more diverse, due to the effects of migration and easier communications between like–minded individuals across the world.<br><br>Complexity matures as a transformational scientific paradigm. Better connectivity through IT may promote bottom–up civic engagement. |

# **Climate Change –** Uncertain impacts and responses

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| **Description of the driver** | Climate change will have both physical and social impacts. People will respond in different ways with associated knock–on effects. Uncertainty regarding the rate, type and magnitude of change is a big issue. This driver is going to act both through the direct impacts of changing climate but also the way in which we respond to its challenges. |
| **What effect is it having now?** | Global temperatures have risen by over 0.7C in the last 300 years with 0.5C of this warming occurring during the 20th century. Average global sea levels have increased by 0.1–0.2m over the last 100 years. There is more precipitation in many mid and high level areas of the northern hemisphere with more of the rain falling in sporadic heavy events. In Asia and Africa there has been an increased frequency and intensity of droughts.<br><br>It is now accepted that human activity through the emission of greenhouse gases (GHG) are responsible. Irrespective of what happens from now on, there will be a 2.0C rise in temperature by 2060 due to historic emissions.<br><br>To put this rise into perspective the Intergovernmental Panel on Climate Change quote research suggesting that up to 20/30% of species would be at a much higher risk of extinction with this temperature rise.<br><br>In the short term, approaches on how to tackle climate change are poorly coordinated and fragmented. This is having the major impacts on the natural environment for example renewables, biofuels and hard flood defences.<br><br>Direct impacts of climate are happening, but are relatively small and manageable in the developed world at least, though there are complex interactions in relation to biodiversity. In the developing world large areas of coastal habitat and settlement are threatened by rising sea levels; and the incidence food scarcity driven by drought is increasing. |
| **In the medium term?** | By 2025 climate change may have become an important source of conflicts between and within states. Global water wars may be common as is mass starvation due to failing agriculture in much of sub–Saharan Africa leading to migration pressures in Europe, on top of a still increasing population.<br><br>The natural environment may experience mass extinctions of terrestrial and marine ecosystems, placing additional pressure on ecosystem services.<br><br>Adaptation responses (e.g. wind farms, tidal energy) will have both adverse and beneficial effects. |

# Project to assist Natural England develop a set of scenarios for England's Natural Environment to 2060: Global Drivers of Change to 2060

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| **By 2060?** | By 2060 emissions should have been reduced through international agreement and technology flows. Peak emissions will be reached later than needed to keep temperature changes below 2C. Drought, flooding, coastal erosion and the resulting displacement of people will still put pressure on national and international relations, social structure and economies.<br><br>There is also a high confidence that climate change will result in extinction of many species and reduction in the diversity of ecosystems. Vulnerability of ecosystems and species is partly a function of the expected rapid rate of climate change relative to the resilience of many such systems.<br><br>It is estimated that nearly 300 million people inhabit a sample of 40 deltas globally, including all the large megadeltas. This analysis showed that much of the population of these 40 deltas is at risk through coastal erosion and land loss, primarily as a result of decreased sediment delivery by the rivers, but also through accentuated rates of sea–level rise. |
| **What will push in the opposite direction in future?** | Reaching global agreement at an early stage which sees a real step change in effort with mass reductions in $CO_2$ by 2015. Peak emissions will then be reached earlier and the built–in climate change managed.<br><br>Total failure to reach any agreement on emissions reduction or approaches to tackling climate change which leads to widespread conflict, social disruption and environmental degradation. |
| **Critical uncertainties – range of possible outcomes** | Uncertainty in rate and magnitude of climate change. 2001 UKCIP worse case scenarios are being exceeded.<br><br>The scale of human impact and the geo–political instability that it causes, will affect global efforts to tackle climate change, national and international trade and disputes. Resulting in either consensus to act or nationalistic shutting of borders.<br><br>The local effects of sea level change on particular structures is uncertain and requires further research, particularly the effect of the speed of sea level change.<br><br>Scarcity of other raw materials (high tech metals) limits technological advances thereby hindering GHG emission reductions.<br><br>Speed of technological advances in finding economic alternative energy sources to fossil fuels.<br><br>Nature and impact of society's adaptation responses. |

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| **Wildcards – low probability events that could disrupt the expected mega trend** | Major physical impacts such a disruption to gulf stream leading to rapid cooling in northwest Europe – leading to massive change in focus and type of effort.<br><br>Unforeseen climatic "tipping points", for example the collapse of the Amazon ecosystem leading to the mass release of carbon, or the rapid melting of the tundra regions leading an uncontrolled methane release.<br><br>Major storm events can have unforeseen effects on coastal systems.<br><br>Successful geo–engineering, once the implications of GHG emission control for economic growth become apparent, countries such as US and China pursue geo–engineering which if successful could remove the need for mitigation and adaptation. |
| **References** | • Intergovernmental panel on climate change 2007 http://www.gtp89.dial.pipex.com/intro.pdf<br><br>Ericson, J.P., C.J. Vorosmarty, S.L. Dingman, L.G.Ward and M. Meybeck, 2006:Effective sea–level rise and deltas: causes of change and human dimension implications.*Global Planet Change*, **50**, 63–82. |

## ***UK response***

In the short term achieving the 80% GHG emission reduction target in the Climate Change Bill will mean dramatic changes in day to day life; transport will be one of the most heavily affected sectors initially.

By the 2020s we have reached the Climate Change Act target of at least 26% reduction, but direct impacts are still increasing. Thus, there will be greater pressure to have more stringent targets. Freshwater floods become more frequent and heatwaves with large numbers of elderly people dying more common. Coastal erosion and flooding is common.

In response the low carbon economy is evolving; all new development is carbon neutral incorporating adaptation techniques, energy policy revolves around nuclear and renewables, Carbon Capture and Storage will be important, transport is moving from being fossil fuel driven to electric.

Energy and climate security will increasingly depend on stronger alliances with other large energy consumers, such as China, to develop and deploy new energy technologies, and less on relations with oil producing states. Energy security may force us to become more self–sufficient.

**Concepts, ideas and paradigms**

- UK leads the way in demonstrating that mass reductions are compatible with economic growth.
  Adaptation becomes 2nd nature, people ask 'will this work in the future?' automatically.
- Individual carbon quotas accepted.

**Social structures and relationships**

- People become more nationalistic as migration threatens to disrupt social structures.
- People recognise that healthy natural environment is part of the cure for climate change.

**How we are connected**

- IT and virtual worlds dominate.
- Local micro or meso generation (i.e. local power generation for villages) becomes the norm.

**Creation of goods and services**

- High tech carbon neutral goods and services.
- UK as leader in green technology – and adaptive technology.

**What we acquire and how we use it**

- Carbon credits as important as money to access goods and services.

## ***Potential paradigm shifts***

- Permission to emit Carbon becomes a tradeable commodity as important as money.

# **Converging Technologies –** Promise and perils

The range of technologies included in this driver include: Biotechnology, IT, Nanotechnology and the combination of these and other technologies.

- **Biotechnology:** advanced genetic techniques are used to generate desired traits in plants, animals or micro–organisms and, ultimately design entirely novel forms of life. This rapidly–expanding field of science has the potential both for great opportunities and for great risks.
- **Information technology (IT):** decreasing in cost and increasing in capability; in silicon based, quantum, nanotech and biologically based carriers. Becoming pervasive.
- **Nanotechnology:** refers to a field whose theme is the control of matter on an atomic and molecular scale. Nanotechnology has the potential to create many new materials and devices with wide–ranging applications, such as in medicine, electronics, and energy production.

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| **Description of the driver** | It is expected that these converging new technologies will bring about tremendous change in, providing new products and services, enabling human personal abilities and social achievements, and reshaping societal relationships. |
| **What effect is it having now?** | There are already hundreds of so–called nano–scale consumer products already available on the market, including clear zinc sunscreens and stain resistant chinos. The future range of different potential uses for nanotechnologies is also considered to be vast, everything from energy supply to food manufacturing, medicines, household cleaners and cosmetics.<br><br>IT devices are increasingly embedded in transport, health/medical, surveillance, language translation and pollution measurement systems.<br><br>However these technologies are not easily abstracted from each other. |
| **In the medium term?** | There will be rapid and highly variable patterns of integration, as research and development in nano, bio, and IT find success in a wide range of applications, including (for example) improved cosmetics, human health, food security, cleaner and more efficient energy, and battlefield domination.<br><br>Each development pathway could throw up a different set of opportunities and challenges on the fronts of safety, health, environment and social and cultural effects. These could be similar to those of nanotechnologies, but even more difficult to anticipate and manage. If the appropriate responses are not in place, there is a risk of an uncontrolled adverse public reaction and of instability in the technology itself. Equally, these technologies may provide solutions to many of the health, food security and environmental problems we face. |

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| **By 2060?** | The US Government refers to convergence as Nanotechnology, Biotechnology, Information technology and Cognitive science (NBIC) and envisions that the mastery of the nano–scale domain will ultimately amount to the mastery of all of nature.<br><br>At the molecular level, in the NBIC worldview, there exists a "material unity" so that all matter – life and non–life – is indistinguishable and can be seamlessly integrated. The goal of NBIC is to "improve human performance," both physically and cognitively (e.g., on the battlefield, on the wheat field, on the job). Range of applications endless – Super soldiers and athletes; changes in manufacturing and food production; and the blurring between life and the inorganic world. |
| **What will push in the opposite direction in future?** | An EU report claims technology also poses "threats to culture and tradition, to human integrity and autonomy, perhaps to political and economic stability." |
| **Critical uncertainties – range of possible outcomes** | • Range of potential uses vast and implications unforeseeable<br>• Breakdown of natural and non natural may lead to backlash especially against improving human performance<br>• Could this be the magic bullet? |
| **Wildcards – low probability events that could disrupt the expected mega trend** | Whole technologies banned for ethical reasons.<br><br>Potential side effects could include disasters in development including toxicity (cancer agent), environmental impacts and effects on global economics. |
| | MANAGING NANO–BIO–INFOCOGNO INNOVATIONS: CONVERGING TECHNOLOGIES IN SOCIETY (2005)<br>edited by William Sims Bainbridge National Science Foundation* and Mihail C. Roco National Science Foundation*<br>http://www.wtec.org/ConvergingTechnologies/3/NBIC3_report.pdf<br><br>Converging Technologies – Sensemaking Scenarios James martin Institute, University of Oxford<br>www.martininstitute.ox.ac.uk/JMI/Research/technology/Converging+Technologies+–+Sensemaking+Scenarios.htm<br><br>Foresighting the New Technology Wave. The European Commission, High Level Expert Group 2004<br>http://cordis.europa.eu/foresight/reports.htm |

## ***UK response***

**Concepts, ideas and paradigms**

- "Back to nature" / "small is beautiful" – increased rejection of technological approaches.
- Holistic vs "silver bullet" approach to crop/tree/animal management.
- Playing God – are we too powerful for our own good?
- Biotech is just an extension of millennia of human manipulation of genetics.
- Synthetic biology – concept of redesigning life from basic building blocks – based on "engineering" concept.

- Climate change and other environmental pressures threaten our survival so much that environmental risks of biotechnology become largely irrelevant.
- Should we genetically modify key native species to help them to adapt to rapid climate change?
- UK leads discussion on human augmentation.

**Social structures and relationships**

- A shift to greater localisation (in the face of credit crunch / peak oil) could challenge the domination of faceless corporations and their control of food and commodity chains. Shift away from high–tech forms of biotech.
- Increased shift to electronic forms of communication and working and "virtual reality" could support shift to more individualistic thinking and or living, focus on designer foods, drugs and genetic enhancement of humans etc.
- High risks = tough regulation? High costs = dominance by few large corporations? Could increase dominance of corporate and/or government control over all aspects of our lives.
- Effect on job mobility and global competition.
- Education re–designed for social skills and information use.

**How we are connected**

- Use of IT–enabled processes to replace current democratic mechanisms.
- Use of virtual reality to reduce stress on natural environment, share visual arts.
- English language advantage reduced.

**Creation of goods and services**

- As oil declines there is likely to be an increased focus on bio–based production of fuels and industrial components. Likely to increase pressure on limited land (and water) resources.
- Plant–based production of drugs/chemicals/fuels is more natural/environmentally friendly than using fossil fuels/chemicals.
- "Biorefinery" concept – where one factory makes a range of bio–based products from a single raw material.
- "Designer" drugs tailored to the individual, produced by plants grown in the lab.
- Entirely synthetic organisms could be used to manufacture energy/drugs etc.
- Life (bio, nano, cogno) sciences as basis of most innovation.

**What we acquire and how we use it**

- Technology has reduced energy use.

## ***Potential paradigm shifts***

- "Mutate to survive".
- Human augmentation: what it means to be human.
- Technologies not predictable but expected to be transformative.

# **Demographics –** Growth in Africa and most of Asia

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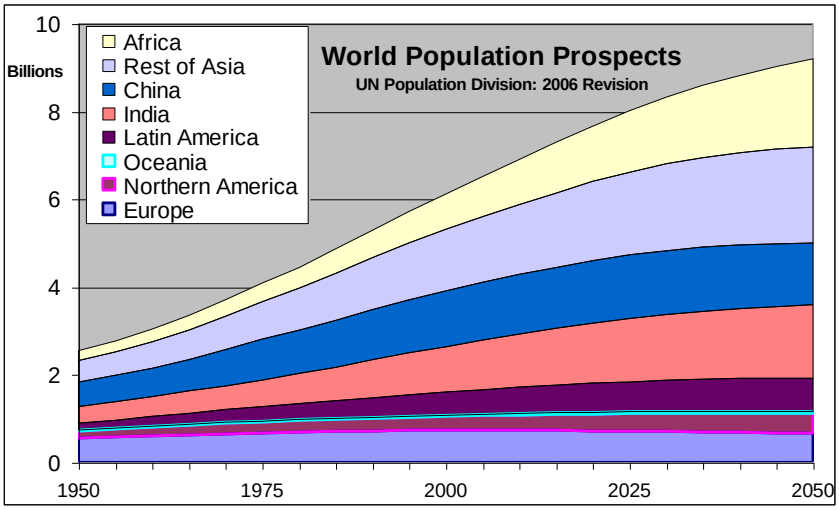
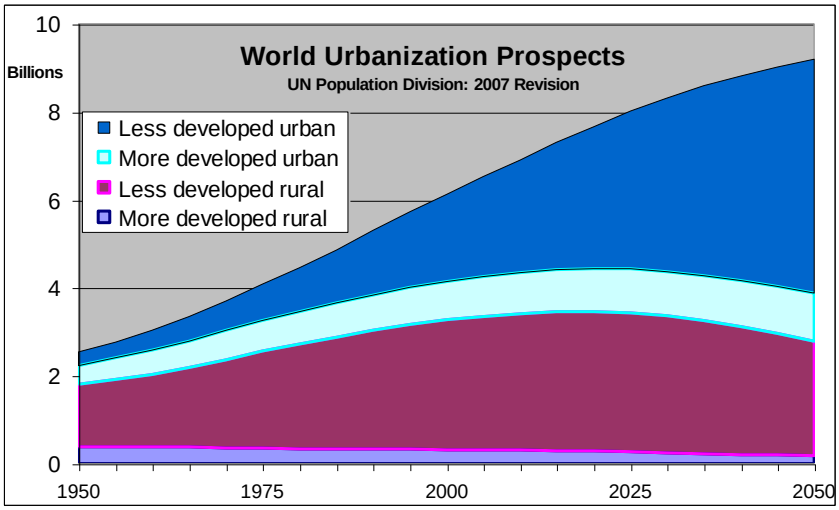
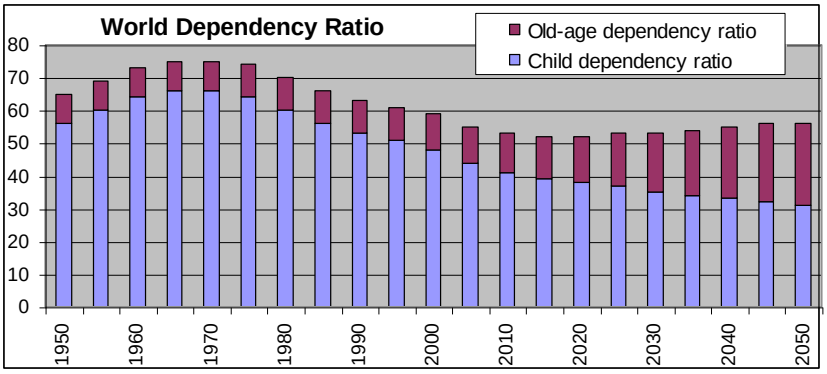
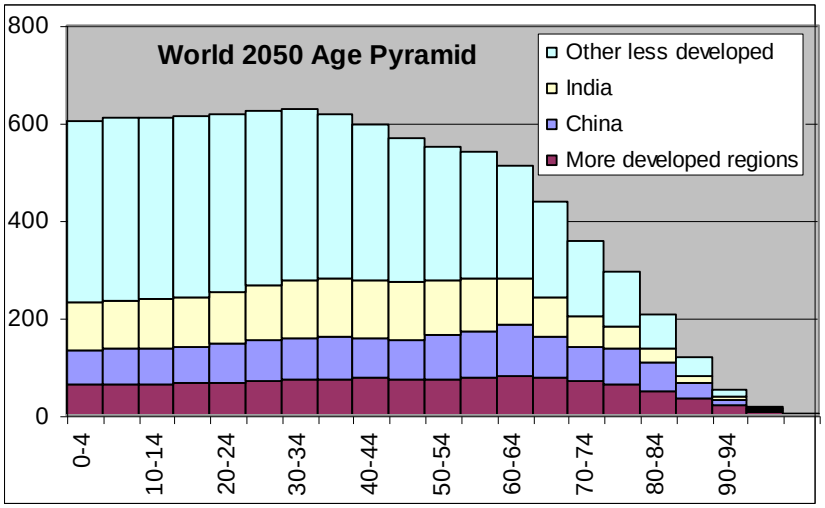
| **Description of the driver** | The global population (currently 6.8 billion) is increasing and is expected to peak at around 10 billion before the end of this century.<br>  <br> |
| **What effect is it having now?** | Population growth is putting pressure on resources, food, water and raw materials. |
| **In the medium term?** | The population is rapidly migrating to urban centres. By 2025 half the world's population will live in urban areas.<br>  <br><br>China will be ageing rapidly as well as Western countries.<br><br>After 2020, population growth will be entirely due to increasing longevity. The number of babies born in the world will reduce each year. See 2050 age pyramid below. |
| **By 2060?** | Pressure on resources must be expected to get worse by 2060. Ecosystems and the services they provide are under threat.<br><br>Even though the number of babies born each year is falling, the world population will still be rising due to increased longevity. |




By 2060 the world dependency ratio will have increased, as more people survive to old age.

Even China and India (by 2060 rapidly ageing themselves) will have been overtaken by younger populations elsewhere in Africa and Asia.

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| **What will push in the opposite direction in future?** | Lower fertility or plagues would curtail population. Increased welfare and increased urbanisation would reduce fertility, which would impact on population growth but only after many years. |
| **Critical uncertainties – range of possible outcomes** | World 2050 Population: Low variant: 8.8 billion; High variant 10.8 billion. |

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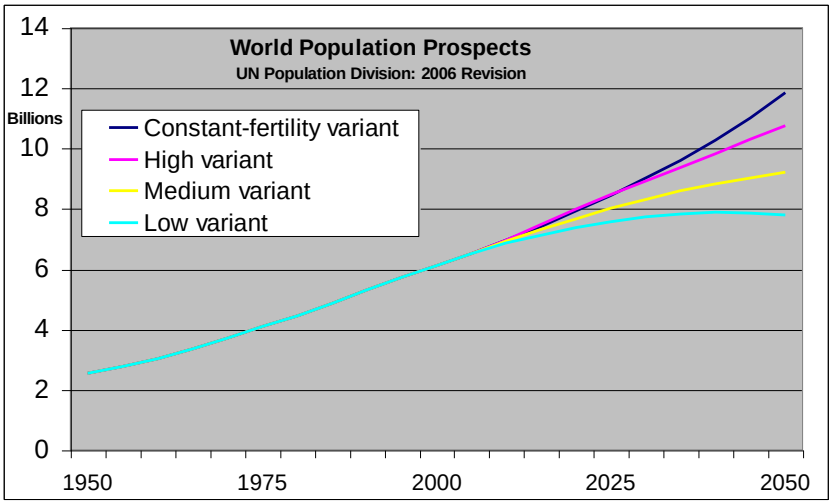
| |  |
| **Wildcards – low probability events that could disrupt the expected mega trend** | • Plague<br>• War<br>• Climate catastrophe |
| **References** | • UNPD: UN Population Division. http://www.un.org/esa/population/unpop.htm Population statistics and projections 1950 – 2050. |

## *UK response*

**Concepts, ideas and paradigms**

- Shifting attitudes towards fertility: more prevalent 'one family, one child' view.
- Retirement age increases – value of old people in workforce appreciated or found to be burdensome because lack of re–trainability?
- More flexible working patterns – time allowed off after birth – balancing later prolonged working life.

**Social structures and relationships**

- Greater movement of people in search of employment, resources, benefits: increased cultural diversity of communities, more short–term relationships, looser community ties.
- Household structure: in a world of high carbon taxes, instead of living alone in a bungalow, Granny lives with the family to save on heating bills.

**How we are connected**

- Accelerating reliance on media connections, virtual communities.
- Accelerating production of pidgins, creoles, as cultural communities intermix.

**Creation of goods and services**

- Due to its ongoing scarcity, ownership of land and living space continues to be a main source of wealth.

**What we acquire and how we use it**

- Pressure on world's resources continues to grow. This is manifest in prices rising faster than the ability of UK citizens to pay for them.
- Food and energy security issues are linked, and water will be a big issue.

## ***Potential paradigm shifts***

In the UK, the ethnic mix will be very different. but after two or more generations or inter–marriage, the concept of ethnic origin will not mean the same as it does now.

After 2020, the number of babies born in the world will reduce each year; so that attitudes to population may well have turned into anxiety over de–population and the continuing replacement of the human race.

# **Energy –** New technologies and diverse supply

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| **Description of the driver** | Energy is one of the fundamental requirements for economic growth and demand has increased in line with population and economic development throughout the recent past. Fossil fuels have been the fuel of choice since the late 19th century and throughout the 20th century. We are approaching peak global oil and gas production whilst demand especially from the emerging economies is increasing rapidly. |
| **What effect is it having now?** | The distribution of the remaining fossil fuel reserves are not in the countries with major economic development (US, Europe, India and China). Around 80% of the world's oil and gas reserves are now controlled by governments rather than oil companies (for example Russia, Iran. Qatar hold 56% of the world's reserves of natural gas). With reduced supply and greater national control of reserves, energy security is becoming an increasingly important driver for change.<br><br>The impact of the use of fossil fuels on climate change through the emission of greenhouse gases is now accepted, and the drive for low carbon alternatives is now a global objective.<br><br>There have been some shifts to low–C options in developed countries (OECD), but these remain a very small percentage of total energy production. |
| **In the medium term?** | In the short term, the demand for energy will stagnate or decline leading to more stable oil and gas prices.<br><br>Global production of oil will fall steadily from 2015 as newer projects fail to replace depleted fields, creating an energy shortfall. This will encourage greater exploration and possible exploitation of reserves in the world's "commons" i.e. resources that society collectively own. The cost of energy will increase in the short to medium term and is likely to remain high, depending on the speed of development of alternatives to fossil fuels. Increasing costs are likely to reduce demand, both encouraging economy of use and driving the development of low energy technology.<br><br>In the short to medium term, coal is likely to play a renewed role, with carbon capture techniques increasingly used to manage GHG emissions. Nuclear power in developed countries is also likely to significantly expand in the medium term. Other sources of renewable generation (photovoltaic and wind) and improvements in battery technology will also increase rapidly.<br><br>There will be some switching to biofuels, which will have risks and benefits.<br><br>The scarcity and cost of energy will drive energy efficiency across all industries and change many aspects of our way of life. In less developed countries energy poverty will increase. The impact on Transport will be notable. |

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| **By 2060?** | New technologies will be developed, but it takes an average of 25 years for a new production technology to be adopted in the energy sector.<br><br>By 2060 global energy supply is likely to be far more diverse than now with fossil fuels playing a minor role. The energy mix will be made up of both existing low carbon technologies and new technologies.<br><br>Major exporters such as Russia and Iran will substantially augment their levels of national power in the medium term. However a fundamental switch to new energy sources in the long term could trigger a long–term decline for producers as global and regional players.<br><br>Dependent on the speed of new energy technologies filling the void of declining fossil fuels, the scarcity and control of energy supply will play an increasing important role in global politics with the potential influence economic development or trigger wars. |
| **What will push in the opposite direction in future?** | • Technological advances in exploration, extraction, refining and processing of oil could push peak supply towards 2030.<br>• New discoveries (such as the recent discovery of oil, in the Santos Basin) in the Arctic and Antarctic.<br>• Technological advances in energy efficiency, use and transmission reducing demand.<br>• Technological advances in the processing of oil sands could increase oil reserves significantly. |
| **Critical uncertainties – range of possible outcomes** | • Speed of climate change and the international will to resolve it through GHG emission targets will play a major role in the speed of transition from fossil fuels.<br>• An energy transition from one type of fuel (fossil fuels) to another (alternative) is an event that historically has only happened once a century at most with momentous consequences. A new technology may revolutionise energy supply. |
| **Wildcards – low probability events that could disrupt the expected mega trend** | • Cold fusion or another technological breakthrough becomes an economic reality.<br>• Geo–engineering removes the need for greenhouse gas curbs. Major economies and polluters such as the US and China are unable to reduce emissions and look for alternatives to managing climate change thereby removing the drive to reduce GHG emissions. |
| **References** | • ITPOES (2008) The Oil Crunch Securing the UK's energy future. First report of the UK Industry Taskforce on Peak Oil and Energy Security.<br>• US National Intelligence Council (2008) Global Trends 2025: a transformed world.<br>• World Energy Outlook 2008. |

## *UK response*

**Concepts, ideas and paradigms**

- Promotion of carbon neutral living and carbon accounting.
- Critical role of limits and feedback more deeply seated as a working assumption.

**Social structures and relationships**

- Energy costs prohibitively high so work and social networking becomes "virtual" reducing the need to travel.
- Air travel for the wealthy only – long–distance 'face–to–face' family get togethers a luxury!
- More respectful of natural environment.

**How we are connected**

- Electric and hydrogen vehicles.
- IT and virtual worlds.

**Creation of goods and services**

The UK faces two major long–term energy challenges: climate change, which requires a cut in damaging emissions, and the need to deliver secure supplies of clean energy at affordable prices. A twin track approach of developing alternative energy sources and reducing demand is therefore likely.

- Continued rapid decline of oil and gas from the North Sea and desire to lead the climate change debate encourages diversification of energy production.
- Short to medium term increase of low carbon energy production such as wind, tidal wave and bioenergy.
- Short to medium term drive for nuclear power.
- Short to medium term drive for biofuels for transport overtaken by electric and hydrogen powered systems.
- Expansion of micro–generation makes significant contribution to the national grid.
- High tech energy efficient products.
- Domestic micro–generation the norm.
- Zero carbon housing.

**What we acquire and how we use it**

- Acquire less, and what we acquire uses less energy.
- Solar powered and fuel–cell powered appliances and consumer goods the norm.
- Default state of consumer goods is "off" rather than "on".

## *Potential paradigm shifts*

- Carbon neutral living.

# **Food Security –** Will supply rise to meet demand?

Food security is critically important to people, as insufficient quantities of food of sufficient nutritional value result in malnutrition, ill health, and starvation. Food Security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs, as well as culturally acceptable food preferences for an active and healthy life (definition from World Food Summit, Rome 1996).

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| **Description of the driver** | The global demand for food is projected to increase (by 100% by 2050), caused by increasing population (50%), and increasing wealth and urbanisation leading to changes in lifestyles and diets (50%). At the same time the current and future constraints on food production and supply include the scarcity of natural resources, impacts of weather and climate change, agricultural technological developments, the structure of farm and food businesses, and prevalence of pests and diseases. |
| **What effect is it having now?** | Food supply has kept pace with demand, but stocks have recently become depleted. Global food insecurity is currently caused by unequal distribution and access to food, rather than a lack of overall availability. The rise in world food prices during 2007 and 2008 is estimated to have increased the risk of hunger for an additional 100 million people globally[1]. The reasons for the rise in food prices include: growth in demand (due to population and changing diets), particularly in China, speculation on agricultural commodity markets, crops being diverted to produce biofuels, severe drought in Australia, and responses to higher prices in some countries, such as export bans on rice. Global supply has now increased for some major commodities (lowering prices) as production has increased due to good harvests in 2008, more intensive production, and areas brought back into production, particularly in Russia and Eastern Europe. |
| **In the medium term?** | • Climate change is predicted to increase the risk of famine for several hundred million people worldwide, higher temperatures reduce global cereal production by 5% although may allow increased yields in parts of the North.<br>• Energy and inputs: 95% of food is 'oil dependant'. The price of food and the price of energy converge. Nitrogen and phosphate fertilizers become more expensive.<br>• Production and environmental capacity: technological developments, greater competition for land, soil, and water, and declines in genetic diversity available to agriculture.<br>• Social and economic capacity: labour (supply, skills, knowledge), health, infrastructure and population, urbanisation and wealth.<br>• A key issue will be competing pressures for land use – especially if new habitats need to be created to adapt to climate change. |

[1] UN, see http://www.un.org/apps/news/story.asp?NewsID=26412&Cr=food&Cr1=price

# Project to assist Natural England develop a set of scenarios for England's Natural Environment to 2060: Global Drivers of Change to 2060

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| **By 2060?** | • 'Business as usual' – supply responds to increased demand, but with the same industrial model of agriculture. Intensification and expansion into new areas. High environmental impacts.<br>• 'Crisis' – food supply fails to keep pace with demand, increasing levels of malnutrition and hunger, increasing prices lead to changes to more plant–based diets, poor countries and poor people suffer most.<br>• 'New 'green' revolution': supply increases due to technological developments, such as plant breeding, GM, etc. Environmental impacts could be positive or negative.<br>• 'Eco–transition' – low carbon farming and adoption of agro–ecological approaches to increase productivity, adoption of lower impact diets, 'localism' and more community initiatives. |
| **What will push in the opposite direction in future?** | • Reductions in demand: through fewer people, less waste in supply chains, and changed patterns of diets.<br>• Increased availability in natural resources. |
| **Critical uncertainties – range of possible outcomes** | • Population growth rates and changes in diets and lifestyles, affecting demand.<br>• Availability of land, water, and soils, and rate of depletion of genetic diversity and global fish stocks.<br>• The price and scarcity of oil and other energy required for agriculture, including impacts on fertilizers.<br>• The pace of technological advances in food production, such as biotechnology.<br>• The rate and extent of impacts of climatic change on the main producing areas of the globe.<br>• The extent of competition for agricultural land for energy production – e.g. biomass or biofuels.<br>• Developments in aquaculture and fishery management. |
| **Wildcards – low probability events that could disrupt the expected mega trend** | • Unpredicted and global climatic shifts resulting from climate change, e.g. global freeze.<br>• Global pandemic or war causing a significant drop in global population – could reduce demand due to reduced population and or supply by reducing the labour force.<br>• Global pandemic or resource wars causing a breakdown of international trade. |

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| **References** | • Natural England Policy on Food Security and Environment<br>• A note on Rising Food Prices, Mitchell D, World Bank, 2008<br>• The State of Food Insecurity, FAO, 2008<br>• Ensuring the UK's Food Security in a Changing World, Defra, 2008<br>• Food Security and the UK: Evidence and Analysis, Defra, 2006<br>• The story of phosphorus, Cordell, 2008<br>• UK Food Supply in the 21st Century: The New Dynamic; Chatham House, 2008<br>• How vulnerable is Europe's food supply? AgraEurope, Oct 2008<br>• Towards a national sustainable food security policy, Centre for food policy, City University, 2008<br>• Can Britain Feed Itself? Should Britain Feed Itself? James Martin Institute, Oxford University, October 2008<br>• An Inconvenient Truth About Food, Soil Association, 2008<br>• Food Security: Back on the agenda, Food Ethics Council, 2008 |

## ***UK response***

*Possible responses include:*
**Markets:** largely driven by interaction of supply and demand, with prices and costs affecting profitability, and therefore decisions for profit maximizing businesses;

**Government:** emphasises imports for food supply: increases risk and lowers resilience in the food system to shocks, 'exports' environmental problems, increases in impacts of transport;

**Consumers 1:** continue with current levels of consumption and existing diets and, coupled with less exercise/greater inactivity, leads to more obesity and diet–related ill health;
**Consumers 2:** adopt lower impact and healthier diets, with less meat and dairy products, lowering demand for some food, increasing demand for others: less GHG emissions from fewer numbers of livestock, but more polytunnels possibly lowering landscape quality;

**Agriculture 1:** responds to global food security concerns by increasing production for direct supply to food insecure countries or through lowering agricultural commodity prices on world markets: intensification on existing agricultural land driven by global demand/prices;
**Agriculture 2:** seeks to maintain similar level of self–sufficiency for UK by increasing production: intensification on existing agricultural land of 25%, but possible adoption of practices which mitigate some impacts on environment;
**Agriculture 3:** adopts lower carbon agriculture and more agro–ecological approaches, concerned more with sustainability and profitability than production, but with development of local and regional markets for high quality added value products.

**Concepts, ideas and paradigms**

- **Eco–Malthusians** – not enough resources to go round, Gaia will have her revenge.
- **Deniers** – something will come along, not a problem for us.
- **Markets will sort it** – more global trade and price incentives to produce.
- **New ruralists / farm revival**: 'back to the land', new nationalism.
- **Technical fix**: new Green revolution: GM is the answer.
- **Consumer fix**: reduce waste and change diets: 'eat less meat'.
- **Egalitarians**: rich over–consume; poor under–consume, need equality.
- **New Localists:** stop idiotic 'exchange', rebuild the local.
- **Interventionists:** Price controls, rationing, raise incomes to keep food affordable.

**Social structures and relationships**

- Land owners become increasingly influential.

**How we are connected**

- Supply chain security.

**Creation of goods and services**

- Development of GM based agricultural products.
- Manufacture and export food production systems.

## ***Potential paradigm shifts***

- Changed concepts of what food is.

# **World Economic Power Shifts –** Dominance of China and India

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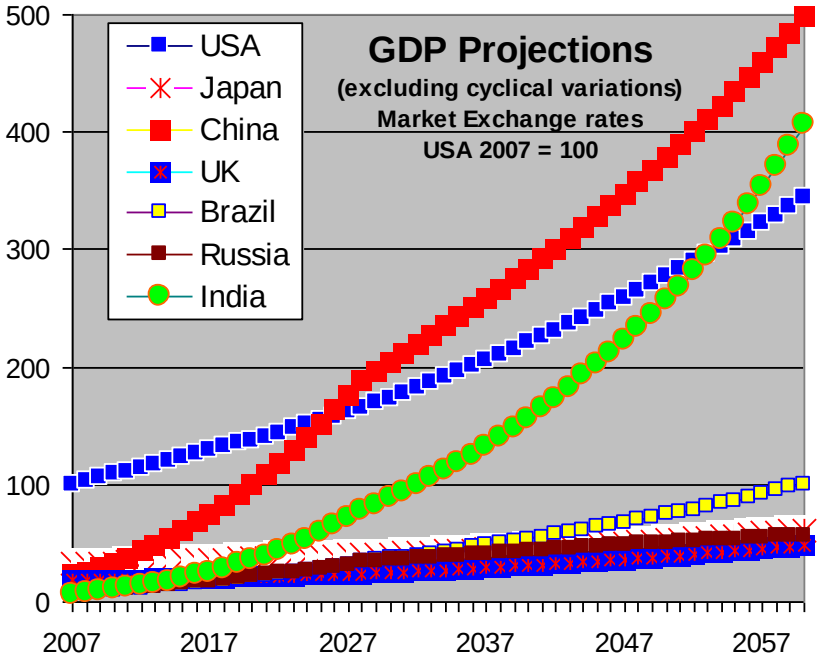
| **Description of the driver** | By 2060, the economy of China is predicted to be substantially larger than America's.<br>  <br><br>Source: SAMI updates and extensions to PwC economic forecasts. Excludes impact of 2008 credit crunch (assumed temporary). |
| **What effect is it having now?** | China's GDP (at market exchange rates) is still small compared to the USA, but already the annual increase in China's economic output is the biggest single contributor to world economic growth.<br><br>Allowing for the cheaper goods and services, Chinese GDP (at PPP) is more than half that of the USA. |
| **In the medium term?** | By 2025, China may well have overtaken the USA in GDP. This is an effect of its enormous population; China will still be a poor country as GDP per head will only be a fraction of American levels.<br><br>Purchasing power between Chinese and US currencies are predicted to have equalised, giving a boost to Chinese MER growth between 2007 – 2027. |
| **By 2060?** | • Economic power after 2030 is likely to lead to political, social and ethical dominance in the following decades. The geopolitical landscape will change.<br>• By halfway through the "Pacific Century", China is the new economic superpower. The health of the global environment will depend more on Beijing than on Washington.<br>• The global political dynamic is likely to be driven by the relationship between China and India, with the USA in third place. |

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| **What will push in the opposite direction in future?** | America preserves its relative economic performance, and matches the growth rate of China through better education and innovation.<br><br>Resource constraints may limit global growth. But even if the total growth is constrained, the relative ranking of China and the USA is likely to reverse over the next 50 years. |
| **Critical uncertainties – range of possible outcomes** | Ability of the planet to sustain continued economic growth (Though, even if overall world growth stalls, the relative strength of China and the USA will change, due to the population effect). |
| **Wildcards – low probability events that could disrupt the expected mega trend** | People's sense of affiliation may not be based on geographical distinctions at all.<br><br>Political upheaval in China deflects it from its current trajectory. |
| **References** | *PricewaterhouseCoopers LLP* – The World in 2050, March 2008. GDP Projections at Market Exchange rates. Projections do not include short–term business cycle variations |

## *UK response*

**Concepts, ideas and paradigms**

- Spread of various Asian culture worldviews / paradigms, (based e.g. on Confucian rather than Judeo–Christian values).
- Much more difficult to reach consensus about what is important in the Natural Environment and what should be protected: multiple cultural paradigms and perspectives.

**Social structures and relationships**

- Relations with China will become more important than any Special Relationship with the USA.
- Countries, like the UK, with rich ex–pat connections to China will have a comparative advantage in terms of cultural and economic 'bridges' and 'conduits' into China.

**How we are connected**

- English will not necessarily stay the predominant business language.
- Interactions across the world are as important as local or national links.

**Creation of goods and services**

- The UK will command an ever–decreasing share of the world's resources.

**What we acquire and how we use it**

- Consumers will no longer be able to take advantage of (relatively) low–cost manufacturing in China.

## *Potential paradigm shifts*

- The concept of "Natural England" could be overtaken by a non–geographic paradigm for government.

# **Governance –** All levels attempt to reduce risk

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| **Description of the driver** | Regulation – national, EU, international – is likely to increase in an attempt to reduce risks of climate change, migration and radicalisation. It may be that this regulation will be undertaken by local governments on behalf of international organisations.<br><br>There is the potential for a "Clash of Civilisations" as demographic changes and shifts in economic power have political repercussions. |
| **What effect is it having now?** | Regulation increases around carbon emissions, financial transactions, migration, food, drugs, water quality, health care, trade and nuclear proliferation. EU regulation on agriculture (CAP) affects farming in Europe. |
| **In the medium term?** | • There is more regulation because "we can" – the data is available through IT.<br>• The carbon issue is resolved by a mixture of pricing and new energy technologies rather than regulation.<br>• Financial systems continue to oscillate between regulation and anarchy.<br>• Nuclear proliferation becomes a fact and regulation struggles to keep up.<br>• Migration increases, changing the relationship between people and the state.<br>• Exponential increase in law, national, international and regional.<br>• As the EU expands towards the East, the richer countries of Western Europe will support the poorer East through transfers of wealth and the attention of EU policy makers.<br>• China will gain in economic power and influence.<br>• Huntingdon predicts a "Clash of Civilizations" as e.g. a generation of young footloose males from China and Muslim countries make their presence felt. |
| **By 2060?** | • National governments may not be responsible for enforcing regulations: this could be done by local governments on behalf of international organizations.<br>• China economic power over the previous few decades will translate into political and cultural influence. |
| **What will push in the opposite direction in future?** | People's fear and protectionism of current national states, ability to police borders – physically and electronically. |
| **Critical uncertainties – range of possible outcomes** | The uncertainty is in the extent to which protectionism prevents the implementation of global regulation. |

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| **Wildcards – low probability events that could disrupt the expected mega trend** | Difficult to see how this could not be a 50 year trend. A disconnect in the ability of governments to enforce regulation is perhaps the wild card. |
| **References** | • John Brockman (ed) "The Next Fifty Years", Weidenfeld and Nicholson, ISBN 0 297 829254<br>• http://www.21school.ox.ac.uk/research/technological_change.cfm, the web site of the James Martin School for the 21st Century<br>• Samuel P. Huntington. The Clash of Civilizations: And the Remaking of World Order |

## *UK response*

**Concepts, ideas and paradigms**

- UK acts as global think tank for regulation, spanning BRIC and US cultures
- EU regulation enforced in UK.
- Increased attempts to encourage "better" more sustainable living through international conventions.
- BRIC and developing countries will require more action by developed nations to remedy the damage of the past.

**Social structures and relationships**

- Business "automatically" configured to obey regulation.

**How we are connected**

- Greater sense of monitoring across branches of government, between government, businesses and consumers.

**Creation of goods and services**

- Costs go up as regulation requires more documentation, source certification of raw materials, and disposition of waste materials.

**What we acquire and how we use it**

- Increased regulation could limit what is available to consume.
- Wealth is largely in the hands of immigrants (First and second generation).

## *Potential paradigm shifts*

- The concept of "Natural England" could be overtaken by a non–geographic paradigm for government.
- Natural England becomes more of an ecological enforcer.

# **Health and Wellbeing –** Spread of lifestyle diseases

The two concepts of health and wellbeing are inter–connected. Without wellbeing good health is vulnerable, and without good health wellbeing fails to thrive. Good health does not guarantee wellbeing.

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| **Description of the driver** | In the developed world, health (and wellbeing) is declining due to preventable lifestyle disease. In the developing world, diseases once thought of as being a developed country problem are rapidly increasing due to a globalisation of lifestyle, urbanisation and increasing affluence. |
| **What effect is it having now?** | Globally, there are more than 1 billion overweight adults, at least 300 million of them obese. The key causes are increased consumption of energy–dense foods high in saturated fats and sugars, and reduced physical activity. Developing countries, while they continue to deal with the problems of infectious disease and under–nutrition, are experiencing a rapid upsurge in chronic disease risk factors such as obesity and overweight, particularly in urban communities.<br><br>Heart disease and strokes (often linked to obesity) are also related to our modern lifestyles. Research has now shown the onset of heart problem is due to our modern lifestyle changes. The same dietary and exercise drivers contribute, but the life we lead today is more stressful than for previous generations.<br><br>Smoking related–diseases kill one in 10 adults globally, or cause four million deaths. Smoking is on the rise in the developing world but falling in developed nations. In the developing world, tobacco consumption is rising by 3.4% per year.<br><br>In developed countries, children's lifestyles have changed dramatically over the past decades with an increasingly technologically engaged, 'urban', indoors, sedentary and consequently unhealthy cohort.<br><br>People perceive an increasing number of risks in their lives, many of which centre around health. Fears of sustaining an injury, coming into contact with fast traffic or picking up an infectious disease (such as Weil's disease) can discourage engagement with the outdoors, and reduce support for habitat protection. Added to this is the possibility of health (either physical or mental) being undermined by an attack on your person (which 35% of people consider a significant risk). Regular news of the environment being dangerous may well exacerbate this trend.<br><br>Between 1991 and 2000, expenditure on anti–depressants rose from 15 million to 395 million. Mental illness costs in the UK are an estimated £76 billion per year. Reports of emotional and hyperactive problems in children have doubled from 6.4% to 14%. |

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| **In the medium term?** | • Obesity and allied health problems such as diabetes reach epidemic proportions. Heart disease and stroke may become the leading cause of both death and disability worldwide, with the number of fatalities projected to increase to over 20 million a year and by 2030 to over 24 million a year.<br>• National health programmes are stretched by a combination of ageing populations and these lifestyle diseases; ensuring that action is taken on lifestyle and diet.<br>• Smoking may become marginal in developed countries and peak in developing countries, however smoking related diseases are likely to kill one in six people globally by 2030.<br>• The WHO predicts that depression will be the second greatest cause of ill health globally by 2020. |
| **By 2060?** | Smoking may be marginalised and global smoking related deaths decline rapidly.<br><br>The UK Governments Foresight programme has predicted that by 2050, 60% of men, 50% of women and 25% of children under 16 in Britain could be obese. Foresight predicted rise in obesity could increase levels of diabetes by more than 70%, strokes by 30% and heart disease by 20%. |
| **What will push in the opposite direction in future?** | • Drive to greater physical activity. Increased public awareness of the health benefits of greater physical activity and sustained Government commitment to promote it.<br>• Wellbeing leading to a heightened interest in quality of life, encompassing health, physical activity levels and connection with nature.<br>• Changing priorities of policy and expenditure in healthcare.<br>• Actions taken to address social inclusion. Provision of local green spaces near to low income and ethnic minority groups live.<br>• Actions taken to address mental health through increased contact with Greenspace. Priority given to outdoor recreation, greenspace close to where people live, green exercise and walking to health as public health approach to mental wellbeing.<br>• Global patterns of diet change to reflect food scarcity and climate change concerns. The "western" meat and dairy based diet is rejected and vegetarianism becomes the norm. |
| **Critical uncertainties – range of possible outcomes** | • Food scarcity and climate change considerations lead to more healthy eating.<br>• The speed of onset of the obesity time bomb and the response of governments to it.<br>• Medical and biotechnological advances in plant breeding, food production and processing produce pharmaceutical food.<br>• Genetic/gene therapy developments.<br>• How much public health and government messages about what is good for you in terms of healthy activity, wellbeing and diet are taken on board by the general public. |

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| **Wildcards – low probability events that could disrupt the expected mega trend** | • New technologies may come up with the pill to cure obesity so we can continue as we are.<br>• Other global drivers such as food, energy and climate change mean a step change in lifestyle – more manual labour, less personal transport. |
| **References** | • WHO (2006) Obesity and overweight<br>• Sustainable Development Commission 2007 Health, Place and Nature How Outdoor Environments influence health and Well–being: A knowledge base.<br>• Mitchell R, Popham F, Effects of Exposure to natural environment on health inequalities: an observational population study<br>• Royal Commission on Environmental Pollution 2007<br>• Foresight (2007) Tackling Obesities: Future Choices Project |

## *UK response*

**Concepts, ideas and paradigms**

- Greenspace and the environment are seen as an important contributors to the health and wellbeing of the nation and given greater priority.
- Priority given to outdoor recreation, greenspace close to where people live, green exercise and walking to health.
- Continued development of "National ill health service approach". Public health continues to be given low priority.
- Priority given to leisure industry solutions (gym membership).
- Social exclusion is one of the main causes of poor health due to lifestyle is addressed.
- Genetic screening and gene therapy reduce levels of genetically based traits.
- Technology fix: more drugs to manage problems.
- Lifestyle changes with more outdoor or active lifestyles being encouraged.
- Wellbeing emphasis rather than wealth (index of Gross National Happiness, Bhutan).
- Personalised organ growth means that people can live recklessly and not pay the price.

**Social structures and relationships**

- Health Sector/ Public health working with environment.
- Health Sector/ Public health working with leisure industry.
- The 'polluter pays' approach adopted for health provision for lifestyle diseases.

**How we are connected**

- Healthy food, 'slow food' appreciation groups.
- Health spaces (gyms, meditation centres) as key places for social connection.

**Creation of goods and services**

- 'Green' and 'healthy' production processes emphasized / regulated.
- Pharmaceutical products.
- GP's referral to active lifestyles rather than drugs.
- Local greenspaces (Green Infrastructure and Accessible Natural Greenspace standards).

**What we acquire and how we use it**

- Healthy lifestyles and attitudes.
- Walking to health.
- Gym referrals.
- Green Gym.
- Greater links to natural environment.

## ***Potential paradigm shifts***

- Food is medicine.
- Prevention of ill health rather than cure.
- Active lifestyles.

# **Infectious Diseases –** Disease goes global

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| **Description of the driver** | Infectious human and plant diseases are on the increase; globalisation has increased the spread of otherwise local diseases.<br><br>Old diseases are becoming resistant to current control techniques; social changes are promoting sexually transmitted diseases; and climate change is making humans, plants and animals more susceptible. |
| **What effect is it having now?** | Greater movement of goods, services and people increase the risk of disease transmission, as does social and sexual behaviour. Infectious diseases are now spreading geographically much faster than at any time in history and emerging more quickly than ever before.<br><br>Increased incidence of:<br>• hospital acquired diseases.<br>• sexually transmitted infections, including HIV/AIDS.<br>• food–borne infections and zoonoses in general.<br>• imported and exotic infections (e.g. Swine fever in UK).<br>• Cholera, yellow fever and epidemic meningococcal diseases made a comeback in the last quarter of the 20th century.<br>• Drug–resistance in tuberculosis (XDR–TB), and also in diarrhoeal diseases, malaria, meningitis, respiratory tract infections, and sexually transmitted infections.<br><br>Emerging viral diseases such as Severe Acute Respiratory Syndrome (SARS), Ebola, Marburg haemorrhagic fever and Nipah virus pose threats to global public health security.<br><br>Climate change is increasing the natural range of diseases, either directly or through the range of their vectors. Whilst environmental safety considerations are leading to the removal of many pesticides used to manage vector borne and plant diseases. |

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| **In the medium term?** | Sporadic outbreaks of tropical diseases are likely to occur in temperate zone ( e.g. West Nile Virus). The distribution the five major human vector carried diseases (malaria, sleeping sickness, leishmaniasis, schistosomiasis and filariasis) is likely to increase in the tropics; and tsetse– and tick–borne diseases livestock production in Africa.<br><br>Population increase, the demand for food and climate change will increase the stresses on the natural environment making it more susceptible to potential disease outbreaks. Stretched ecosystem services such as world food supply will become increasingly vulnerable to losses or changes caused by diseases. Diseases that have been managed through lifestyle, behaviours, crops husbandry will move into areas which do not have the systems in place to respond.<br><br>International efforts to manage the spread of diseases are likely to be increasingly coordinated. |
| **By 2060?** | Plant breeding including biotechnology could substantially increase the genetic base of the main global crops providing greater security over food. |
| **What will push in the opposite direction in future?** | Technological advances in medical and pharmaceutical areas, eliminate major global diseases e.g. HIV, malaria.<br><br>Reversal of trends in globalisation (economic global retrenchment, increasing transport costs) or slowing or reversal of climate change (management of $CO_2$ emissions, geo-engineering). |
| **Critical uncertainties – range of possible outcomes** | The greatest potential impact on ecosystem services as a result of disease outbreaks would be to undermine water and geochemical cycles, ultimately contributing to climate change, but the probability of this is regarded as very low.<br><br>Impacts on natural production systems and on other useful biodiversity, while of lower impact, have a greater probability. The probability, and therefore risk, of both events will increase as human activities simplify and degrade ecosystems.<br><br>The frequency and virulence of new human, animal and plant diseases. |

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| **Wildcards – low probability events that could disrupt the expected mega trend** | Wild cards for this driver are often worst case scenarios:–<br>• High death rate global human pandemic. Improved healthcare suggests a lower mortality rate than with historic diseases, but there is the potential for a new highly virulent density–dependent disease to cause far higher global mortality.<br>• High death rate animal pandemic (as above).<br>• Loss of major crop – staple crops are genetically narrow, risking a new or mutated disease wiping out the global resource.<br>• Loss of keystone species and collapse of local or regional ecosystem services. For example, bee pollinators.<br>• A disease that eliminates one or more keystone species and thereby generates a domino effect through an ecosystem. This could result in the disruption of major natural production. Systems such as fisheries, other valuable biodiversity, essential geochemical cycles, or all three.<br>• Microbial viral disease reduces oceanic plankton levels and lead to acidification of the oceans, with impacts on carbon cycling and climate. |
| **References** | • FAO (2008) EMPRES Plant Pest and Disease – managing new transboundary threats.<br>• WHO (2006) Global public health threats in the 21st century<br>• Foresight (2006) The Detection and Identification of Infectious Diseases |

## *UK response*

**Concepts, ideas and paradigms**

- Personal responsibility for a healthy way of life.

**Social structures and relationships**

- Heightened suspicion of 'the other' and 'the strange'.
- Heightened suspicion of the natural world because animals cause disease.
- Greater connectivity but at greater risk of rapid lock–down as a response to global disease risks.
- Disease outbreaks in natural ecosystems can affect human health, for instance, through zoonoses such as Lyme disease, avian influenza and West Nile virus or wetlands supporting malaria vectors; this could increase the perception of the natural environment as the threat.

**How we are connected**

- Early warning systems and contingency planning.
- High tech surveillance and quarantine of people, food, plants and animals on borders.
- Central monitoring of individuals' diagnosis kits.
- Citizen science used for monitoring.

**Creation of goods and services**

- IT Modeling capability to predict, model and design responses to disease threats.
- Pharmaceutical solutions such as genomic–based detection and characterisation technologies and techniques for the identification of new or newly resistant/virulent pathogens.
- Development of new control chemicals to replace current antibiotics and pesticides.
- Sanitation infrastructure and waste disposal adapted to suit warmer environment.

**What we acquire and how we use it**

- Individual kits for the identification and characterisation of infectious diseases.
- 'Purity' becomes a key brand characteristic.

## ***Potential paradigm shifts***

- Acceptance of governmental monitoring and guidance.
- Isolation at national, regional, local or individual level.
- Don't go near "nature".

# **Marine –** Ocean acidification and over–fishing

Our oceans and seas dominate our world, covering over 70% of our world and occupying around 94% of the biosphere – the habitable part of our planet. Globally the oceans provide protein for hundreds of millions of people through fish. Without healthy and productive oceans, life on Earth would not be possible as we currently know it.

The UK has one of the world's richest marine environments. As an island we are responsible for a sea area more than 3 times larger than our land area.

| **The Oceans** | **Ocean Acidification** | **Over–Fishing** |
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| **Description of the driver** | Acidification of our oceans is now a critical problem as the absorbed carbon dioxide exhausts our oceans ability to buffer the excess amount in the atmosphere. | If fish populations crash due to over–fishing, acidification, or pollution, the consequences could be disastrous. |
| **What effect is it having now?** | Excess carbon dioxide in the air is rapidly pushing the oceans into more acidic conditions as $CO_2$ dissolves in water to form carbonic acid, threatening all species and habitats that contain calcium carbonate,– shells, shellfish, and many young stages of species are increasingly at potential or actual risk.<br><br>The surface ocean has absorbed nearly half of the increased $CO_2$ emissions due to burning of fossil fuels over the last 250 years, thus reducing the amount remaining in the atmosphere. | Since 1990, at least 70% of overall UK fish stocks have declined in their reproductive capacity and have been harvested unsustainably. Mainly through over–fishing now over 90% of the big fish in our seas have gone.<br><br>The pressures from fishing have altered not just the size, the species present, but even the genetics of some species, forcing them to reach maturity at increasingly small sizes.<br><br>It is now know that micro–plastics are an increasing pollutant of marine habitats, and species which ingest such items. Further increasing pressure on fish and other sea creatures. |
| **In the medium term?** | Continued acidification will reduce the ability of the ocean to take up $CO_2$ from the atmosphere, which will have feedbacks to future climate change, further accelerating the accumulation of $CO_2$ in the atmosphere. | The English fishing fleet is now much smaller than in the past but technical efficiency means these impacts on marine biodiversity will continue. |

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| **By 2060?** | The full impacts of acidification remain largely unknown but organisms such as corals, some plankton, shellfish, and sea urchins are expected to become less able to produce calcareous parts such as shells by the middle of this century.<br><br>Reef building corals and phytoplankton are two major marine groups that we think will be hit extremely hard by falling pH. Plankton help stimulate cloud formation due to the chemicals they naturally emit – thus playing a crucial role in temperature regulation of our planet and are the main mechanism for locking in $CO_2$. | Acidification, along with pollution and overfishing could have disastrous consequences for coastal communities throughout the world with potential food shortages or starvation for communities without alternative food sources or national support. At the least there may be severe economic problems as a result in the decline of fishing industries. |
| **What will push in the opposite direction in future?** | • Move to a low carbon economy reducing $CO_2$ emissions, with technological advances in energy efficiency, use and transmission. | • Reduction in pollution/waste.<br>• Fish farming and potential bioengineering.<br>• Increasing exploitation of fresh water fisheries (carp become popular to eat).<br>• Response of conventional farming to new markets.<br>• Marine Protected Areas recognised as key tool to recover biodiversity and improve ecosystem health. |
| **Critical uncertainties –** range of possible outcomes | • Ability of the oceans to absorb $CO_2$ severely compromised therefore atmospheric $CO_2$ levels increase dramatically.<br>• Acidification leads to collapse of maritime ecosystems, loss of fish populations/ loss of major protein food source in many parts of the world.<br>• Recent study suggests man–made pollution is raising ocean acidity at least 10 times faster than previously thought, leading to reduced $CO_2$ absorption and problems with fish populations much earlier than predicted. | • Can we learn to use the seas sustainably? The development of a sustainable food policy (nutrition based protein policy) could take the pressure off overfishing. |

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| **Wildcards –** low probability events that could disrupt the expected mega trend | • Fusion power or another technological breakthrough becomes an economic reality reducing $CO_2$ output.<br>• Geo–engineering reducing $CO_2$ emissions. | • Famine and resulting political instability through loss of fish stocks.<br>• War over dwindling fish stocks (Cod war again).<br>• The energy breakthrough might enable us to expand hugely the amount of agricultural land under irrigation or indeed the number of fish farms (salt and freshwater)…thus alleviating food security pressures and hence reducing threats from over–fishing.<br>• Protein policy is developed that sees significant reduction in meat and fish consumption and greater consumption of vegetable–based protein. Increased soya production in East Anglia. There could be a link to GM increasing yields. |
| **References** | • Marine Climate Change Impacts Partnership Annual Report Card 2007<br>• Timothy Wootton, Catherine A. Pfister, and James D. Forester (2008) Dynamic patterns and ecological impacts of declining ocean pH in a high–resolution multi–year dataset *Proceedings of the National Academy of Sciences*.<br>• Royal Society policy paper on ocean acidification: Ocean acidification due to increasing atmospheric carbon dioxide (2005) http://royalsociety.org/displaypagedoc.asp?id=13539 | • Natural England: State of the Natural Environment report. Ch 6.8 Marine and Coastal Environments 2008<br>• NE marine and coastal access briefing |

There are concerns about the masses of marine rubbish far out at sea especially the consequences of micro–plastics. It is now known that micro–plastics are an increasing pollutant of marine habitats, and species which ingest the minute fragments that remain when larger plastic items break up through weathering. More localised are impacts from dredging and near shore developments that either remove habitats or alter their characteristics.

## *UK response*

**Concepts, ideas and paradigms**
Economic importance of the marine environment providing food, leisure, tourism and sites for wind farms.

**Social structures and relationships**
- Throw away society increasing pollution of seas.
- $CO_2$ reduction.
- Loss of key element of UK identity/history.

**How we are connected**
- Electric and hydrogen vehicles.
- IT and virtual worlds (reduce $CO_2$ use).
- Less waste / pollution. Reuse / recycle (particularly plastics).

**Creation of goods and services**
- Low carbon products.
- Reuse and recycle potential pollutants rather than dumping.
- Marine protected areas – environmental tourism.
- Biotechnology/fish farming.
- Exploitation of freshwater fish.
- Food producers respond to changed diets.

**What we acquire and how we use it**
- Overfishing / consumption.
- No cod or haddock and chips. Change in diet.
- Domestic micro–generation the norm.
- IT and virtual worlds reduce travel and so $CO_2$ production.

## *Potential paradigm shifts*

- Carbon neutral living ($CO_2$ reduction).
- Loss of Maritime identity results in taking the environment seriously.

# **Mobility –** Human movement continues to increase

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| **Description of the driver** | People like to travel, and the amount of travel increases with other forms of communication.<br><br>Migration will also increase as globalisation encourages labour mobility, and populations shift following war, environmental degradation or climate change. |
| **What effect is it having now?** | Air travel is being challenged by efforts to reduce carbon emissions, public transport suffers world–wide from lack of investment (with a few exceptions), and the car is the vehicle of choice. |
| **In the medium term?** | The number of vehicles is likely to double. Air travel is likely to treble, with more small planes, and public transport in urban areas will improve. Sea transport could move to extremely large container ships. Undersea and space could be leisure destinations. |
| **By 2060?** | • All transport vehicles will be "intelligent".<br>• Cars and goods vehicles will no longer be carbon emitters.<br>• Orbital space travel will be used for leisure and medical care.<br>• Most travel world–wide will be for leisure; virtuality being used for business contacts.<br>• Floating cities to deal with capacity constraints.<br>• Phased transitions to electric or hydrogen based infrastructure. |
| **What will push in the opposite direction in future?** | Lack of investment – some elements of infrastructure are very long lead time, for example, can we foresee how to deal with 10 million arrivals in UK as tourists? |
| **Critical uncertainties – range of possible outcomes** | One uncertainty is in the extent to which the infrastructure to support intelligent vehicles is in place (air traffic control, etc). |
| **Wildcards – low probability events that could disrupt the expected mega trend** | • Long term global recession (20+ years).<br>• Development of under–ocean goods transportation systems. |

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| **References** | • BCS, "IT in 2057", www.bcs.org<br>• John Brockman (ed) "The Next Fifty Years", Weidenfeld and Nicholson, ISBN 0 297 829254<br>• Ian Pearson, Futurist, BT Exact, "Technology Timeline", stored on Basecamp as http:/futserpub.updatelog.com/projects<br>• Foresight Unit, "Intelligent Infrastructure Technology Timeline", 2004, www.foresight.gov.uk<br>• RAE report on Transport in 2050: http://www.raeng.org.uk/news/publications/list/reports/Transport_2050.pdf<br>• http://www.faa.gov/airports_airtraffic/air_traffic/satms/media/conops_addendum_1.pdf<br>• Department for Transport (2003) The future of air transport. CM6046. |

## *UK response*

**Concepts, ideas and paradigms**

- Travel as experience, education and service.

**Social structures and relationships**

- Urban development denser, with increased use of public transport.
- Environmental impact of cars, planes and boats/submarines.
- Virtual meetings mean that urbanisation occurs less and there is greater pressure on the countryside through village development.

**How we are connected**

- Virtual meetings the norm through holograms etc.
- Use of virtual reality to reduce stress on natural environment, share visual arts.
- Travel increases domestically within the UK and internationally.

**Creation of goods and services**

- Hydrogen cell allows travel to be cheap and low cost to environment.
- UK as designer of transport vehicles.
- Destination for leisure services.
- Intelligent infrastructure.

**What we acquire and how we use it**

- Travel as important leisure activity.

## *Potential paradigm shifts*

- Sense of place.
- Travel is a luxury.
- Travel as experience, education and service: changed paradigms from mere tourism.

# **Money, Wealth, Economy –** Faltering growth

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| **Description of the driver** | Until the 'credit crunch global financial crisis of 2008 the world economy had been through an extraordinary period of growth with global economic growth significantly above average three years in a row (IMF 2006). The reasons for this were:<br>• Enormous increase in the global supply of labour<br>• The world has become flush with money<br>• Improving global communications<br><br>Whether the current crisis is a blip in the global economy or a long term change is not yet clear. |
| **What effect is it having now?** | Around the world stock markets have fallen, large financial institutions have collapsed or been bought out. Governments in even the wealthiest nations have had to come up with rescue packages to bail out their financial systems. Effects include:<br>• Fall of economic activity<br>• Loss of jobs/increase in unemployment<br>• Lack of credit<br>• Uncertainty around saving and wealth<br>• Collapse of the housing market |
| **In the medium term?** | The current crisis may extend into the medium term, as the global economy staggers through a series of crises, with continuing economic stagnation.<br><br>With global financial crises, the service sector becomes less vital leading to difficulties for established economies, but emerging economies continue to grow. |
| **By 2060?** | • Increasing disparity between rich and poor (the haves and have nots) both at a national and international level.<br>• Areas such as sub Saharan Africa massively miss (2007) targets to reduce poverty.<br>• The possible development of more local economic models.<br><br>By 2060, the 2008/9 crunch (or perhaps the 2008–2015 long depression?) will be a distant memory. Technology will not have slowed down, so we will all be wealthier, in the sense of being able to do more and more clever things with fewer person or time input on our part. But this wealth may not translate into being able to command ever greater quantities of natural resources, because the supply is constrained. |
| **What will push in the opposite direction in future?** | Resurgent growth through the working of enlightened self–interest and Keynesian "animal spirits" of enterprise. |

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| **Critical uncertainties – range of possible outcomes** | Which economic model will be adopted? Are we connected with resources or still tied to consumerist models?<br><br>How do we measure wealth: are we still tied to growth models or do we measure gross national happiness? What new industrial models will develop in a world of scarce resources?<br><br>Effects of Globalisation and the new world order.<br><br>Change in values to a more affordable society.<br><br>Protectionism reducing consumption. |
| **Wildcards – low probability events that could disrupt the expected mega trend** | • Divisions within society lead to conflict and between nations lead to wars.<br><br>• New economic social paradigms and changes.<br><br>• In this uncertain climate, issues around scarce resources may lead to new economic paradigms with reduced basis in growth (see resources driver) and more around measuring wellbeing (e.g. gross national happiness in Bhutan). |
| **References** | • World Economic Outlook April 2006 IMF<br>• Global economic prospects 2007 World bank |

## *UK response*

**Concepts, ideas and paradigms**
- New world order changing the place of the UK in the world.

**Social structures and relationships**
- Organisations will become smaller, more open and transparent.
- Smaller organisations will become more important.

**How we are connected**
- ICT – social networking becomes a fiscal resource.

**Creation of goods and services**
- Financial and service sector crisis may lead to development of new smaller scale industries and skills.
- Green industries and environmental trading systems.

**What we acquire and how we use it**
- More part–time jobs and less established career structures increasing have and have not divisions within society.

## *Potential paradigm shifts*
- Survival society – move from capitalism and consumption to a system where relationships and communication are more important.

# **Resources –** Global scarcity

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| **Description of the driver** | Increasing populations and unprecedented levels of economic growth and associated growth in consumption amongst emerging economies is resulting in a worldwide rush for resources.<br><br>Simultaneously there is a growing recognition that resources need to be used efficiently; that 'waste' is a valuable resource, with new processes and legislation being developed to reduce material inputs and increase reuse and recycling.<br><br>Climate change is placing an additional burden by reducing the availability of water, or changing the distribution and demand for water, causing shortages for people, agriculture and forestry. |
| **What effect is it having now?** | Water resources are under pressure from increasing populations and urbanisation whilst at the same time climate change is changing the distribution of rainfall and increasing the risk of drought and flooding.<br><br>Nations or trading blocks are attempting to secure future supply through claims to the world's commons (Arctic and Antarctic); agreements with governments of mineral rich countries (China and EU in Africa); and the purchase of extraction/mining rights.<br><br>Strategically important raw materials such as high tech metals are increasingly affected by market distortions and supply risks.<br><br>Governments of resource–rich countries are taking control of their natural assets from multinational countries.<br><br>Recycling and improved waste management are becoming increasingly accepted by the mainstream society as a behaviour to manage climate change and preserve resources. Shortages of resources has increased interest in the use and development of renewable resources (see energy driver). This has increased pressure on other resources – for example, increased production of biofuels has increased the pressure on land for food production. |
| **In the medium term?** | The global resource of "high–tech" metals such as cobalt, platinum, rare earths, indium and titanium will diminish; limiting the supply and increasing the cost to levels which will hinder economic development and technological development.<br><br>Governments and nations holding raw material reserves should become more important global players e.g. Russia, Australia, Peru. Internal and/or international conflict is likely to occur in less developed resource–rich countries. The scope for international disputes whether through trade or military over diminishing supplies is likely to increase.<br><br>Water shortages in both developed and developing countries increase, leading to increased movements of people, declines and/or shifts in agricultural and forestry production patterns, increased environmental damage to depleted wetlands and the development of a "trade" in water. |

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| **By 2060?** | Technological development is targeted towards the exploitation of abundant raw materials rather than the "best" technological advance e.g. PV cell production focus on abundant silica.<br><br>Nations are likely to pursue technologies that play to national raw material resources.<br><br>Reduced per capita consumption and recycling become a strategic necessity.<br><br>Population increase and climate change mean that by 2025/2030 half the world's population is likely to experience severe water stress and shortages, 75% by 2050. There are already 25 million environmental refugees and it is estimated by 2020 some 60 million people will move north from Sub–Saharan Africa to North Africa and Europe.<br><br>Water use in urban centres becomes almost self–sufficient through recycling, urban water capture and storage, and water saving schemes. Solar–driven desalination becomes the norm in coastal region in low latitudes.<br><br>Biotech advances in drought resistance in agriculture and forestry help halt the decline in biotic production systems in key production regions due to climate change. |
| **What will push in the opposite direction in future?** | Demand for resources will continue with increasing global population. There would need to be some significant global event to shift public behaviours and reverse this trend.<br><br>New finds and extraction techniques increase global supply of key raw materials.<br><br>Technological advances identify and utilize alternative raw materials. For example harnessing the energy from the sun by artificial photosynthesis to generate plastics and other raw materials; extraction of minerals from deeper in the earth's core or the oceans. |
| **Critical uncertainties – range of possible outcomes** | • The rate and "success" of exploitation and potential conflict over the 'global commons' Arctic, Antarctica, oceans, space.<br>• The speed of technological advances that identify and make use of alternative raw materials.<br>• The speed of technological advances aimed at improving efficient use, recycling and recovery.<br>• Unintended consequences of technological development – environment vs. environment solutions, intelligent surroundings – particularly in cities (e.g. cars that talk, shoes generating power).<br>• The impact of water shortages on social and political instability, international conflict and the movement of people. |

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| **Wildcards – low probability events that could disrupt the expected mega trend** | • Unpredicted and global climatic shifts resulting from climate change – reduced water, soil and timber supplies.<br>• Global pandemic or resource wars causing a breakdown of international trade and decline in demand for raw materials.<br>• Technological developments that allow us to achieve 'One Planet Living.' |
| **References** | • International Water Association (2006) Meeting the Future Global Water Challenges: Thoughts, Visions and Recommendations<br>• EU (2008) The Raw Materials Initiative — meeting our critical needs for growth and jobs in Europe<br>• New Scientist (2007) Earth's natural wealth: an audit |

## *UK response*

**Concepts, ideas and paradigms**

- Changing public perceptions of national security and demand for more resource–efficient lifestyle to achieve self sufficiency.
- Use of natural resources for human benefit seen to outweigh intrinsic value of natural environment. Change in emphasis of legislation to resource efficiency rather than environmental protection; valuing of natural resources.

**Social structures and relationships**

- Maximising the UK's resource assets – individual budgets for natural resource consumption.
- Micro–generation and self sufficiency (thrift) become more important than spending/acquiring personal possessions.

**How we are connected**

- Changes in UK partners from Europe to other 'resource rich' nations. Loss of our economic influence in a more global economy.

**Creation of goods and services**

- The UK has become depleted of many of its core resources and is increasingly reliant on imports (for example, iron ore, fertilizer, fossil fuels, lithium) for its continued economic development.
- Irrespective of the global response (free trade vs protectionism) to the scarcity of raw materials, the UK will find it increasingly difficult to access the resources it requires to maintain economic growth.
- Focus on resource efficient technologies.
- Focus on high tech–low input industry.
- Recycling across all sectors becomes the norm.
- Resource intensive manufacturing replaced by high tech industry and service sectors.
- Landfill sites will become a resource.
- Water supply and demand is unlikely to be a significant driver in the long term due to infrastructure solutions to regional differences in supply and demand.

**What we acquire and how we use it**

- Cradle–to–cradle, infinitely recyclable products.
- Acquire less, use less, waste less as consumers.

## ***Potential paradigm shifts***

- Globally water becomes the new gold.
- Focus on resource efficient lifestyle – equitable sharing to achieve One Planet Living.
- Waste is a criminal offence!

# **Values and People –** Generational shift and complexity

Between 2009 and 2060 today's children will come to maturity, as will their children: two generations of difference from our current decision–makers. Age cohort analyses suggest that the milieu in which any given generation is raised and educated affects their value systems. Millennial and post–millennial children will be raised and educated in an environment of pervasive, immersive information and media technologies based on open source architecture and a worldview underpinned by paradigms of chaos and complexity.

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| **What effect is it having now?** | **Generational shift:**<br>As one generation replaces another societies views and values gradually change over time, both brought about by and influencing changes in the economy, technology and society. This change is inevitable as generations pass. The so called 'silent' generation (born before 1946), are gradually exiting the workforce The baby boomers (born 1946/64) are now becoming the aging part of the workforce. Currently, the workforce will be increasingly be made up of generation x (1979/1986) and generation y (1978/1986). Those born and over the next few years, growing up in a very different world to previous generations will be active members of the workforce by 2060. These millennials, or "Net Gen–ers" have very different norms those that went before:<br><br>In his recent book, *Grown Up Digital: How the Next Generation is Changing Your World*[1], Don Tapscott summarises eight norms that define the millennials, or "Net Gen–ers":<br>• they value freedom and choice in everything they do.<br>• they love to customize and personalize.<br>• they scrutinize everything.<br>• they demand integrity and openness, including when deciding what to buy and where to work.<br>• they want entertainment and play in their work and education, as well as their social life.<br>• they love to collaborate.<br>• they expect everything to happen fast; and<br>• they expect constant innovation.<br><br>***Complexity matures as a transformational scientific paradigm***[3]***:***<br>Systems thinking (emerged from the study of living organisms, their communities, and ecologies) is likely to give rise to the paradigm of complexity, which in turn underlies and informs other new mental models like biomimicry or social networking.<br><br>As a mental model, complexity proposes certain design rules to create stable, flexible, robust living systems, like organizations and communities. Complex systems are 'open' systems, exchanging energy, resources, and information with their environment. They emphasize resiliency rather than stability (i.e. they acknowledge the need for constant incremental change to remain strong). They distribute decision–making among the various local sub–systems |

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| | that make up the whole system. In terms of human organisations, this will increase focus on distributed decision–making and emphasise local communities and local expertise to resolve civic, social, and economic challenges.<br><br>This perspective is the foundation of Web 2.0 as well as social networking sites and businesses such as LinkedIn, Facebook, YouTube, and Zopa. It also underlies self–organising, bottom–up social and political movements and experiments in distributed decision–making and practical applications in distributed computing and allocated power generation. It in many ways underpins the values and aspirations attributed above to the "Net Gen–ers". |
| **In the medium term?** | Better connectivity through IT will promote bottom–up civic engagement (though at the risk of giving more influence to special interest groups).<br><br>In the short to medium term, Tapscott suggests the Net Gen–ers worldviews and aspirations will transform everything from the workplace to structures of social justice: 1) "working and having fun can and should be the same thing" – they want work itself to be enjoyable, expecting collaboration and constant feedback; 2) they are more positive than their predecessors about their families, and Tapscott sees an improved, more collaborative version of family life he calls the "open family" emerging; and 3) they care strongly about justice, and are trying to improve society.<br><br>By 2030 increased levels of education worldwide will be bearing fruit with ever increasing numbers of qualified engineers and scientists in developing countries. |
| **By 2060?** | By 2060, human organizations and communities are likely to apply these world views and design rules to localize decision–making, cut waste, enhance sustainability and draw insights from the cultural diversity within their populations. |
| **What will push in the opposite direction in future?** | While the next generation may expect everything to happen fast, including constant innovation, this could be countered by a balance or backlash stressing the slow, the local, the traditional, and the historical.<br><br>Generational value and paradigm shifts assume that nurture and socialization strongly affect people's behaviour; but sociobiology suggests innate primate hardwiring may drive behaviour more towards selfishness than self–organising communitarianism.<br><br>A re–flourishing of religion might reduce concerns over the environment. |
| **Critical uncertainties – range of possible outcomes** | • What will be the strongest driving force molding future behaviour: nurture and cultural milieu – the open source, self–organising society? or nature and sociobiological hardwiring – the 'selfish gene'?<br>• Will this worldview translate into progressive and conservative political ideologies, or permissive and fundamentalist spiritual values?<br>• Whether the educational system will be able to adapt to these shifts in context and effectively close the know–know not gap |

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| | between digital natives and the digitally disenfranchised. |
| **Wildcards – low probability events that could disrupt the expected mega trend** | • Rise in popularity of globally charismatic fundamentalist religious leader (attractive, top–down, hierarchical worldview propagates worldwide); or<br>• Sudden global catastrophe perceived to require command and control response. |
| **References** | 1. "The net generation: The kids are alright," in *The Economist*, November 15th 2008, p. 106, a review of Don Tapscott's book, *Grown Up Digital: How the Net Generation is Changing Your World*, reporting the results of a $4.5 million study interviewing over 8,000 people in 12 countries born between 1978 and 1994.<br>2. Benyus, Janine. *Biomimicry* [http://www.amazon.com/gp/product/0060533226], and the Biomimicry Institute for numerous examples: http://www.biomimicryinstitute.org/.<br>3. For example, see *Chaos*, by James Gleick; *At Home in the Universe: The Search for Laws of Self–Organization and Complexity*, by S.A. Kauffman; or the Santa Fe Institute [www.santafe.edu].<br>4. See *Leadership and the New Science*, by Margaret Wheatley [http://www.amazon.com/Leadership–New–Science–Discovering–Chaotic/dp/1576753441/ref=pd_bbs_sr_1?ie=UTF8&s=books&qid=1205683010&sr=8–1]. |

## ***UK response***

**Concepts, ideas and paradigms**

- Open source architecture.
- Emphasis on systemic interconnections – nothing "externalized".
- Closer connection to nature.

**Social structures and relationships**

- Self–organising social networks.
- More mutable social location and layered, multiple self–identities.
- Greater acceptance of diversity – in fact, mining diversity for innovation and discovery.

**How we are connected**

- Broadly, deeply, immersively, pervasively: across social and technological. networks, using multiple media generated by 'pro–sumers' (everyone is a reporter / journalist); slowing of language extinction with increased accuracy and widespread use of translation software.

**Creation of goods and services**

- "Pro–sumers" – consumers as producers; collaborative design; bottom–up design and production.
- "Mass customization" as consumers home tailor and home fabricate products and share improvements in open source product communities.

**What we acquire and how we use it**

- Wealth is the number of networks in which you are an active member.

## ***Potential paradigm shifts***

- Open source innovation and collaboration.
- Greater emphasis on complex evolving systems and chaos more specifically.
- Greater emphasis on inter–relationships with each other and with nature, including a greater emphasis on learning from nature, a la biomimicry.
- Greater acknowledgement of creativity emerging from diverse perspectives – the innovative value of cultural diversity.