The science of greenhouse gas reduction targets:

What is needed to avoid dangerous climate change?

The "zero-minus fast, with cooling" target

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Convener

Greenleap Strategic Institute

16 December 2006 (Version 1.g)

Philip Sutton

Summary

- There is too much CO_2 (and other greenhouse gases) in the air now
  - serious damage is *already* occurring
  - there is already a small but unacceptable risk of very large sea level rises and *runaway heating* perhaps leading to a catastrophic 8ºC warming (step change)
- Within a decade we need to achieve zero emissions and we need to take excess CO_2 out of the air as well
- To trigger this huge/fast change governments need to declare a state of sustainability emergency

Rapid zero–minus target

The target presented here is being actively advocated by:

- Greenleap Strategic Institute
- Beyond Zero Emissions
- WREC – Western Region Environment Centre

Basic orientation

Philosophy

- **Double-practicality** – need to get things done, but what is done has to actually solve problem
- ***A commitment to actually achieving sustainability in a timely way***
- ***Natural Step*** – backcast from principles of sustainability
- ***Lean thinking*** – backcast from ideal

Anchor on actually achieving sustainability, fast, with least loss

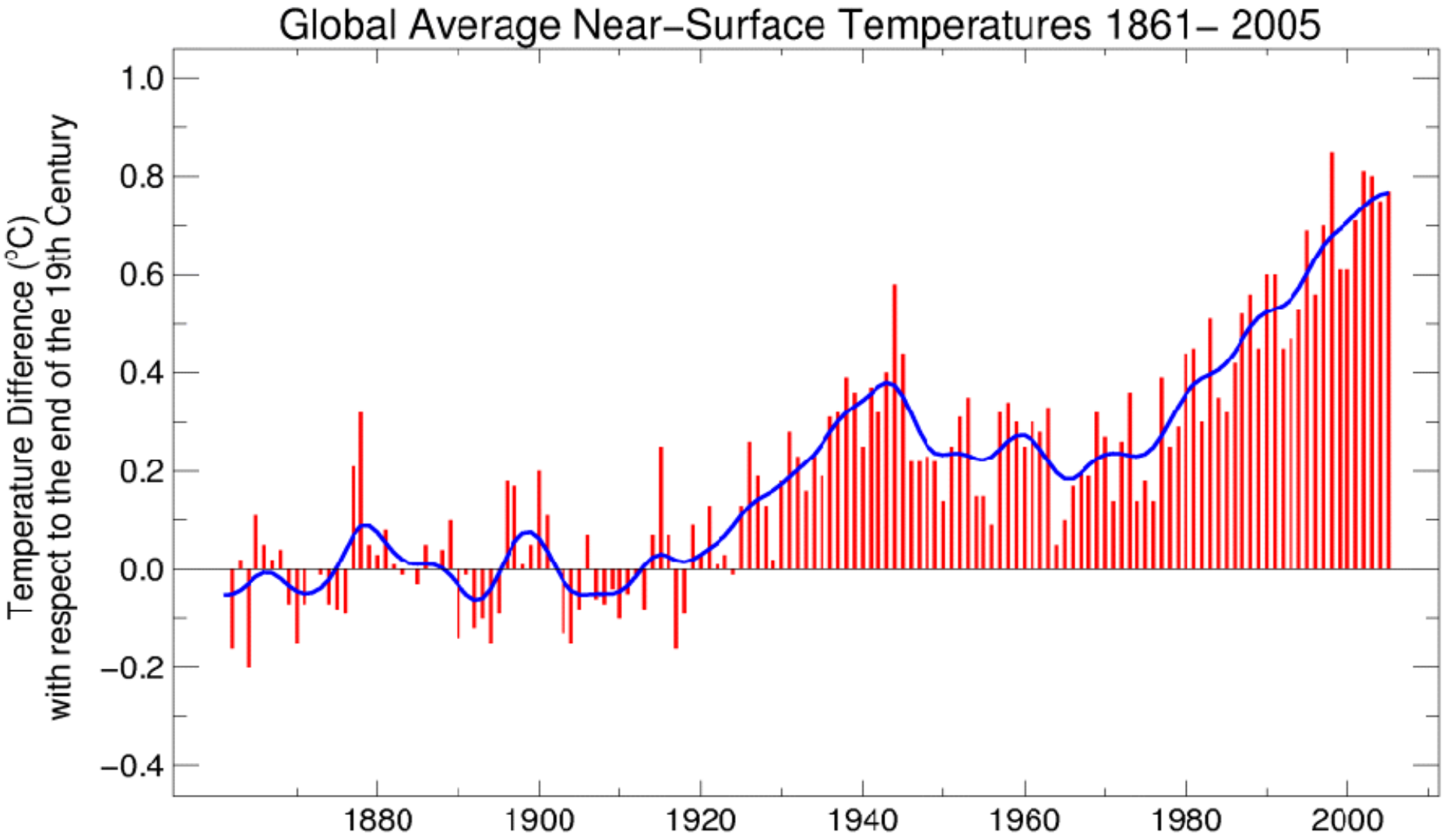
What are we trying to sustain?

- All people and all other species (ethical care)
- Life support systems/ ecosystem/ geosystem services (practical necessity)

The challenge

The challenge so far

Strong Global Warming Observed

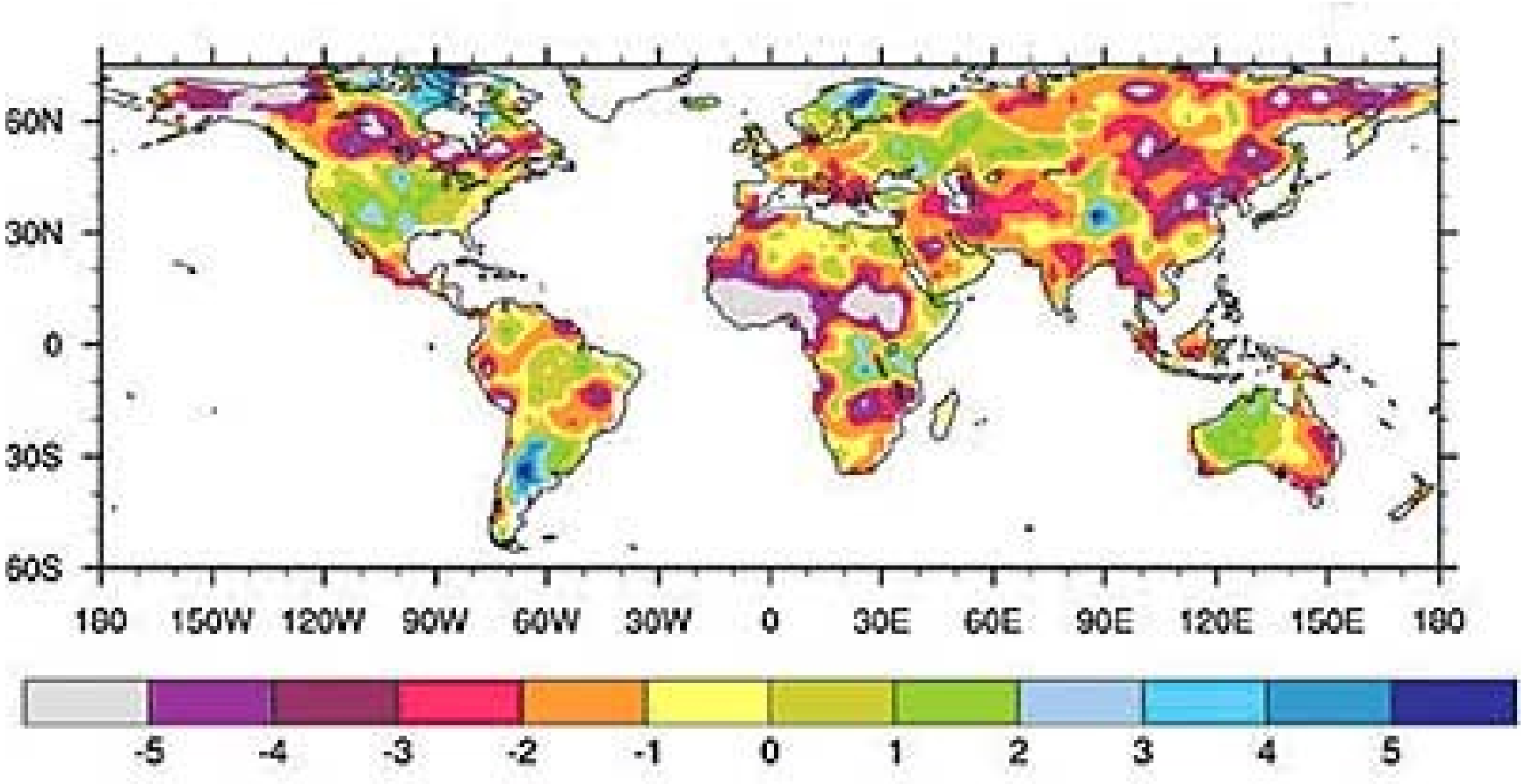


Hadley Centre for Climate Prediction and Research
Based on Folland et al (2000) and Jones and Moberg (2003)

The greenhouse gases already in the air.....

- have caused 0.8ºC warming over pre-industrial
- will cause, *at least*, a further 0.5ºC
- ....thus making a total of *at least* **1.3ºC** warming inevitable (unless CO2 can be take out of the air, or some countervailing cooling process used).

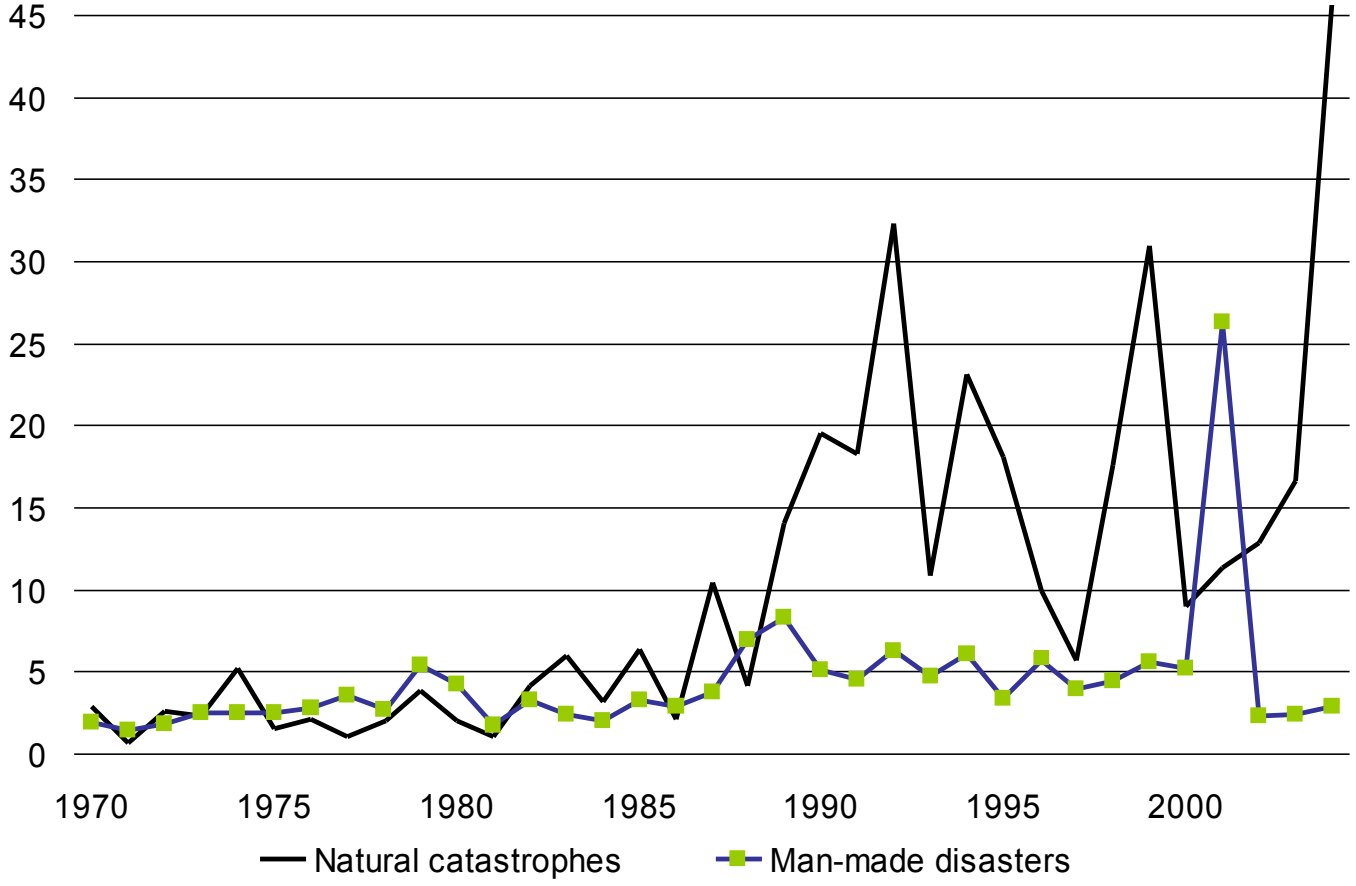
Global soil moisture trends – 1948 - 2002



This depiction of linear trends in the Palmer Drought Severity Index from 1948 to 2002 shows drying (reds and pinks) across much of Canada, Europe, Asia, and Africa and moistening (green) across parts of the United States, Argentina, Scandinavia, and western Australia. (Illustration courtesy Aiguo Dai and the American Meteorological Society.) National Center for Atmospheric Research (NCAR) http://www.ucar.edu/news/releases/2005/drought_research.shtml

Number of flood events by continent and decade since 1950

Global insurance losses 1970 – 2005



Source: Swiss Re sigma no1/2005
www.theclimategroup.org/assets/Bruce%20Thomas%20(06-04%20pm).ppt

Social impacts
from warming up to 1.5 ºC

- Drought/water shortage
- Soil damage
- Damage to ecosystems supporting people – fisheries
- Reduced food production
- Extreme-weather-event damage
- Tension/Conflict (including war)

“We need to treat climate change not as a long-term threat to our environment but as an immediate threat to our security and prosperity” “It is now becoming increasingly clear that it is what we do in the next 15 years that matters most.”

John Ashton, the UK's climate change envoy, 8 September 2006

Challenges to come

Applying the precautionary principle

Known knowns
and known unknowns

2° is too much!

Evidence and Implications of Dangerous Climate Change in the Arctic

WWF International Arctic Programme

January 2005

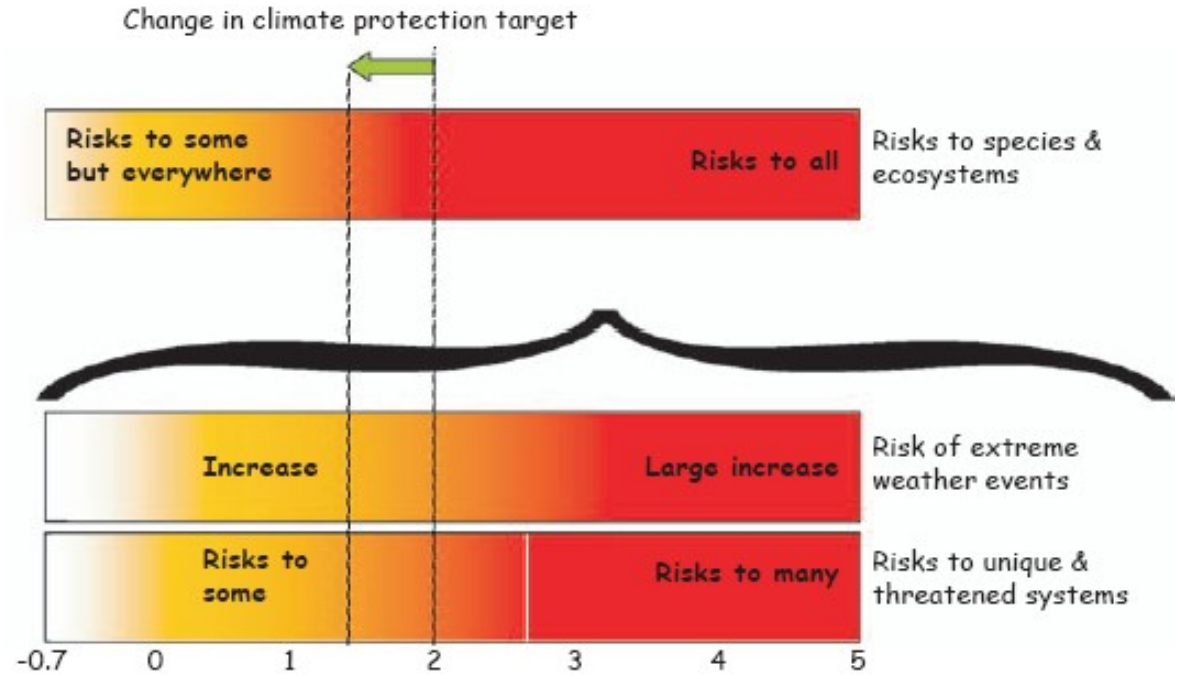
CHAPTER 12

Rapid Species' Responses to Changes in Climate Require Stringent Climate Protection Targets

Arnold van Vliet & Rik Leemans
Environmental Systems Analysis Group, Wageningen UR, The Netherlands

We conclude that a target of 2°C warming is too high.

Based on our current understanding of responses of species and ecosystems, we propose that efforts be made to limit the increase in global mean surface temperature to maximally 1.5°C above pre-industrial levels



Risk of 'irreversible' damage at relatively 'low' levels of additional warming

- Greenland ice sheet (→ 3^{+}m sea rise)
- West Antarctic ice sheet (→ 3^{+}m sea rise)
- Possibly I metre per decade sea level rise as a result

Risk of 'irreversible' damage at relatively 'low' levels of additional warming/CO2 (cont.)

- Species losses (generally but especially acute for cryosphere, coral reefs)
- Ocean acidification (driven by CO2 level, not temp)
- Loss of the Amazon

Risk of runaway warming: some drivers

- Loss of ice reflectivity
- Reduced capacity to absorb CO2 – terrestrial vegetation and marine ecosystems
- Loss of bushland due to fire/drought
- Increased mobilisation of organic carbon – permafrost, soils, peat
- Expansion of dark heat-absorbing forests in Northern Hemisphere high latitudes (if allowed to grow)
- Lack of new regions for intense plant growth
- Decreased cloudiness
- Mobilisation of methane hydrates

Effect of runaway warming – without major methane hydrate mobilisation

- 8^{+} metres sea rise over 100 years
- $1/3^{+}$ of all land desert and unusable for agriculture
- high famine levels and many 100s of millions of environmental refugees
- acidification of the oceans
- 60% species loss
- many significant regional wars (with risk of escalation globally)
- economic collapse –worse than the1930s Depression – and not letting up for many decades

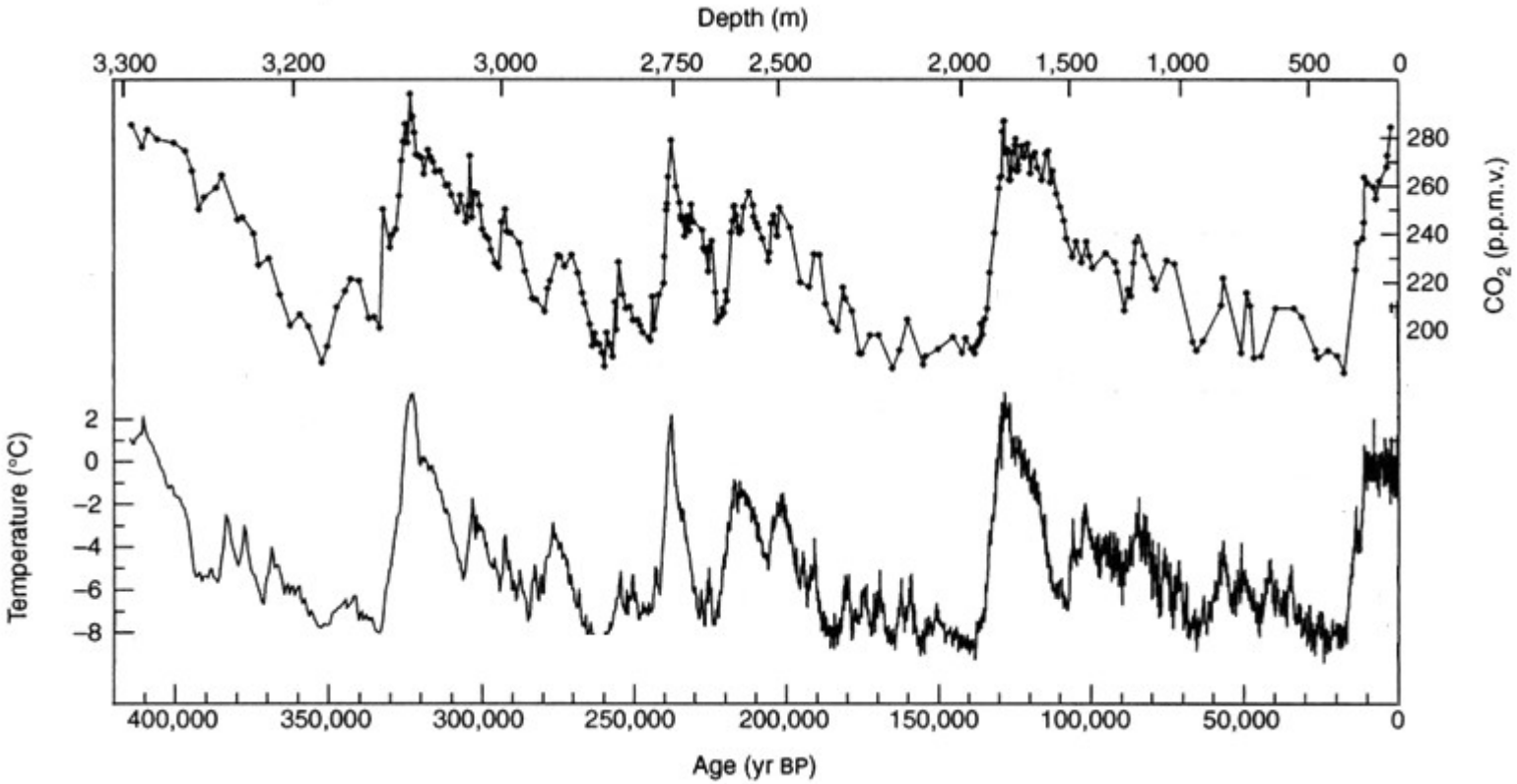
Effect of runaway warming – with major methane hydrate mobilisation

- 55 million years ago (PETM) is one possible analogue
  - 90% species loss
  - Vast increase in deserts, most of land not able to support agriculture at all
- Now most poor people would have to relocate (towards Arctic Circle?)
- Now carrying capacity for the poor would be very dramatically reduced – to say1/10?
- Major wars and huge death rates from many causes

Unknown unknowns,

complete surprises

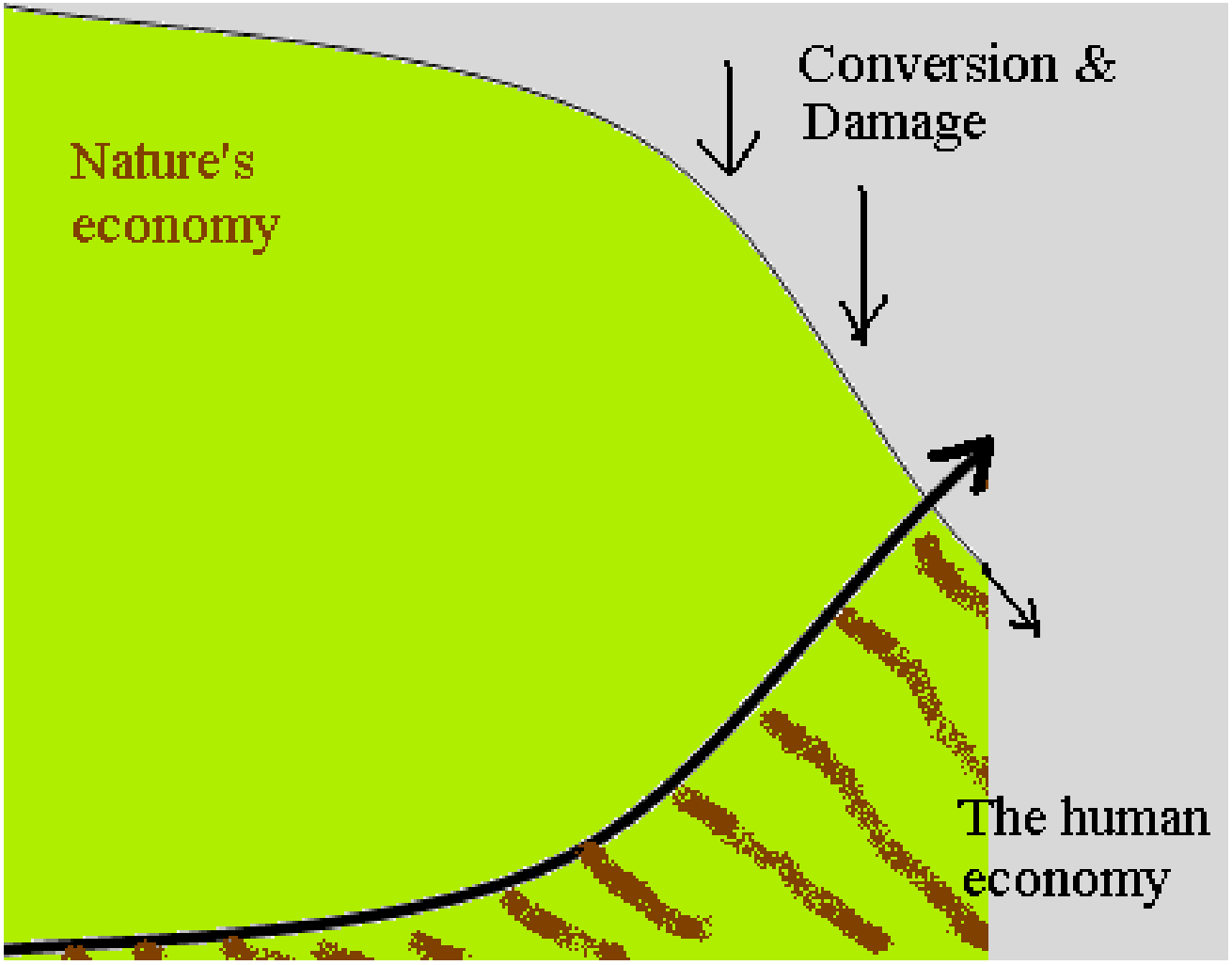
400,000 year record of CO2 and temperature



Petit, J. et al. (1999). *"Climate and atmospheric history of the past 420,000 years from the Vostok ice core, Antarctica"*, Nature, Volume **399** Number **6735** Pp. 429-436.

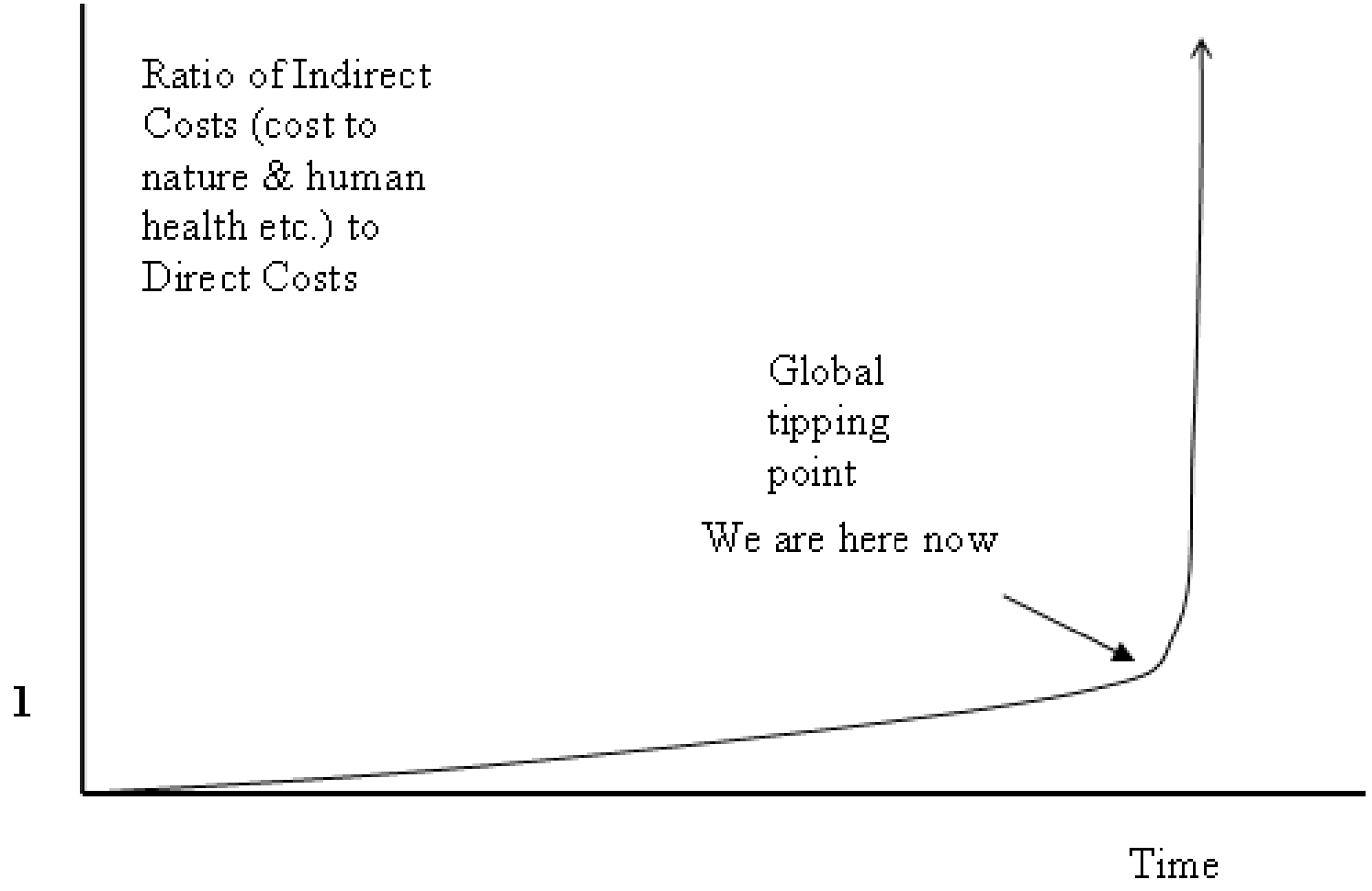
Goal setting framework

Conversion of Nature's economy to the Human economy



Hyper-exponential switch in the ratio of Indirect vs Direct Costs of developments

as nature's economy shrinks and human economy grows



Scoping needs

- Future state conditions
- Scale of change
- Speed of change

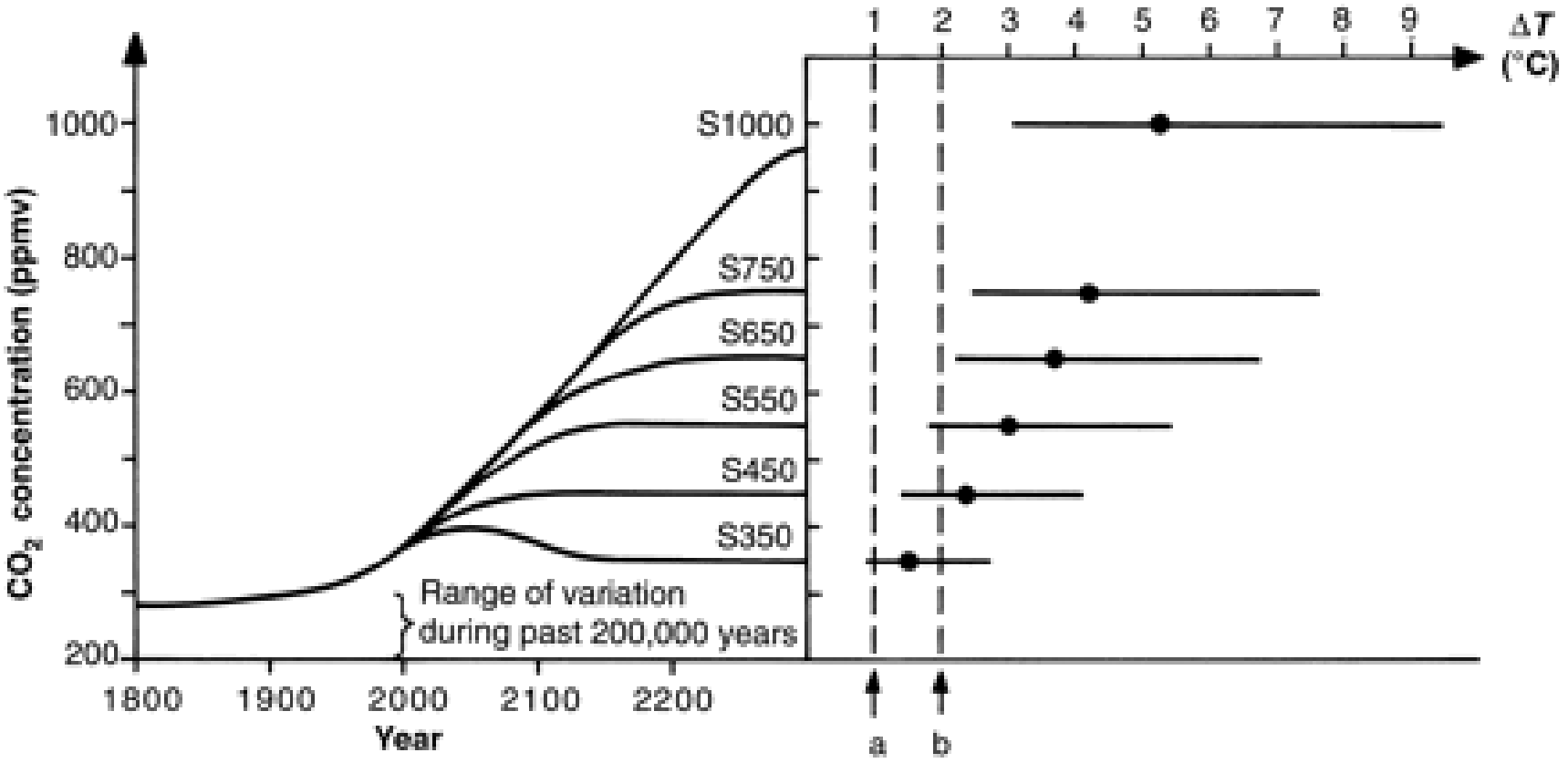
Dangerous Interference in Climate vs Dangerous Climate Change

- Dangerous (or catastrophic) climate change causes unacceptable impacts
- Dangerous interference in the climate is warming that creates an unacceptable risk (*possibility*) of unacceptable impacts

Appropriate risk philosophy

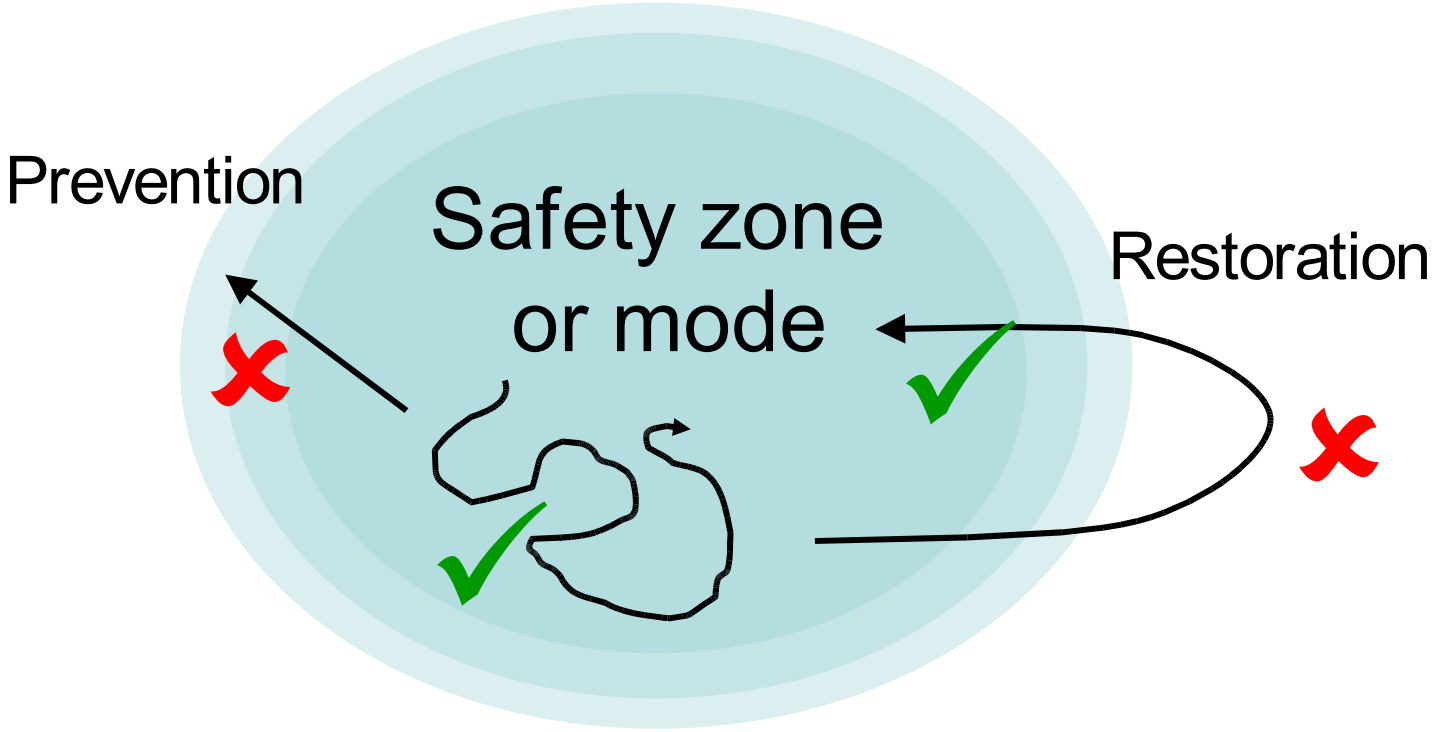
- Given that we have only one planet, which we cannot afford to ‘crash’, we need to use the same level of risk as is accepted for aircraft performance or chemical or nuclear plants
- US EPA & Nuclear Regulatory Commission standard is no more that 1-in-one million risk ie. much less than 1%
- Current actual practice in the US is to have 1 fatality for about 2000,000,000 flown miles
- Allowing runaway greenhouse warming is, for the earth, the equivalent of crashing an aircraft with very few survivors

Global average surface equilibrium temperature change for various stabilization targets.



Source: Azar, C., & Rodhe, H., 1997. Targets for Stabilization of Atmospheric CO2. *Science* **276**, 1818-1819. . Dashed line *a)* refers to an estimate of the maximum natural variability of the global temperature over the past millennium, and dashed line *b*) shows the 2°C temperature threshold.

Homeostatic management



Dynamically creating/maintaining a state of sustainability

- prevention (eg. Natural Step principles)
- recovery/restoration

What are the chances of *exceeding* a range of temperatures at a particular level of CO2 equivalent?

0.8°C now, plus further >0.5°C* in pipeline

490?

PPM CO_2e	Acid	1.5°C	2°C	3°C	4°C	5°C	8+°C
300			?	(most likely 0%)	(most likely 0%)	(most likely 0%)	0%
350		?	?	?	?	?	?
400		50%	57%-**33%**-13%-8%	34%-**3%**-1%-1%	17%-**1%**-0%-0%	3%-**0%**-0%-0%	?
430		We are here	We are here - according to Stern Review		We are here - according to Stern Review		
450		100%	78%-**78%**-38%-26%	50%-**18%**-6%-4%	34%-**3%**-1%-0%	21%-**1%**-0%-0%	?
500		100%	96%-**96%**- 61%-48%	61%-**44%**-18%-11%	45%-**11%**-4%-2%	32%-**3%**-1%-0%	?
550		100%	99%-**99%**-77%-63%	69%-**69%**-32%-21%	53%-**24%**-9%-6%	41%-**7%**-2%-1%	?
Species loss		?	15-40%	60%	90%	90%	90%
Runaway warming to ~8+°C		No	No	Maybe	Yes	Yes	Yes
Mode of climate change		Serious	Dangerous	Catastrophic			

Temperature probability data in the range (400 < = > 550 ppm and 2°C < = > 5°C is from Stern Review 2006, Box 8.1, Part III, p. 195. The clusters of four percentages are probabilities generated by a range of models that have, from left to right: (a) the highest estimates, (b) The Hadley Centre ensemble (more recent and towards the higher end), (c) the IPCC TAR 2001 ensemble, and (d) the lowest probabilities. The probabilities for a 1.5 °C warming at 400 ppm CO2e has been taken from Azar and Rodhe (1997).
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According to Prof. Danny Harvey, University of Toronto, the *current* (late 2006) level of carbon dioxide equivalent is: *~490 ppm*

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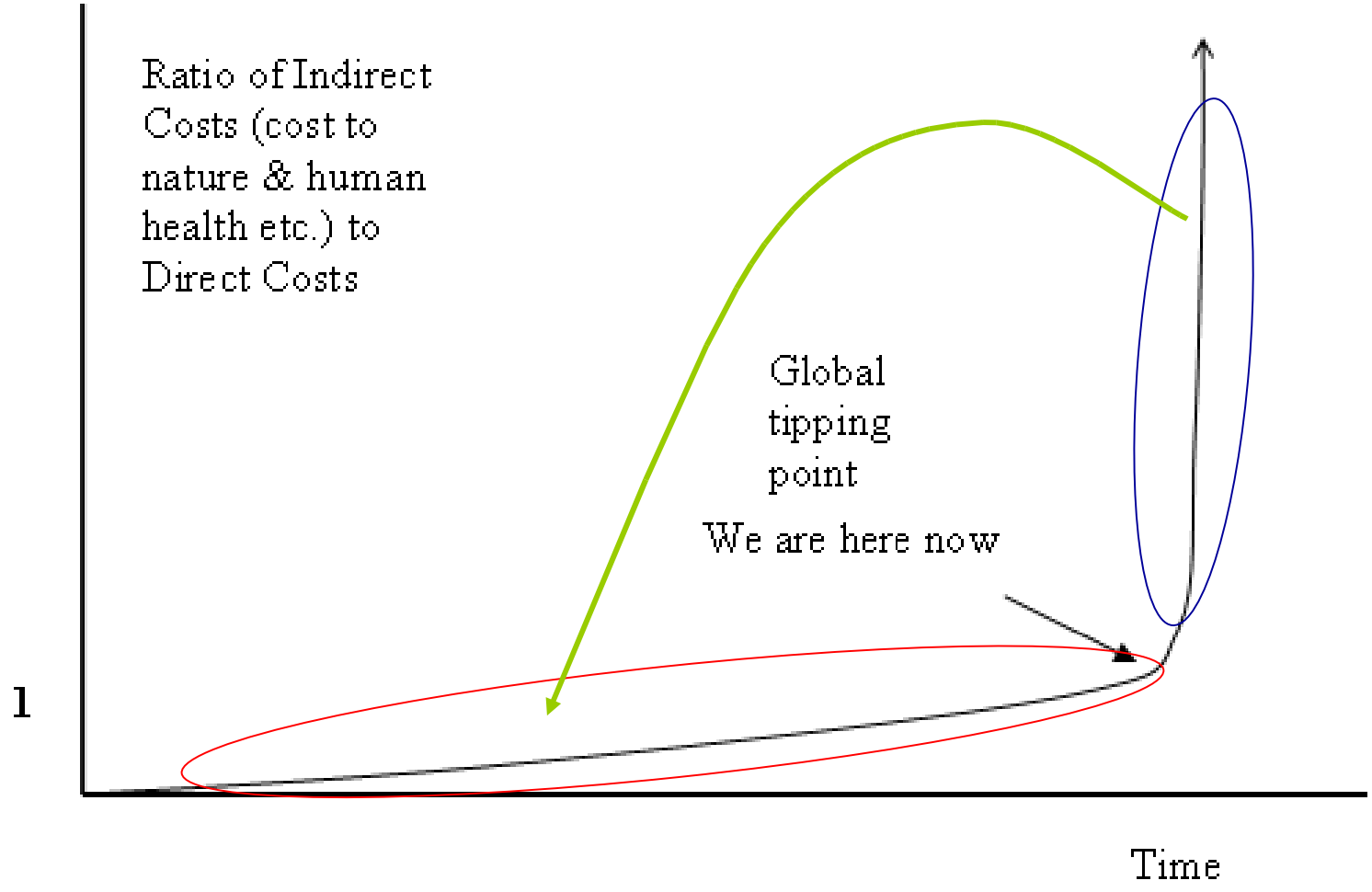
There is huge momentum in the economy to put more greenhouse gases into the air

- 450 CO_2e will be reached in less than 10 years
- makes it almost certain that 2ºC warming will be exceeded
- ***and*** puts the world's oceans right on threshold for dangerous acidification
- ***and*** adds to the existing small but unacceptable risk of runaway heating.

(* According to Prof. Danny Harvey, University of Toronto:
the ***current*** level of carbon dioxide equivalent is: ***490 ppm***)

Hyper-exponential switch in the ratio of Indirect vs Direct Costs of developments

as nature's economy shrinks and human economy grows



Strategic versus tactical targets

Strategic targets

- to be achieved ultimately
- to guide strategies development (as opposed to framing of tactics)
- to underpin education

Tactical targets

- to get things moving

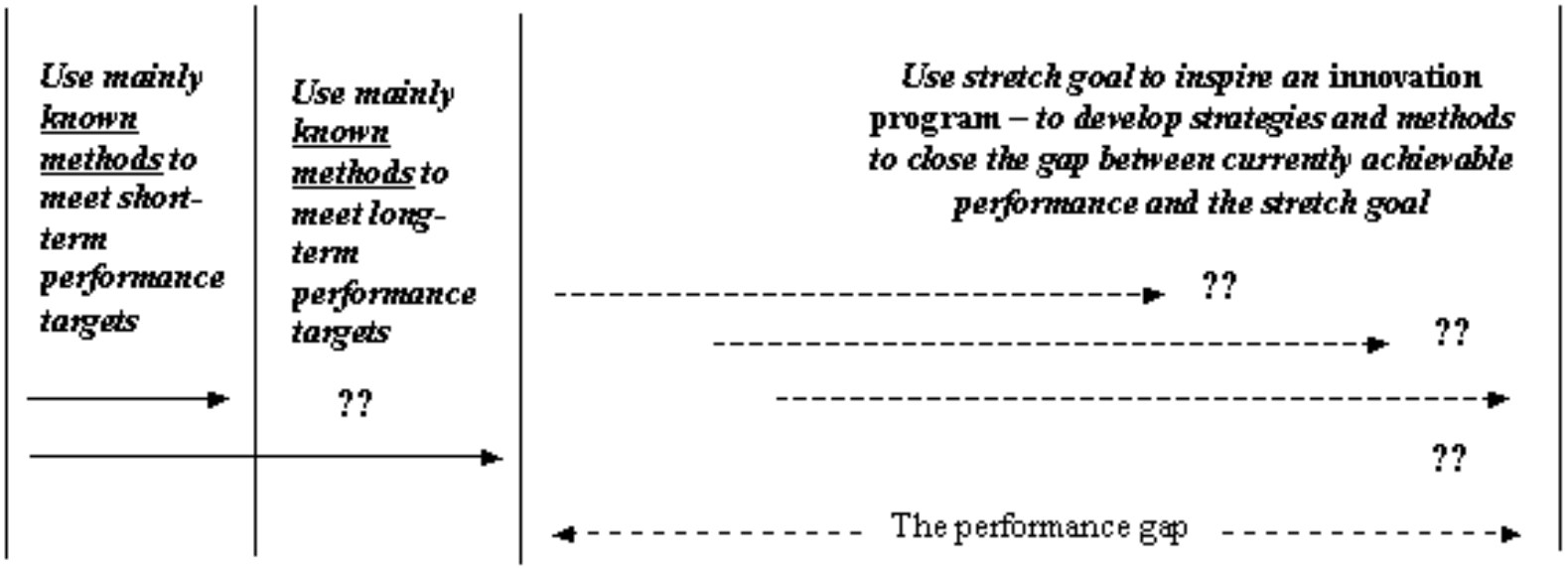
If goal is critical, take account of feasibility/cost

- in action plans and innovation processes
- NOT in strategic targets

Take account of risk of falling short on practical action by:

- Going for tougher goals, and/or
- Taking more actions than are apparently needed to achieve the goal.

Using stretch goals



The preferred strategic targets

Zero-Minus, Fast
with active cooling?

Prevent:

- Zero anthropogenic CO_2 emissions – now

Restore:

- Remove CO_2 from the air – to get back to temperature norm for last 12,000 years – over time go to below 400 ppm CO2e?

Manage transition:

- Consider low environment impact ways to directly cool the earth (to prevent runaway)

Speed

Physical changes needed ASAP

- We need to make the bulk of the change in 10 years

Comparisons:

- Sth Korea industrialised in 20 years
- US converted consumer economy to war economy after Pearl Harbor in 12 months

What targets **won't** work?

- UK, SA, Vic target of 60% by 2050
- New Mexico target of 85% reduction by 2050 / California target of 80% by 2050
- UK FOE/George Monbiot 90% for developed countries by 2030
- Any targets that are less strong than these!

Making it happen

To trigger effective change....

- We need to get a formal declaration of a sustainability emergency – ASAP
- The emergency needs to be premised on a zero-minus target with an immediate turn-around decade to make the bulk of the big physical changes in CO_2 emissions.

Suggested personal action

- Adopt the zero-minus fast goal personally
- Spread the goal around as a “without prejudice” scenario
- Advocate the goal to other people and organisations
- Do the same for the idea of declaring a formal ‘sustainability emergency’

The end.

Thanks.

These scientific papers reach the same basic conclusion as that articulated in this presentation

Author: Prof. Danny Harvey, University of Toronto:

- "Allowable CO2 Concentrations Under the United Nations Framework Convention on Climate Change as a Function of the Climate Sensitivity PDF", Environmental Research Letters (submitted). http://www.geog.utoronto.ca/info/facweb/Harvey/Harvey/aspapers/HARVEY_
- "Plausible resolution of uncertainties in global-warming science has no near-term practical implications for climate policy ", Climate Policy (submitted). http://www.geog.utoronto.ca/info/facweb/Harvey/Harvey/aspapers/HARVEY_
- "Dangerous anthropogenic interference, dangerous climate change, and harmful climatic change: non-trivial distinctions with significant policy implications", Climatic Change (in press) http://www.geog.utoronto.ca/info/facweb/Harvey/Harvey/aspapers/HARVEY_