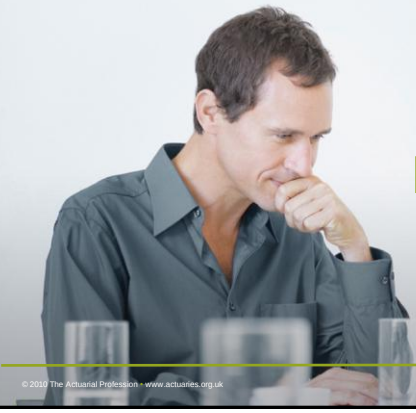
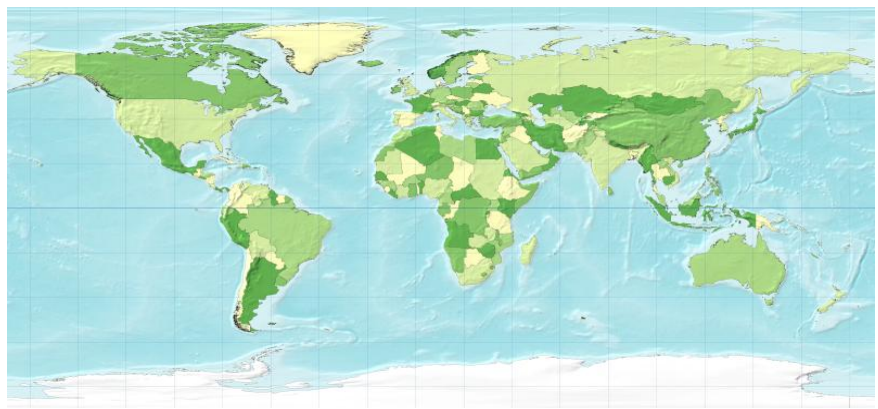
The Actuarial Profession
making financial sense of the future

Climate Change & Resource Depletion: The Challenges for Actuaries
Dr Aled Jones FRSA

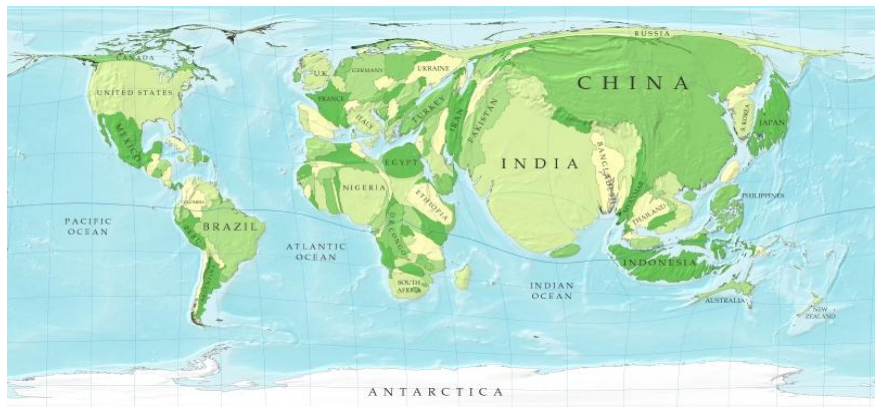


Resource Constraints
Sharing a finite world

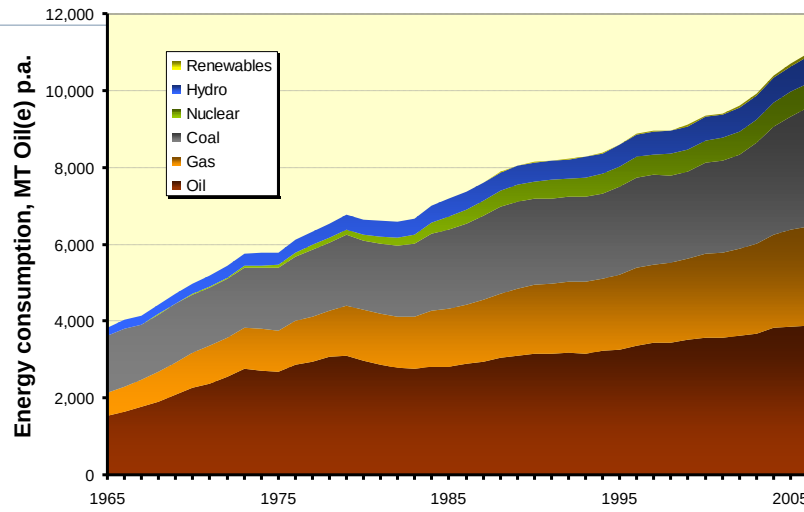
Resource constraints: sharing a finite world



A growing world population

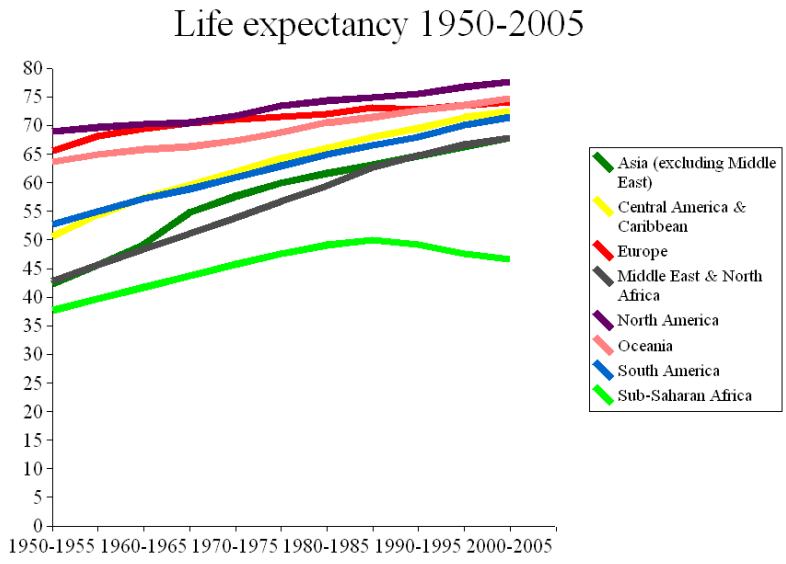


Global energy consumption

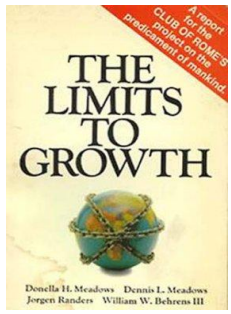


BP Statistical Review of World Energy

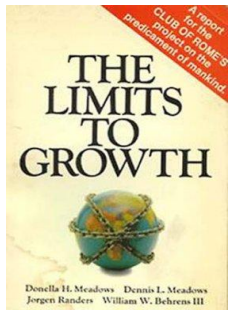
A positive outcome

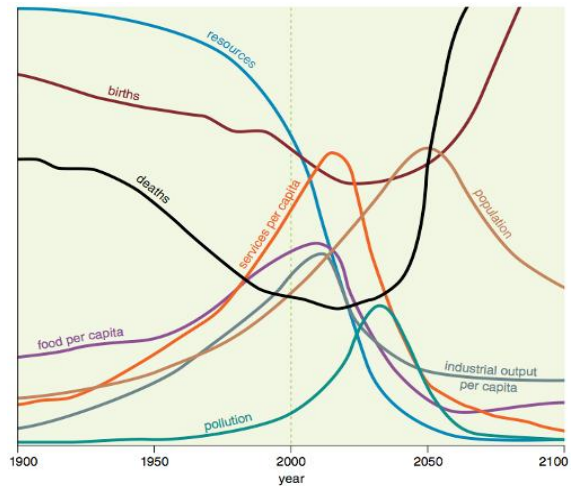


Limits to Growth: 1972 – 2012



Limits to Growth: why it matters



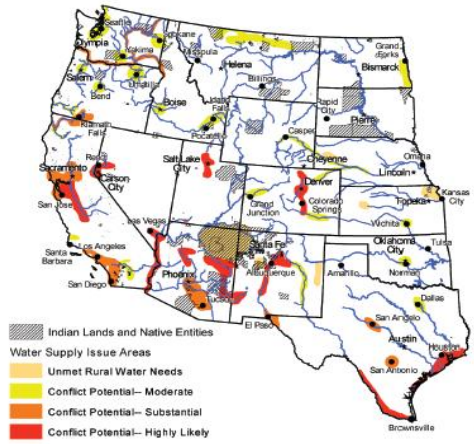


Limited resources

Integrating systemic risks

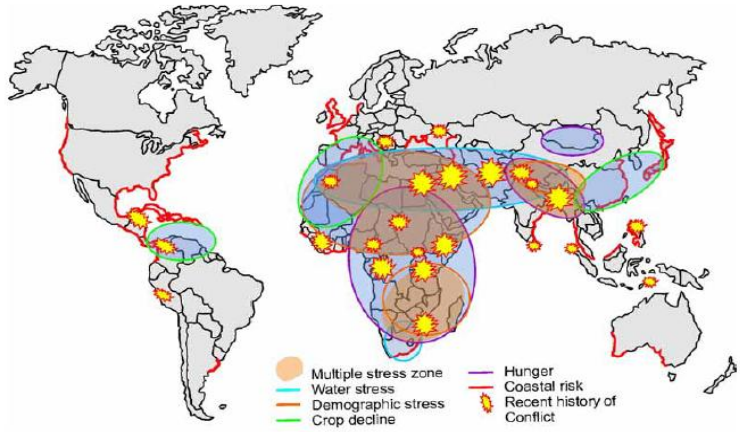
- Insurance companies and businesses of all types consider ‘what if’ possibilities in their long-term planning
- Risk is much more than historical volatility and correlations between assets
- The market is full of behavioural mishaps and is short-term in focus; we regularly overlook systemic risks (aka technology bubble, corporate governance failures, the credit crisis…resource constraints?)

Hidden risks



2025 water stress in the US: increased risks to municipal bonds and corporate lending
(Ceres report: The Ripple Effect, 2010)

Security and correlated resource constraints

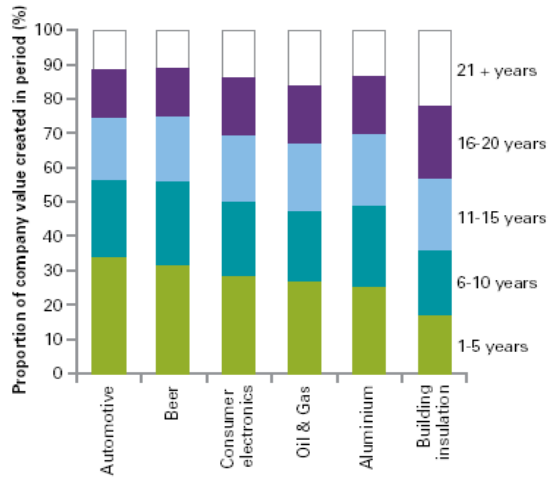


Multiple Stress Zones: Instability is likely to be greatest in areas of Multiple Environmental Stress
Source: The DCDC Global Strategic Trends Programme 2007-2036 (UK Government Ministry of Defence

Physical impacts of climate change

Region	Physical effects	Economic consequences
Africa	Water scarcity; Food and agricultural production declined	Food shortage, malnutrition, major adaptation costs, fisheries and tourism declines
Asia	Central, East and South-East Asia vulnerable to flood	Major flood events coastal areas, disease and deaths. Major reversal of development and urbanisation
Australia	Drought, flooding, fire and death of coral reef	Fall in commodity output / yield, reduce tourism, increase expenditure on disaster mitigation
Europe	Southern Europe faces extreme heat and drought. Glacier retreat and rising temperature in Northern Europe. Higher water stress and heat waves in Central and Eastern Europe	Reduce in crop yields in southern Europe and increase deaths and migration north. Increase yields in northern Europe but winter floods causes greater instability
North America	Coastal city flooding, increase in heat waves and fires, rising pollution levels and intensity of tropical storms	Increase in crop yields in early decades in some regions, coastal city flooding places real estate at high risk, major expenditure on mitigation
Latam	Desertification of agricultural land, rising sea levels increase flood risk, disappearance of glaciers	Increase in soybean yield in drier areas. Food security major risk and major adaptation expenditure needed

Value and resource constraints



Source: Carbon Trust and McKinsey & Co. analysis.

Note: Analysis based on discounted cash flow valuations of hypothetical but typical companies, based on typical company discount rates.

Implications for sectors

- Climate change and resource constraints change the economic and business landscape
- Produces risks and opportunities
- Understanding how trends in resource constraints potentially impact finance and investment is critical

A complex system

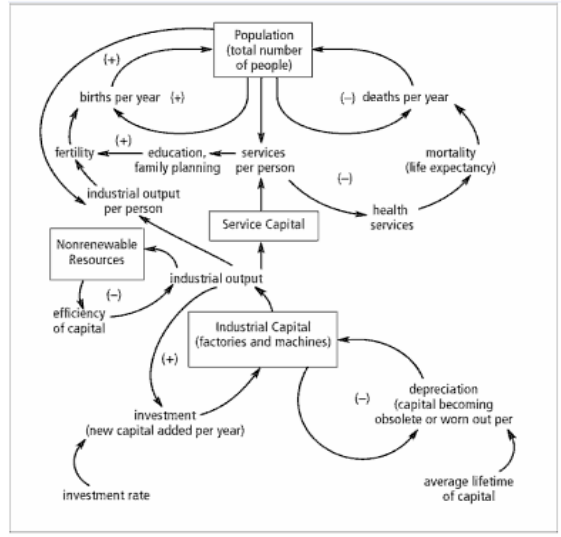


FIGURE 4-6 Feedback Loops of Population, Capital, Services, and Resources

A correlated system?

Prices in US $ over the Last 25 Years

Oil

Coal

Source: Indexmundi

Commodity Price Indices

Food

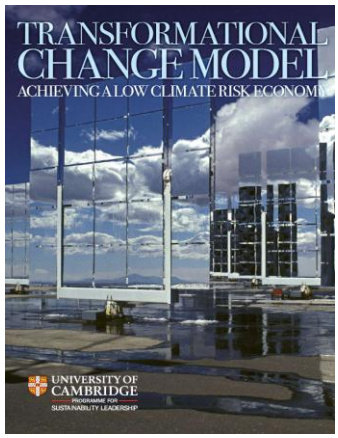
Metals

Source: Indexmundi

Research questions

- Taking a systems view of the natural and social (human) capitals what do scarce resources potentially mean for the system flows in a global economy and in particular to financial capital?
- How do these system flows interact with the financial system and what does this imply for particular actuarial issues?

Building from Climate Scenarios



- **Shut Down**
  - Severe limitation of all emission sources by 2020, and massive capital investment in known technologies
  - Risk of climate change mitigated and little adaptation required
- **Task Manager**
  - Scale back emissions through targets in developed and developing countries
  - Significant climate impacts still seen and need adaptation
- **Work Offline**
  - No political agreement, with efficiency measures and limited investment in renewables for economic and energy security concerns
  - Risk of runaway climate change; large capital investment in adaptation measures (reactive); water availability increasingly problematic; larger risk from regional and global conflicts

To start ….

- The economics of “limits to growth” and what is meant by economic growth
- Evidence regarding ‘peak’ oil and other constraints on the net energy input to the global economy, evidence regarding water scarcity impacting local economies and whether pricing of these resources has increased as a result of these constraints
- The capital intensity of modern economies. One of the Limits to Growth key predictions is that as limits are approached they will be experienced as an increase in capital intensity i.e. each unit of production will require more capital input. Is there evidence for this now?

The team

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