# Climate Change, Globalization and the Uncertain Future of Cities

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# Problem Context:
# Excessive Scale: A World in Overshoot

- GHGs are accumulating
- climate is changing
- soils are eroding
- deserts are expanding
- tropical forests are shrinking
- oceans are acidifying
- sea levels are rising
- fresh waters are toxifying; marine 'dead zones' are expanding
- the seas are over-fished
- biodiversity is plummeting (etc., etc.)

## Bottom line:

***a) The human enterprise already exceeds the long-term carrying capacity of Earth; that is, material production, consumption and waste generation exceed the regenerative and assimilative capacities of the ecosphere;***

***b) We are 'financing' the growth of the human enterprise by liquidating essential natural capital upon which we depend for long-term survival.***

# The Global Picture: *Overshoot*

World GDP has increased 100-fold since 1800

2014 human eco-footprint:
19.0 billion hectares (2.6 gha/cap)

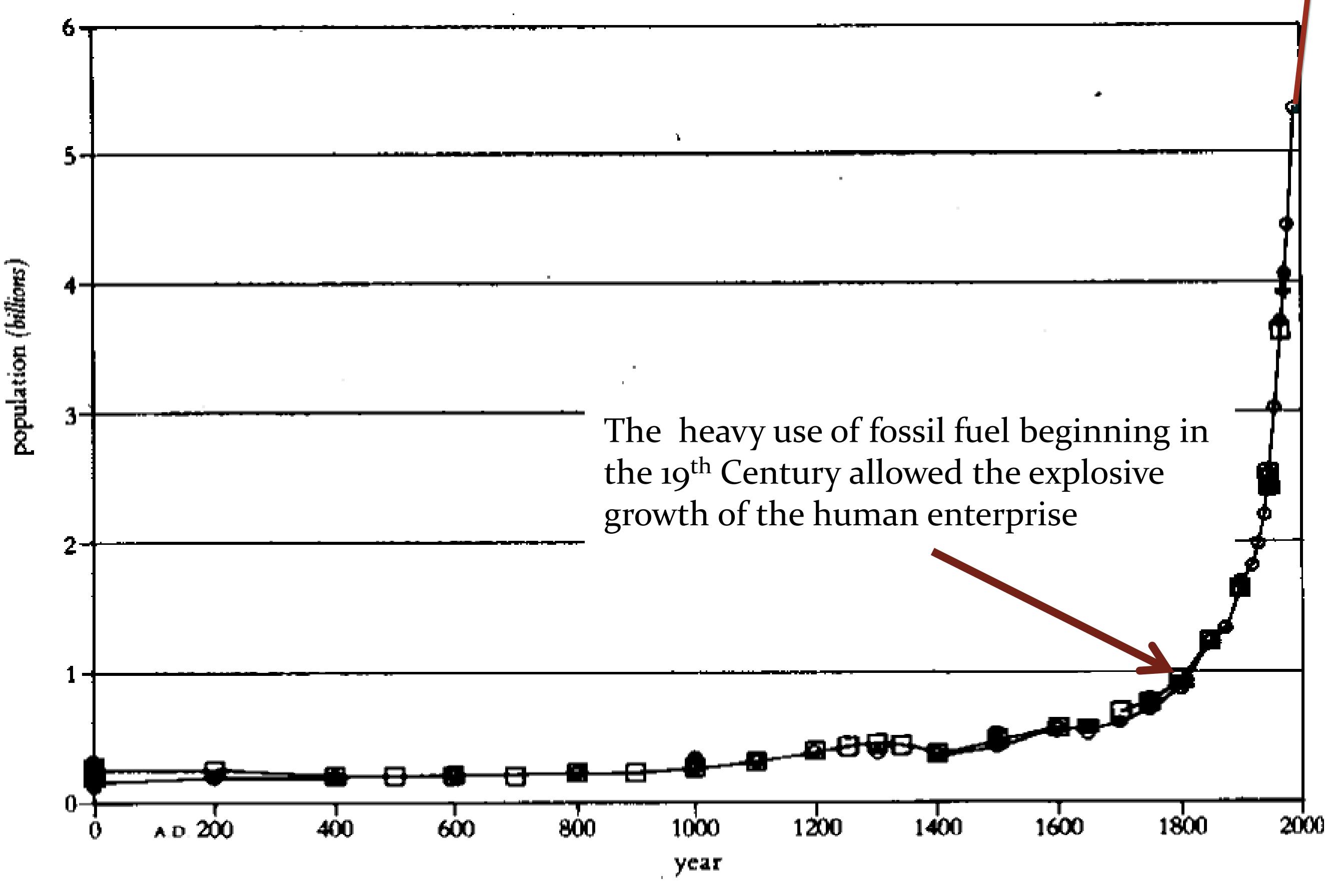
2014 global biocapacity:
12.0 billion hectares (1.7 gha/cap)

**= 58% OVERSHOOT**

NB: Everyone is competing with everyone else for the shrinking bio-capacity of Earth.

# The Proximate Driver: The anomalous, unsustainable, **oil-based** exponential expansion of the human enterprise on a finite planet

July 2018 population: 7.6 billion

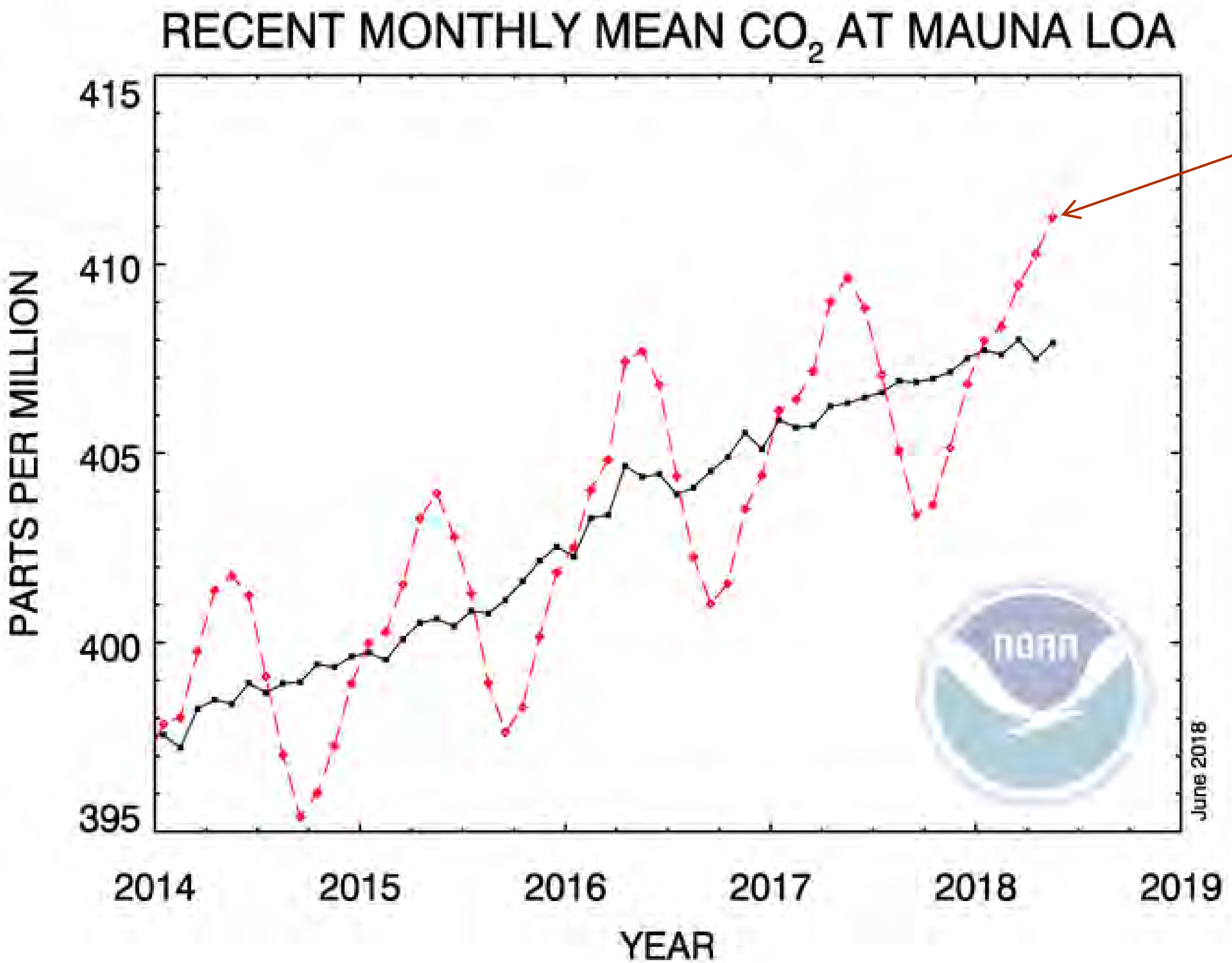



The heavy use of fossil fuel beginning in the 19th Century allowed the explosive growth of the human enterprise

**A four-fold expansion (from 1.5 to 6.0 billion) in the 20th century alone.**

Continuous growth—population and economic—is an anomaly. The growth spurt that recent generations take to be normal is the single most abnormal period of human history.

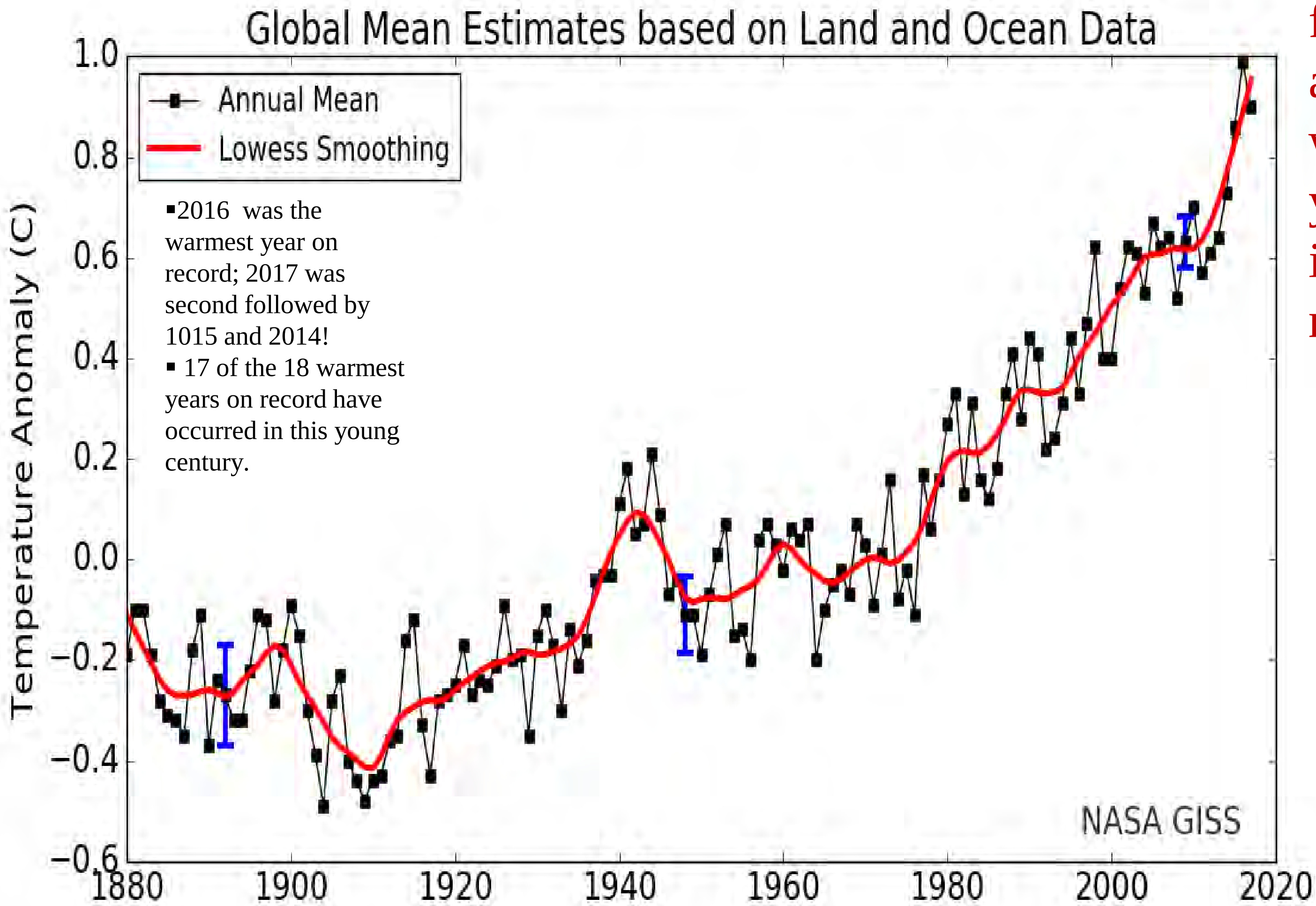
# One Result: A 45% increase in atmospheric $CO_2$ over the pre-industrial level of 280 ppm




May 2018 average concentration = 411.3 ppm $CO_2$.

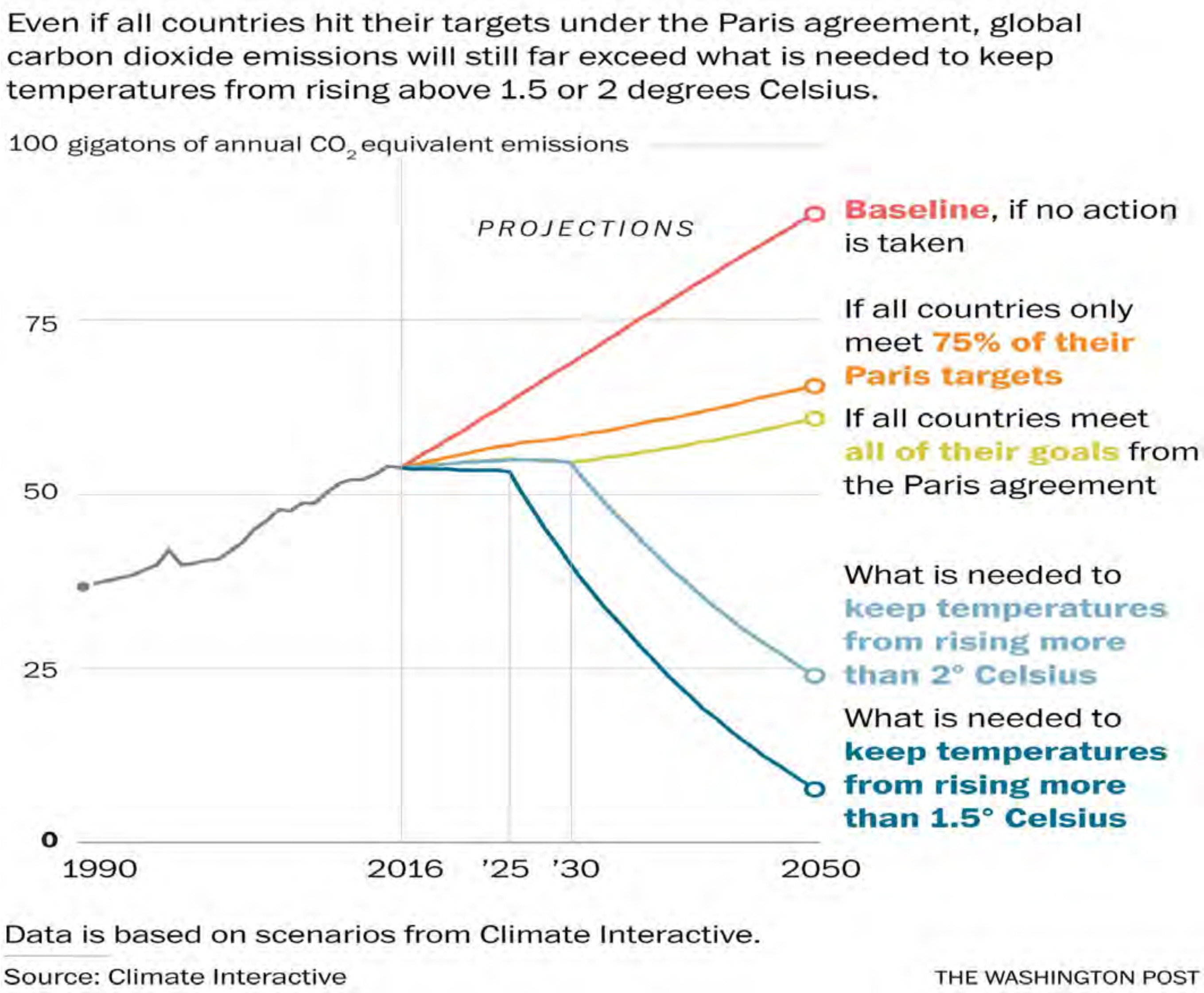
NB: $CO_2$ is a contributing driver to climate change.

# Rising Mean Global Surface Temperature



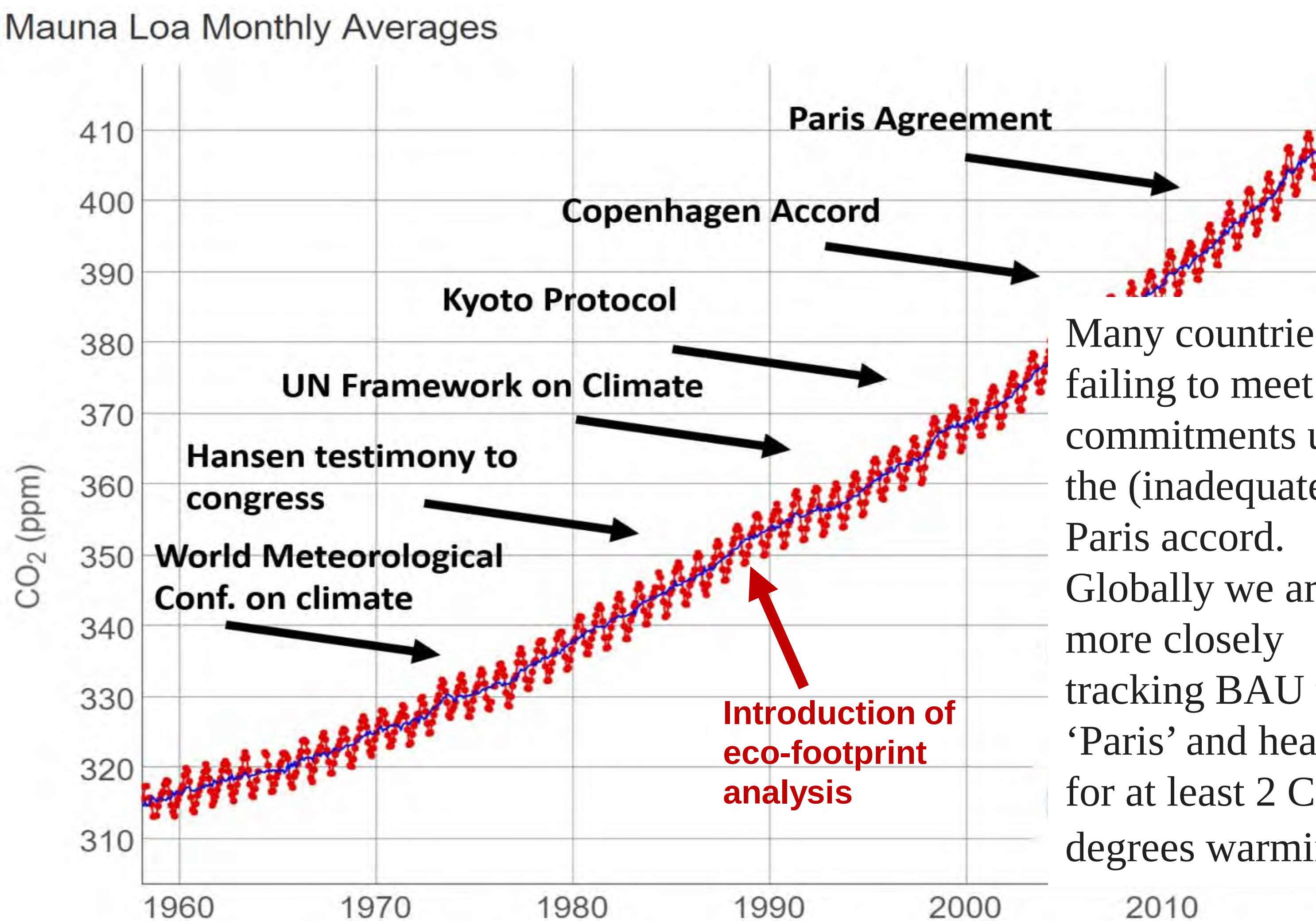

The past four years are the four warmest years in the instrumental record.

# Official emissions targets are not enough to cool the planet




Only four of 38 economic sectors are on target to meet Paris accord.

# International agreements make little difference (no threat to the *status quo*)




Many countries are failing to meet their commitments under the (inadequate) Paris accord. Globally we are more closely tracking BAU than 'Paris' and heading for at least 2 C degrees warming.

# Driving Climate Change: Cities, Consumption and Biocapacity

- A city is a spatial node of intense energy and material consumption and waste generation;
- The necessary resources and resultant wastes depend on a corresponding external area of productive and assimilative ecosystems typically *200-1000 times larger than the city's political or geographic area.*

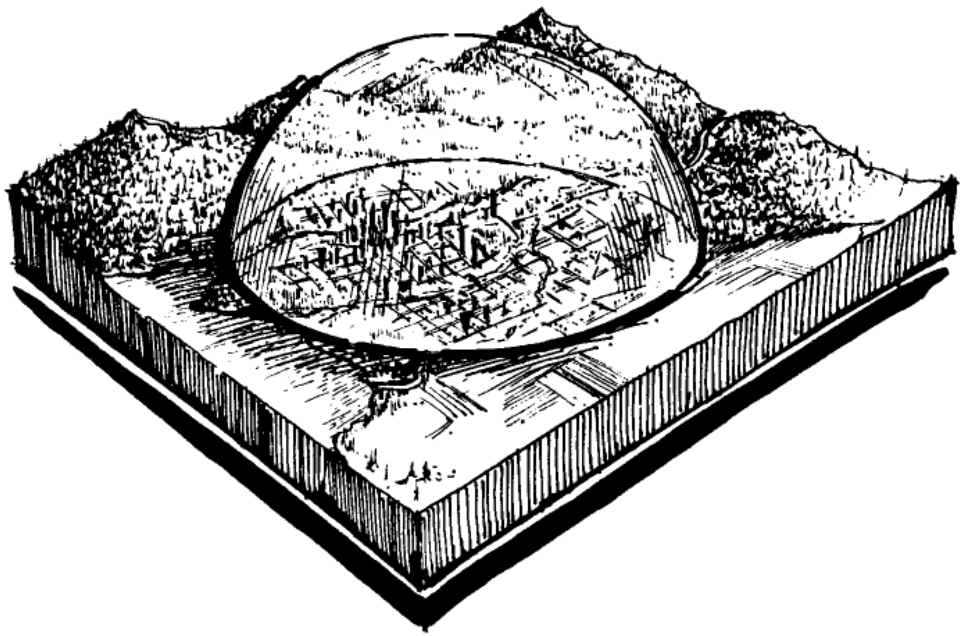
**This extra-urban area represents the city's demand for *bio-capacity* and represents its true 'ecological footprint'**

# The Human Ecological Footprint: An area-based index of consumption and (un)sustainability

- A population's eco-footprint (EF) is ***the area of land and water ecosystems required, on a continuous basis, to produce the bio-resources that the population consumes and to assimilate the carbon wastes it produces, wherever on Earth the relevant land/water is located*** (Rees 1994, 2013).
  - Average human eco-footprint: 2.7 global average hectares (gha)
  - Average North American eco-footprint: 6.5 gha/cap
  - Available bio-capacity on Earth: 1.7 gha/cap

An eco-footprint of 1.7 gha/capita corresponds to sustainable 'one-planet living'. Japanese citizens use 2.6 times and North Americans almost four times their 'equitable share" of bio-capacity!

# Corollary: ‘Sustainable city’ is an oxymoron



Keep in mind: “Civilization is only three square meals away from anarchy” (anon.)

- Globalization and trade have made every country and urban region dependent on other regions for some key resources;
- Cities are therefore increasingly vulnerable to global change;
- Isolated from its external ‘footprint’, any modern city would simultaneously starve and suffocate;
- Climate change, energy shortages, geopolitical discord, etc., all have the potential to destroy transportation links and isolate cities from their life-support hinterlands.

# The Ominous (but all too typical) Case of Tokyo

- Population: 38 Million (approx. 30% of Japan’s pop)
- Total eco-footprint at 4.5 global ha/capita: ~ 171,000,000 gha

Tokyo’s eco-footprint is about 363 times larger than the metro-region, 4.5 times the area of Japan and  2.2 times larger than the nation’s domestic bio-capacity.

How would Tokyo (or Japan) respond if cut off from its increasingly global supportive hinterland?

Another wrinkle: Urban techno-industrial society is a product of, and remains dependent on, abundant cheap energy—mostly fossil fuels.

*Energy is civilization's Achilles' heel*.

# The slow transition: Global energy consumption supply by source (2017)

- **Fossil fuels 85.5%**
- Wind 1.9%
- Solar 0.7%
- Hydro, biomass and nuclear approx 12%

We may be moving away from fossil fuels *but not very quickly* despite the world's (alleged) commitment to decarbonizing by mid-century.

- Of the substantial increase in energy consumption in 2017, 70% was provided by fossil fuels;
- Wind and solar together accounted for only 25% of the increase.

# The Energy-Emissions Conundrum

- Despite progress in renewable energy for electricity generation, there are as yet no adequate substitutes for fossil fuel in key areas—e.g., heating and cooling, inter-city transportation, heavy construction, agriculture—essential to urban living;
- An insufficiently rapid transition to renewable energy implies that the world will remain reliant on fossil fuels, exceed the two Celsius degree warming limit and experience *potentially disastrous climate change*;
- However, if we abandon fossil fuels in the absence of adequate substitutes, *the world will face major energy shortages* (See also Appendix 1).

# A Double-barrelled Threat

- Significant climate change implies changes in agricultural productivity (mostly negative), desertification, sea-level rise, coastal flooding, food shortages, heat waves, mass migrations and geopolitical instability and may make urban life untenable in parts of the world;
- Significant energy shortages imply reduced trade, falling GDP, food and other resource shortages, geopolitical instability, and difficulty in maintaining international and inter-city transportation links. Again, cities are at risk.

# Urbanization and the Energy-Emissions Conundrum

- We may not be able to maintain/provision existing cities let alone accommodate an expected additional 2.5 billion people. Indeed:
- Note that just "building out" cities to accommodate expected urban growth by mid-century would use most of the remaining safe carbon budget.

Question: Will mega-cities (any large cities) still be possible by the end of the century?

# What no one wants to hear

- We are less sustainable today than we were in 1970, less than last year, less than yesterday, regardless of all the "efforts."
- Most of humanity's efforts have been in the wrong direction because those efforts increase rather than decrease overshoot.
- Every day that we continue to grow our numbers and our economies, Earth is poorer, its ecological health reduced and humans are in greater jeopardy.
- *All paths out of overshoot involve contraction*, so unless efforts are helping humanity contract, they are useless to reverse the root dysfunctions.

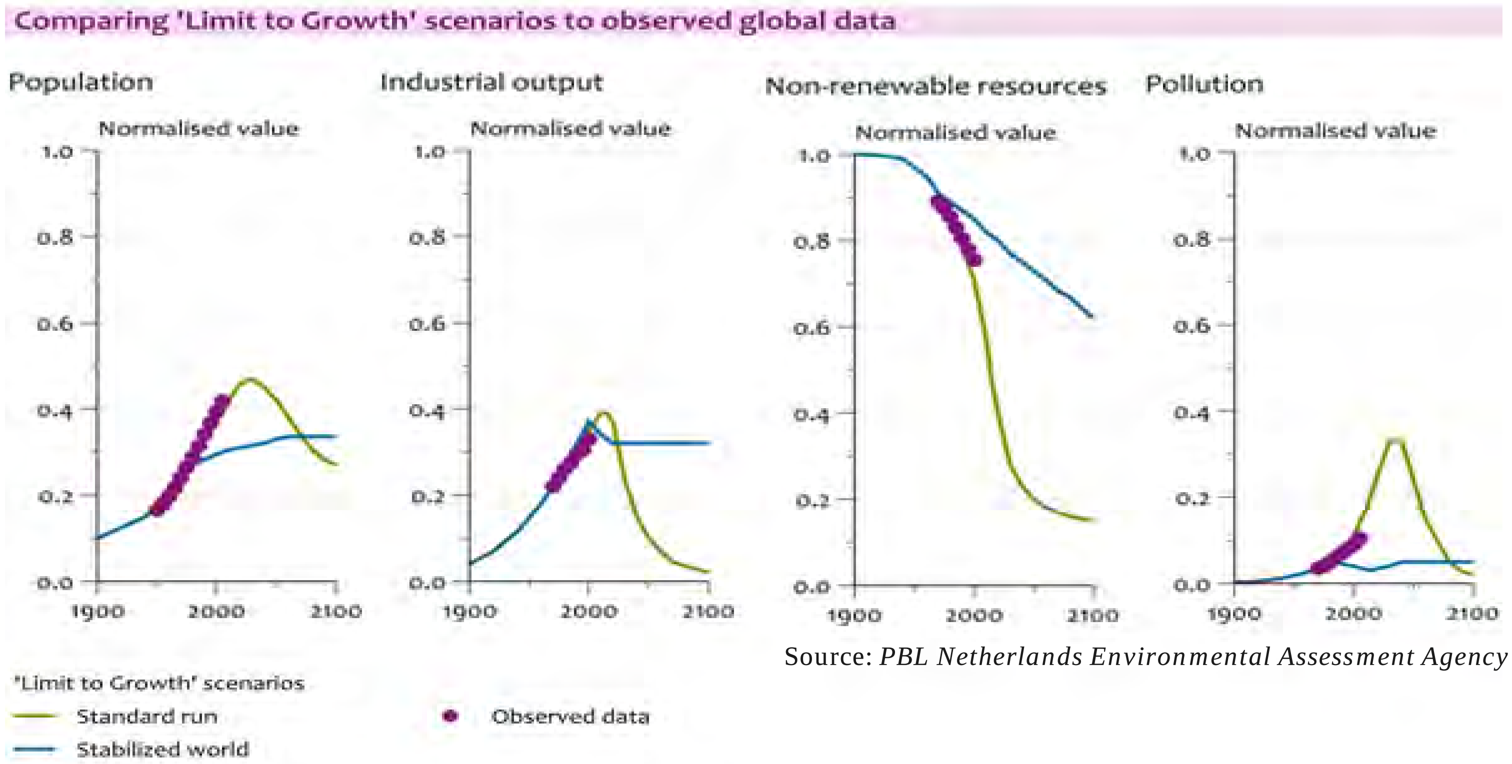
If your 'solution' does not reduce energy and material throughput, it is actually part of the problem.

# What the world community refuses to acknowledge

To act consistently with our best science may well require a planned economic contraction.

Can humanity learn to live more equitably within the means of nature?

# Globally we are still 'business as usual' which puts us on course for collapse




Source: *PBL Netherlands Environmental Assessment Agency*

It wouldn't be the first time: "...what is perhaps most intriguing in the evolution of human societies is the regularity with which the pattern of increasing complexity is interrupted by collapse…" (Joseph Tainter 1995).

# Minimal actions to mitigate the energy-emissions crunch

- Implement serious energy conservation measures to reduce emissions to 'safe' levels and conserve fossil fuels;
- Ramp up investment in renewable energy and infrastructure to two to three times the current total investment in energy;
- Develop an implementation strategy should it become necessary to allocate/ration the remaining fossil fuel budget to essential uses only (e.g., food production, inter-city road transport);
- Prepare for reduced GDP/capita including strategies for income redistribution (climate justice).
- Plan for population contraction. (Japan could become a leader.)

# Additional steps to reduce cities' EFs and their dependence on distant sources

- Rethink 'the city' (and urban governance) as a more self-reliant urban-centred bio-region, incorporating as much as possible of its extended eco-footprint;
- Re-localize local food production/processing; conserve regional farmland; encourage food co-ops;
- Work to re-localize production of other essential goods while maintaining inter-regional linkages; minimize unnecessary travel and shipping;
- Densify urban development to increase efficiency of urban infrastructure—transportation, water, sewage, electrical and recycling systems—and to reduce demand for land;
- Create incentives for housing co-ops and multi-unit housing development; invest in public transportation;
- Implement policies to reduce all energy consumption and eventually eliminate fossil energy consumption;
- Conserve energy and capitalize on economies of scale, e.g., neighbourhood-level technologies, such as electricity co-generation, heat pumps for district heating/cooling, heat extraction from industrial waste heat systems, etc.;
- Invest in multiple/redundant energy systems (wind, solar, hydro, etc.) appropriate to location;
- Encourage low throughput and closed loop industries (through taxes, licencing, positive incentives); when possible use waste material from one industry as feedstock for another; capture waste energy;
- Build to last; penalize planned obsolescence of manufactured goods/physical structures;
- Adopt "One Earth" lifestyles—i.e., "consume less stuff" to reduce per capita demand for energy material, and water resources.

# Appendix 1: Recent simulation studies suggest

- Even if investment in renewables increases to the present *total* investment in energy by 2030, it is insufficient to displace fossil fuels, the emissions ceiling is breached by 2033, fossil fuels still provide more that 50% of primary energy and both fossil fuel use and carbon emissions continue to increase (*and this assumes an optimistic non-declining renewables ERoEI of 15*).
- More realistically, because of necessary investment in storage and grid flexibility, etc., the ERoEI of renewables is likely to decline possibly below viable levels.
- Because of declining ERoEI, the “long run consequence of transitioning to renewables with life-cycle energy returns at sufficient pace to avoid transgressing cumulative emissions limits is a decline in the net energy available to society.”
- “The redirection of investment from the secondary productive sector to the primary energy sector leads to a constraint on the productive capacity of the economy and a commensurate decline in output” (Sers and Victor 2018).