The global change challenge

the role of science

Dr Bob Scholes
CSIR Natural Resources and Environment
9 October 2012
Human activities are messing with many aspects of the global metabolism...

Falkowski, Scholes et al 2003 *Science*

**C**: Natural turnover
- Loading due to anthropogenic CO$_2$ emissions

**N**: Natural turnover
- Industrial conversion of N$_2$ to NH$_3$
- Biological N fixation in agriculture

**P**: Flux due to weathering
- Extraction and relocation due to mining

0% → 400%
The present atmosphere has a composition not experienced in the past 0.4 million years (and probably longer)

Spahni et al. (2005), Science 310: 1317-1321
The climate has changed relative to the norm during the period over which human civilisation developed.

Graphic source: IPCC
Humans and their livestock now appropriate a quarter of global primary production.

Source: Social Ecology Institute, Vienna
The world is losing biodiversity 100 times faster than the historical rate of extinction.

- Deletions from the ‘book of life
- Less resilient ecosystems
- Reduction in ecosystem services

See also Global Biodiversity Outlook 3,(2011)
Welcome to the Anthropocene

...the era during which humans are the dominant influence on the functioning of the Earth System
The roots of the problem...

\[ I = P \times A \times T \]

Impact  Population  Affluence  Technology

- Increasing, but at slowing rate
- Increasing, at high and accelerating rate
- Simultaneously creates new problems and helps to solve them

Climate change: a disruption of the global carbon metabolism

stocks in billion tonnes C, fluxes in billion tonnes C/y

Coal, oil, gas 20 000
Vegetation 610
Soils 1580

Atmospheric CO$_2$ 750
+ 3.2 per year

Ocean 39 000

Uptake 91
Release 92
1.7 net flux

Fossil fuels 6.3
Land use 1.6
Photosynthesis 111
Respiration 110

Rivers 1

vegetation 610
Soils 1580
The Southern African climate system

- Equator
- Subtropical descending dry air
- Westerly waves of cold air
- Cold Benguela
- Warm Agulhas
- The Southern African climate system
How will global change affect us?

• No relief for our water shortage problem
  – Supply unchanged or reduced, but less usable

• Human health
  – Heat stress, vector-borne diseases

• Global food insecurity: pressure on South Africa
  – Reductions of cereal, deciduous fruit and livestock production mainly due to rising temperatures

• More frequent natural hazard extreme events
  – Strong winds, big fires, heat waves, heavy rains and coastal floods

• Biodiversity under stress
  – Fragmented habitat, invaded by aliens, and on the move
3 reasons for South Africa to get ahead of the curve

• A carbon-intensive South African economy will hurt our trade in a global economy focused on climate mitigation
• We need to be part of the emerging market in green technologies, especially renewable energy
• Anticipation and planning will help to reduce ultimate costs
Mitigation
keeping the world in a safe space
Adapting to what can’t be avoided

3 general principles

1. Leave a safety margin
2. Become a learning society
3. Encourage diversity
   - It spreads the risk and accelerates the learning
The role of the CSIR

- CSIR has been formally involved in global change research since 1992
- CSIR has one of the largest and most diverse pools of global change researchers in Africa
  - Earth System Science, carbon cycle, climate models
  - Impact on water, ecosystems, built environment
  - Solar and biomass energy, land use mitigation
  - Monitoring by remote sensing and *in situ* observation