CENTRE FOR
SUSTAINABILITY AND ENERGY

# Dynamic Macroeconomics for a Finite Planet

## A new paradigm for macroeconomic policy analysis, illustrated by the Earth4All system dynamics model

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# Dynamic Macroeconomics for a Finite Planet – Main message

**I give this presentation because I wish to help dethrone neoclassical theory (NCT) as the dominant paradigm for macroeconomic policy analysis.**

**And to replace neoclassical thinking with a new paradigm – system dynamics (SD) – which I believe is better suited to achieve what I see as the ultimate goal: namely high wellbeing for the global majority on a thriving planet.**

# Dynamic Macroeconomics for a Finite Planet – point 1

**1. Looking fifty years ahead, I see accelerating change and rising frictions – between man and nature, among nations, and within nations – in a world that is getting ever fuller.**

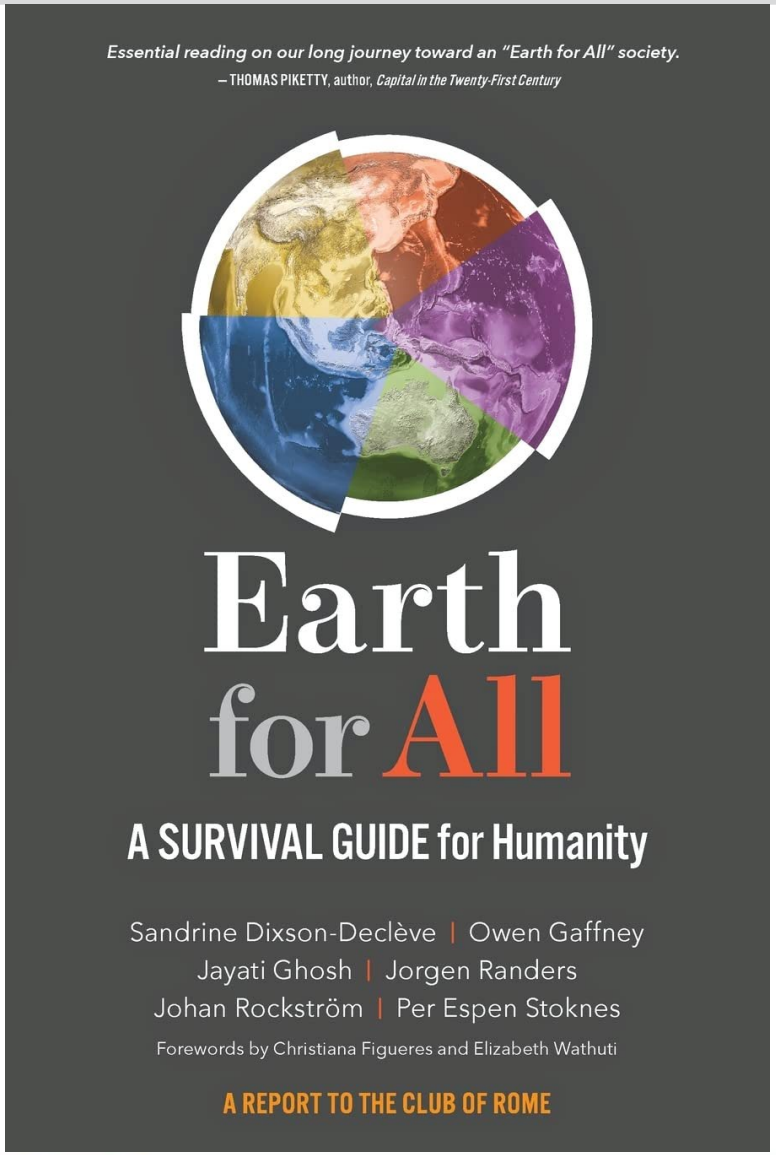
# Change and frictions in an ever fuller world

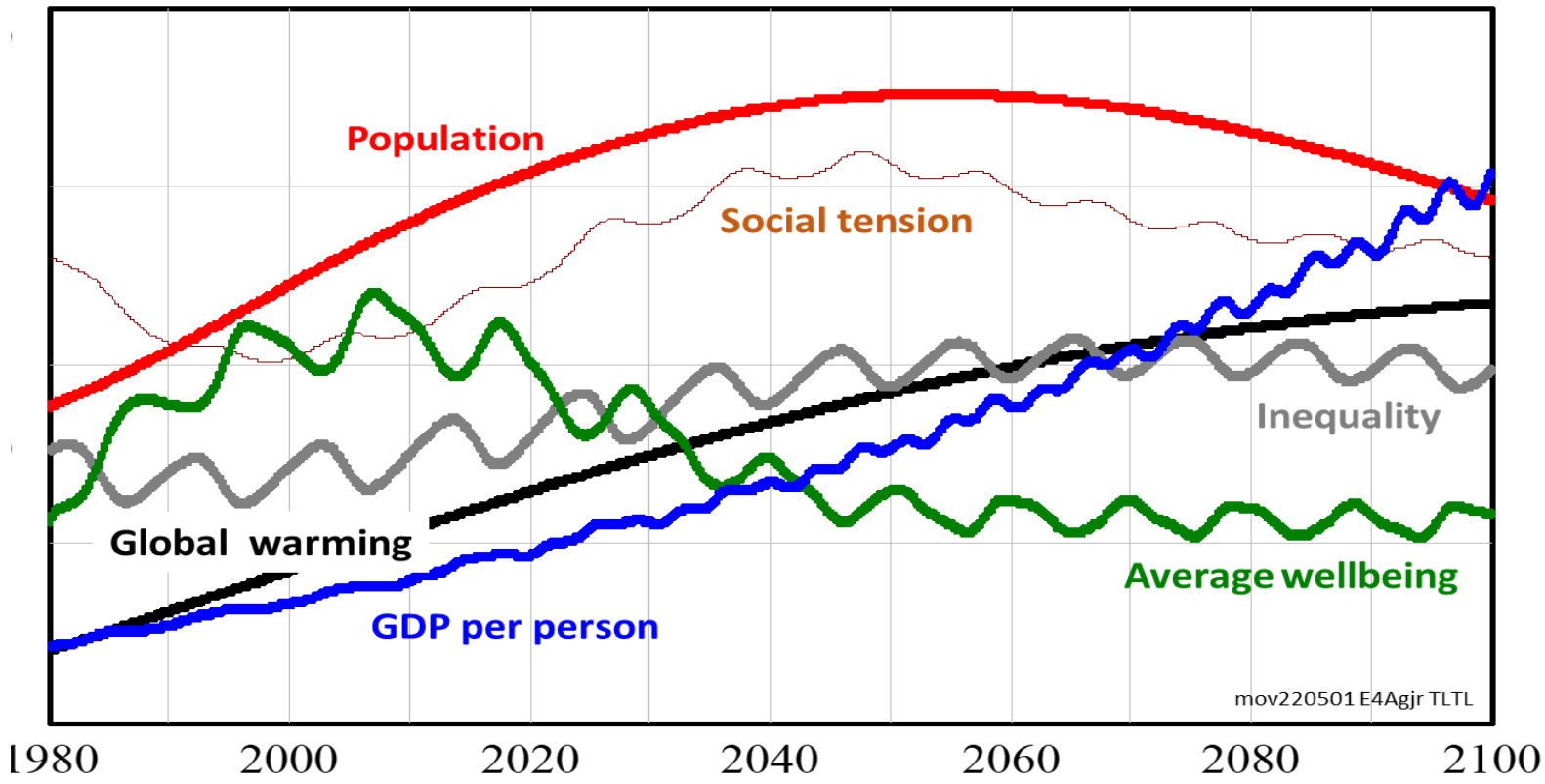



# Dynamic Macroeconomics for a Finite Planet – point 2

**2. Recently my colleagues and I wrote the *Earth for All* book. The book describes what will happen over the next fifty years if we continue conventional decision-making practices – including the continued focus on growth in GDP.**

# 50 years after *The Limits to Growth*: *Earth for All*




The «No Extraordinary Action» scenario (aka TLTL).
See www.earth4all.life



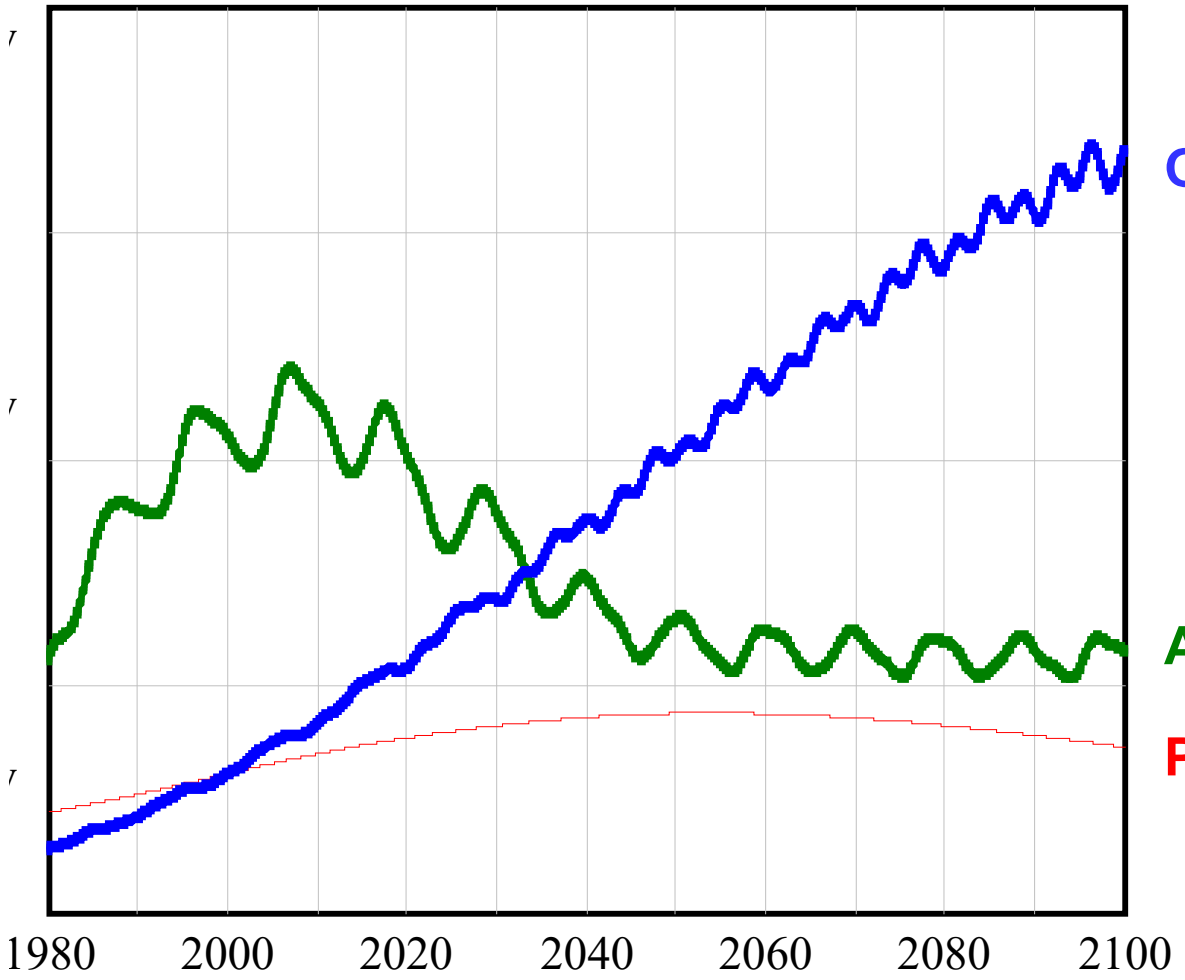
Source: www.earth4all.life/the-science

# Dynamic Macroeconomics for a Finite Planet – point 3

**3. The main conclusion from *Earth for All* is that pursuit of conventional policy will lead to higher GDP, but lower wellbeing for the majority.**

**This decline – if allowed to continue for decades – may trigger local social collapse.**

# GDP growth leads to wellbeing decline - World 2020-60




GDP. Scale 0 – 400,000 G$/y

Average Wellbeing Index. Scale 0 – 2.4

Population. Scale 0 - 40,000 Mp

mov220501 E4Agjr TLTL

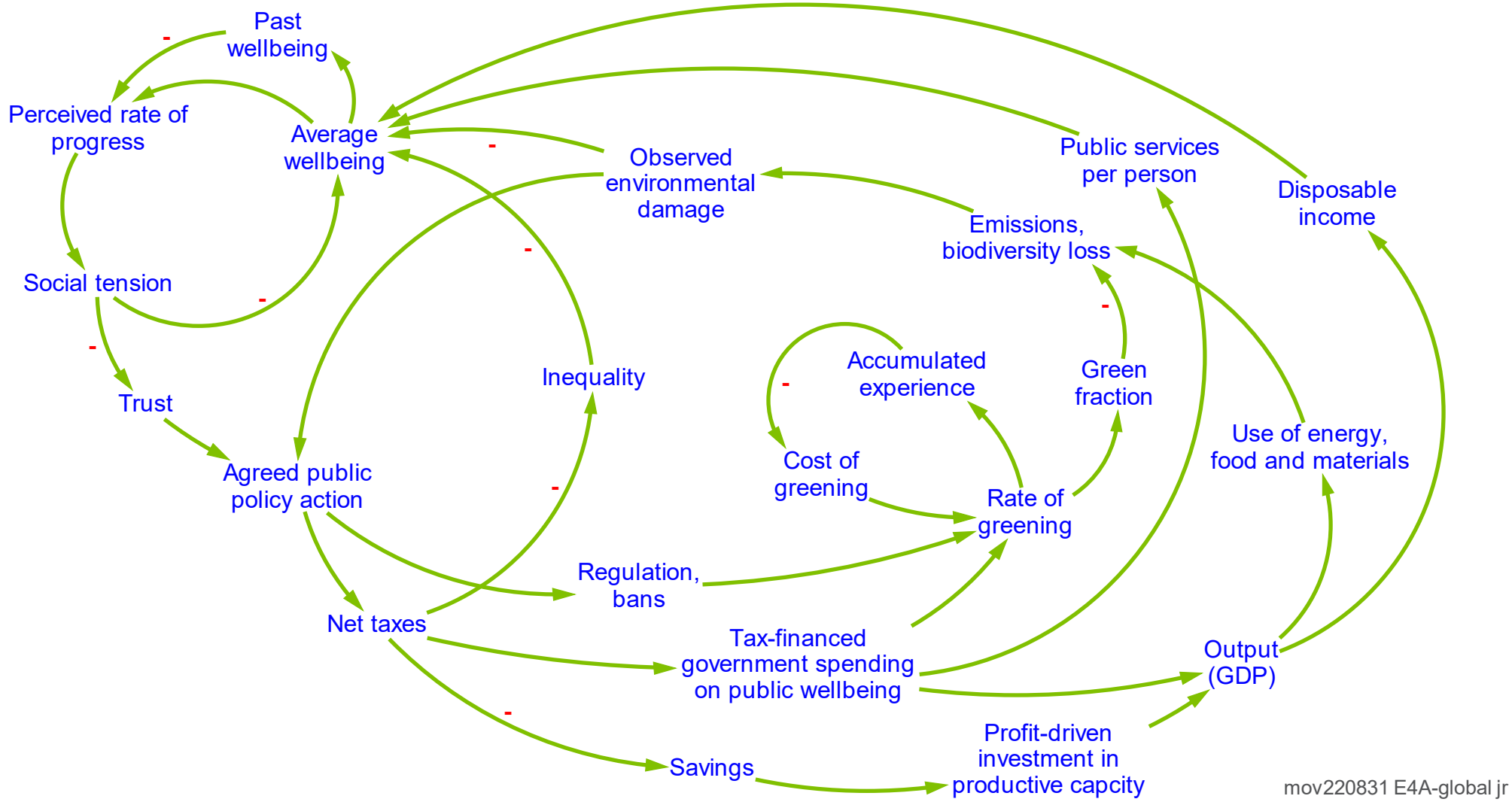


Source: www.earth4all.life/the-science

# Dynamic Macroeconomics for a Finite Planet – point 4

**4. In an increasingly crowded and turbulent, where everything affects everything else, one needs a new way to explore the consequences of policy action.**

# High-level summary of the Earth4All model



# Dynamic Macroeconomics for a Finite Planet – point 5

**5. It is no longer enough to study the effect of proposed policy on GDP.**

**One must study the effect on all variables that influence human wellbeing in a major way.**

# The E4A *Average Wellbeing Index* depends on

1. **Worker disposable income per person – after tax and transfers**
   (in 2017 PPP $ per person per year)
2. **Public spending per person**
   (in 2017 PPP $ per person per year)
3. **Inequality**
   (Owner disposable income divided by worker disposable income)
4. **Environmental damage**
   (Global warming in degrees Centigrade since 1850 )
5. **Social tension**
   (The rate of decline in wellbeing during last 5 years)



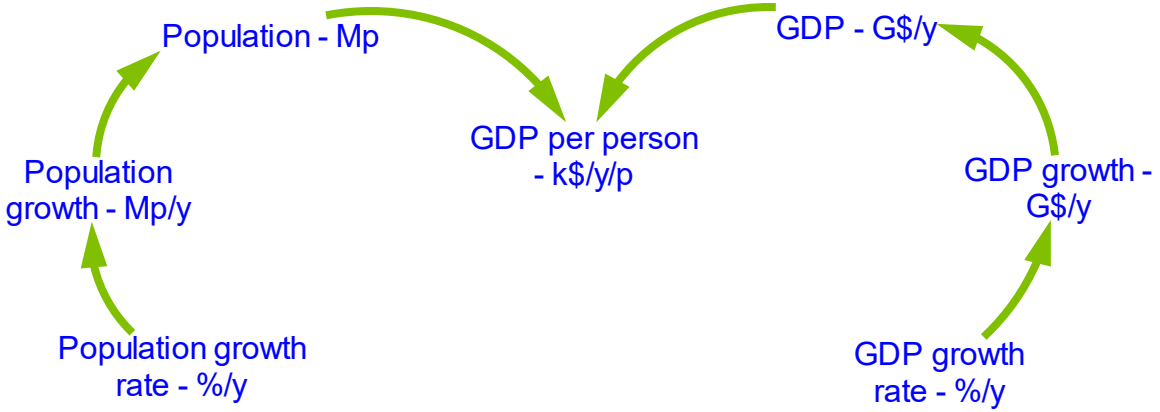
Source: www.earth4all.life/the-science

# Dynamic Macroeconomics for a Finite Planet – point 6

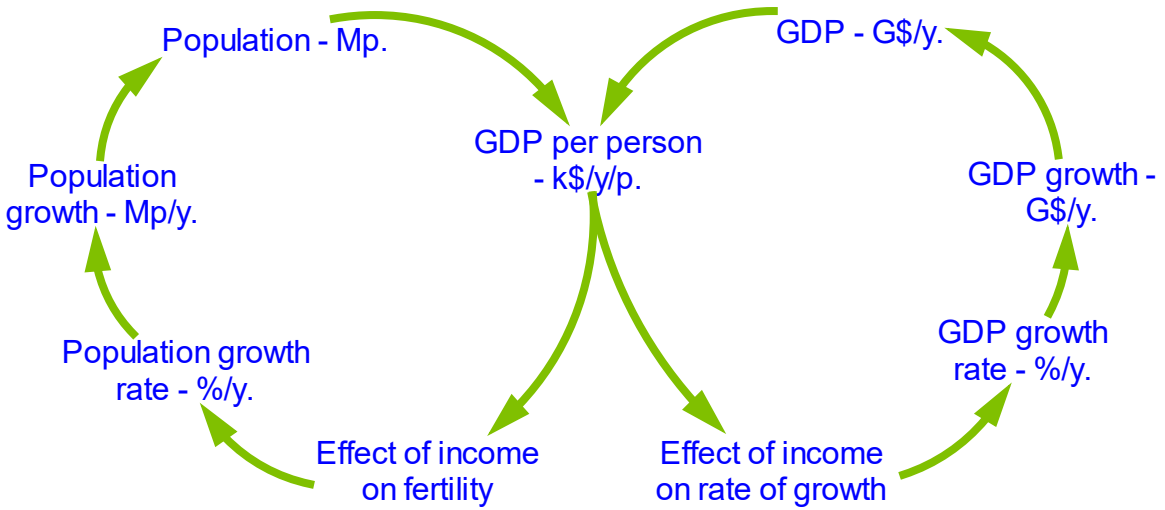
**6. It is no longer enough to use linear thinking and estimate the effect on a final equilibrium. One must accept the reality of circular causality and the need for new mathematics (differential equations instead of linear algebra).**

# Feedback perspective on GDP per person

LINEAR SHORT TERM PERSPECTIVE:




CIRCULAR LONG TERM PERSEPCTIVE:




Fertility declines when nation gets richer

GDP grows slower when nation gets richer

# Dynamic Macroeconomics for a Finite Planet – point 7

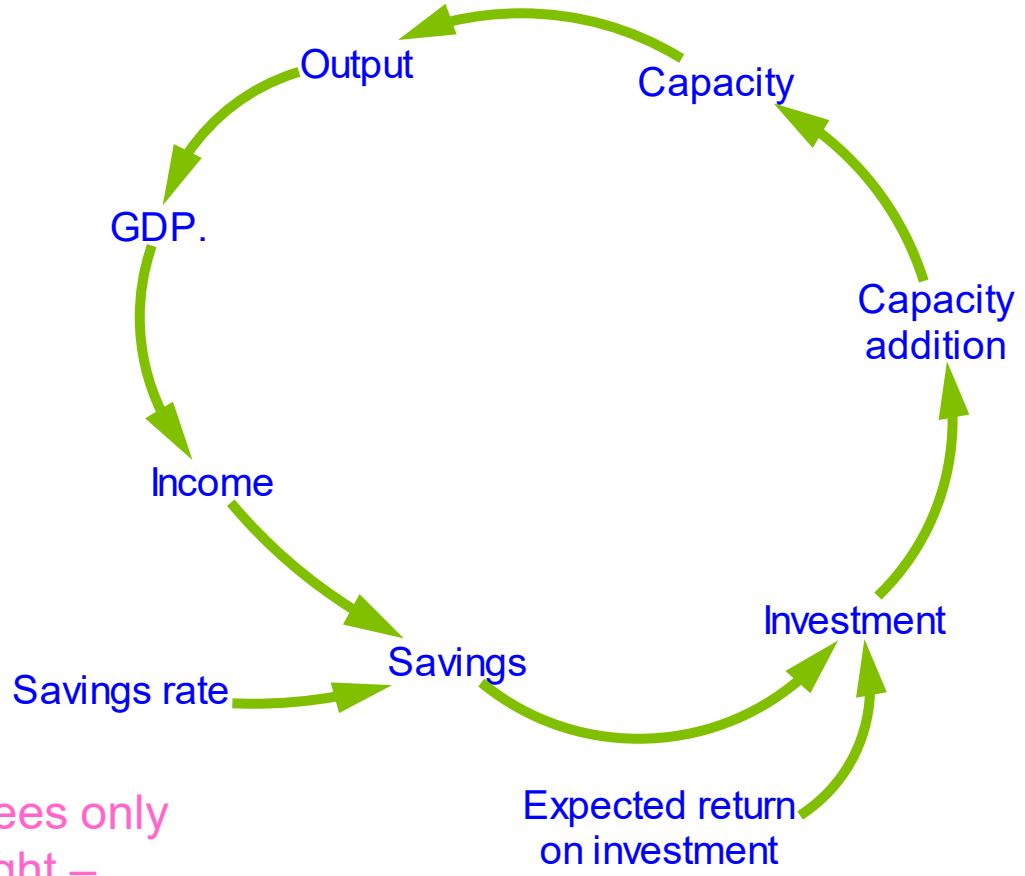
**7. It is no longer enough to study the effects of policy change in the short term (<2 years).**

**One must lengthen the time horizon to cover the feedback effects triggered by the first move.**

# Linear versus circular causality

LINEAR SHORT-TERM PERSPECTIVE:


CIRCULAR LONG-TERM PERSPECTIVE:



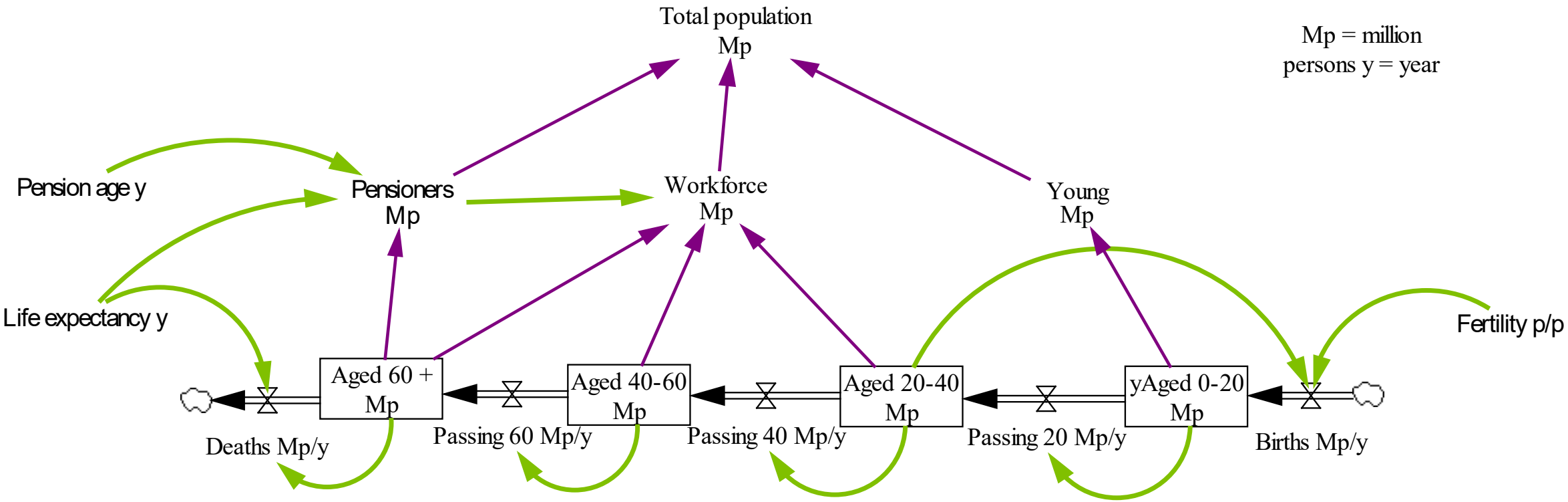

Keynesians and the neoclassicals disagrees only on what starts growth in the loop to the right – more demand or higher return on investment.

# Dynamic Macroeconomics for a Finite Planet – point 8

**8. It is no longer enough to study (economic) flows.**

**One must track the changes in the relevant stocks, since normally it is the accumulated stocks that determines what happens next, not the current flows.**

# Stocks and flows in population growth

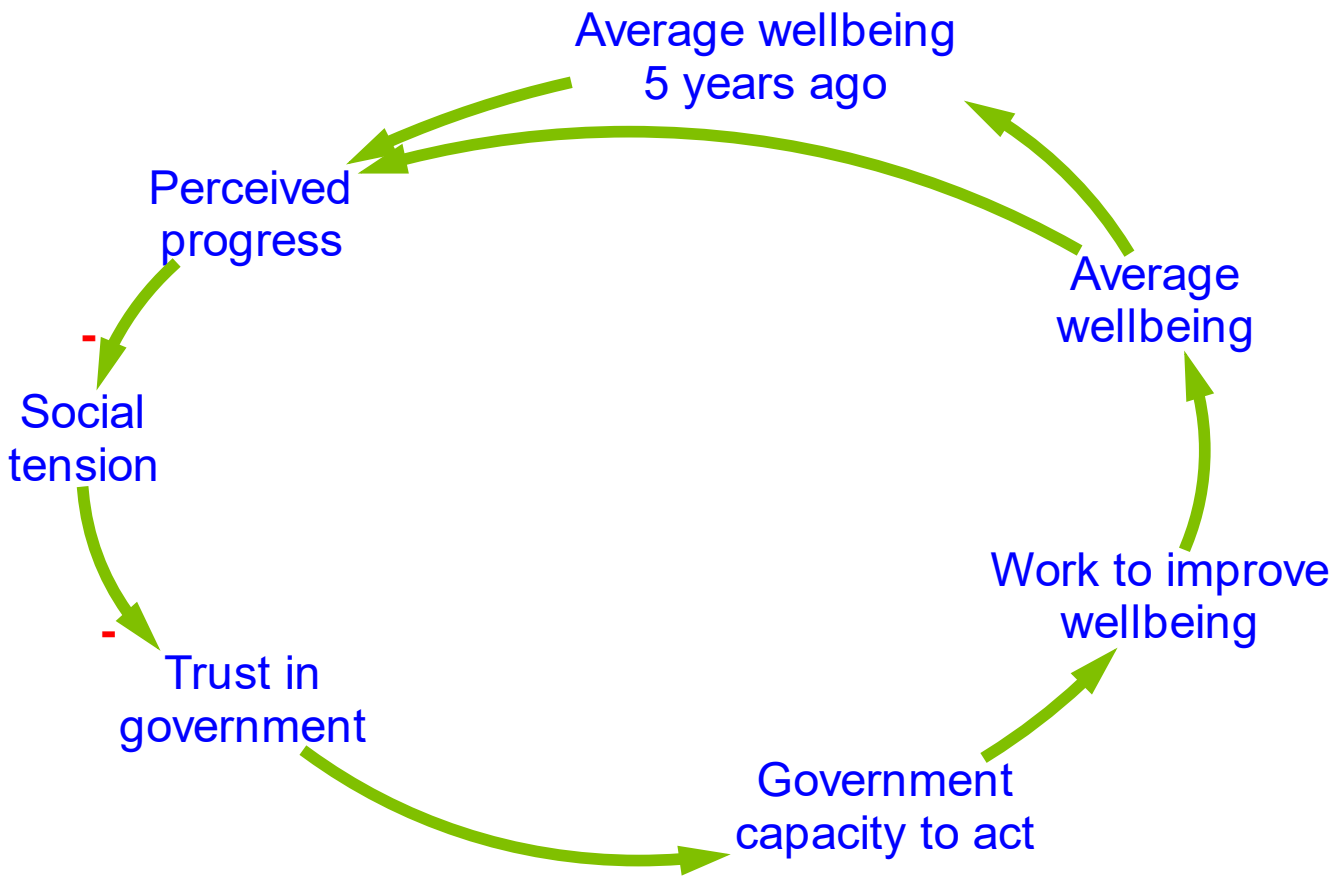


# Dynamic Macroeconomics for a Finite Planet – point 9

**9. It is no longer enough to rely on economic data (time series in dollar terms).**

**It is always helpful – and sometimes necessary – to supplement with non-economic data (physical flows), and even very-hard-to-quantify (soft science) data.**

# The vicious cycle of rising tension (causing social collapse)

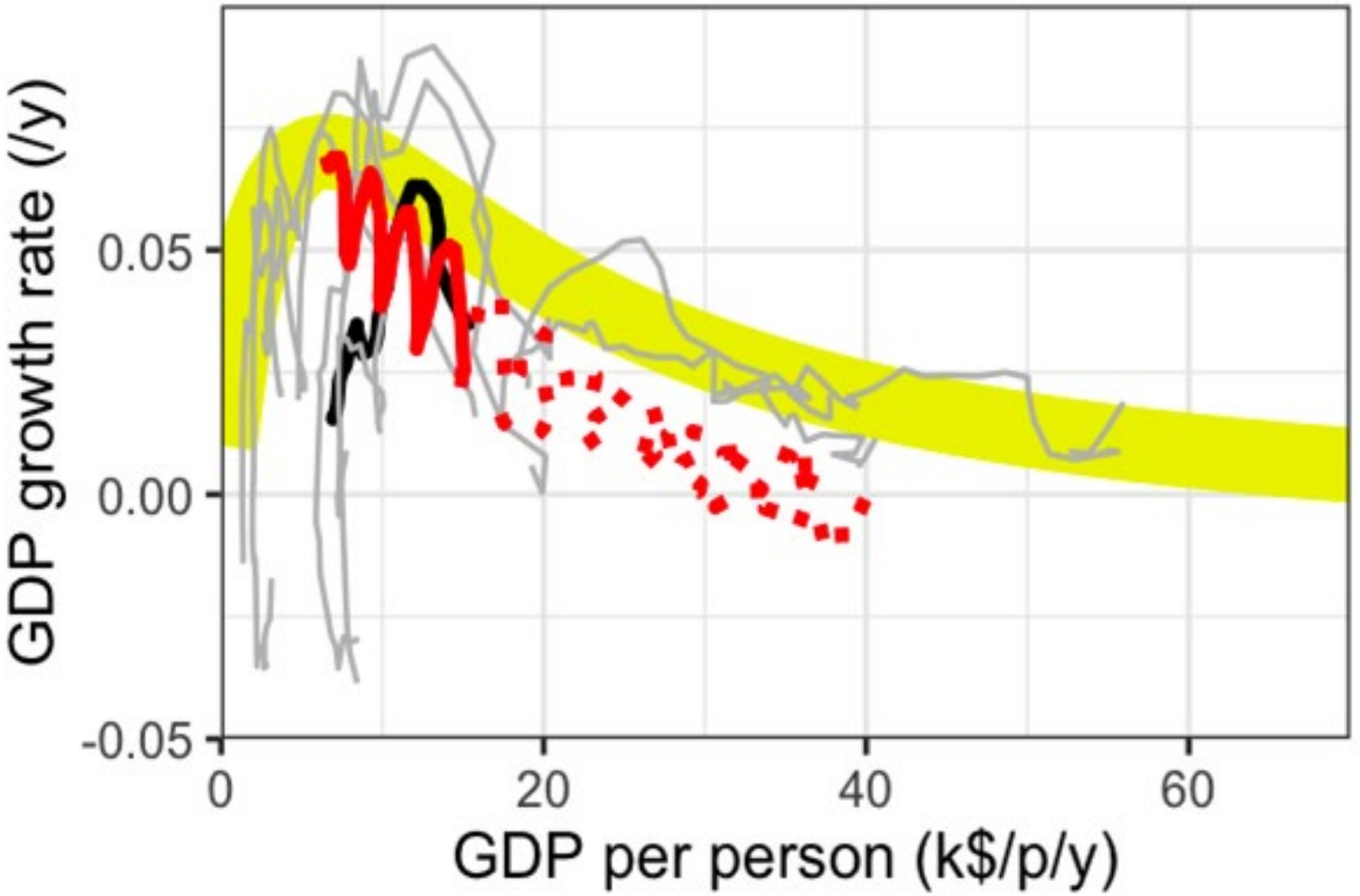


# Dynamic Macroeconomics for a Finite Planet – point 10

**10. It is no longer enough to study/build theory on historical correlation.**

**The focus must be on the underlying causality – cause and effect relationships.**

# GDP growth slows when a country gets richer – regional data




**Yellow**: Global guide
**Black**: Global data (1980–2019)
**Grey**: Regional data (1980–2019)
**Red**: Model output (1980–2019, dotted 2020–2100)



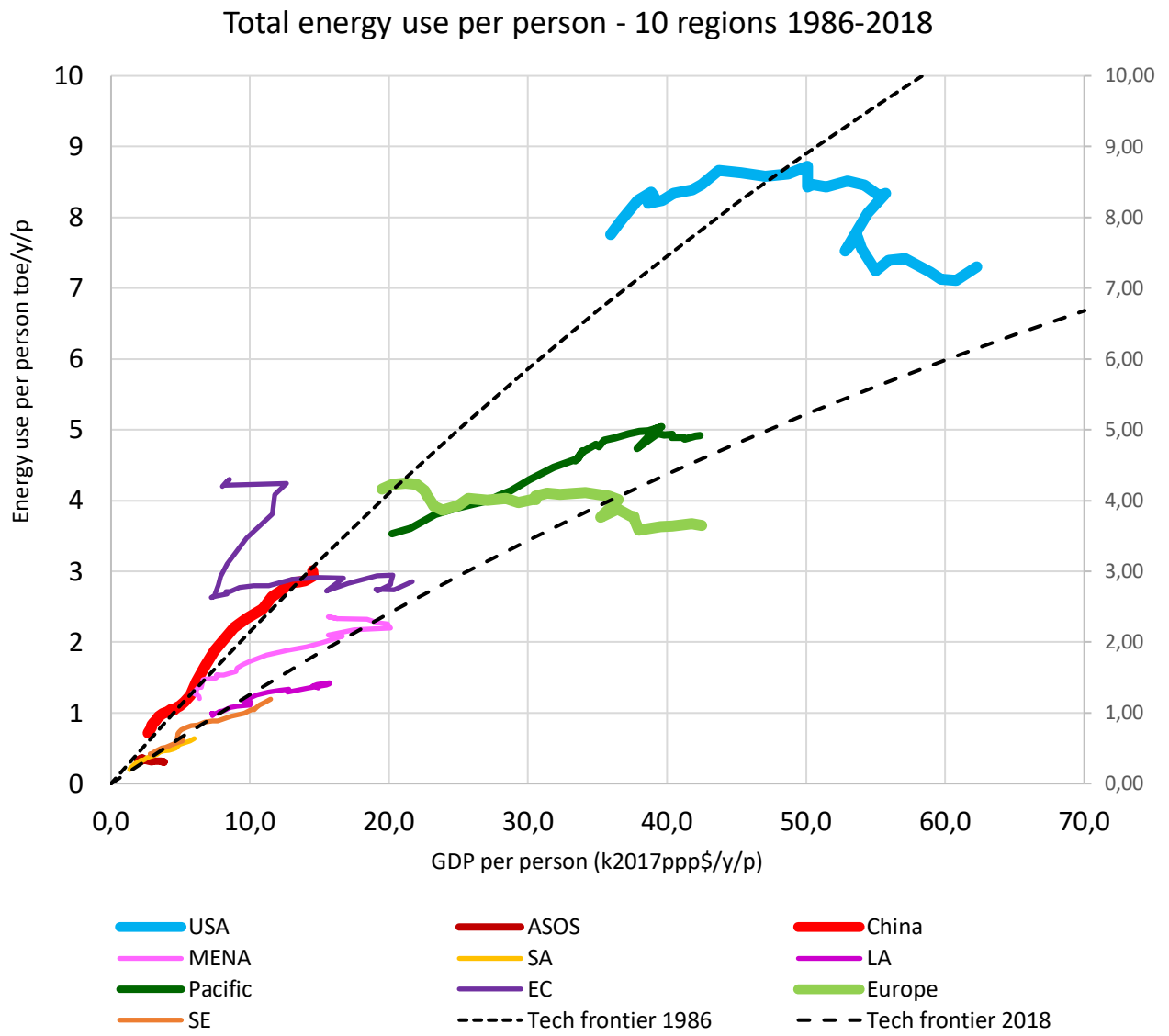
Source: www.earth4all.life plus private communication Felix Barbour and David Collste, 2023

# Dynamic Macroeconomics for a Finite Planet – point 11

**11. It is no longer sufficient to assume a linear response to an input.**

**The real world includes non-linearities – which tend to dominate system behavior when the system is pushed against limits.**

# Total energy use per person rises with income, but stagnates



# Dynamic Macroeconomics for a Finite Planet – point 12

**12. There already exists a practical and mature method for the study of complex systems – system dynamics.**

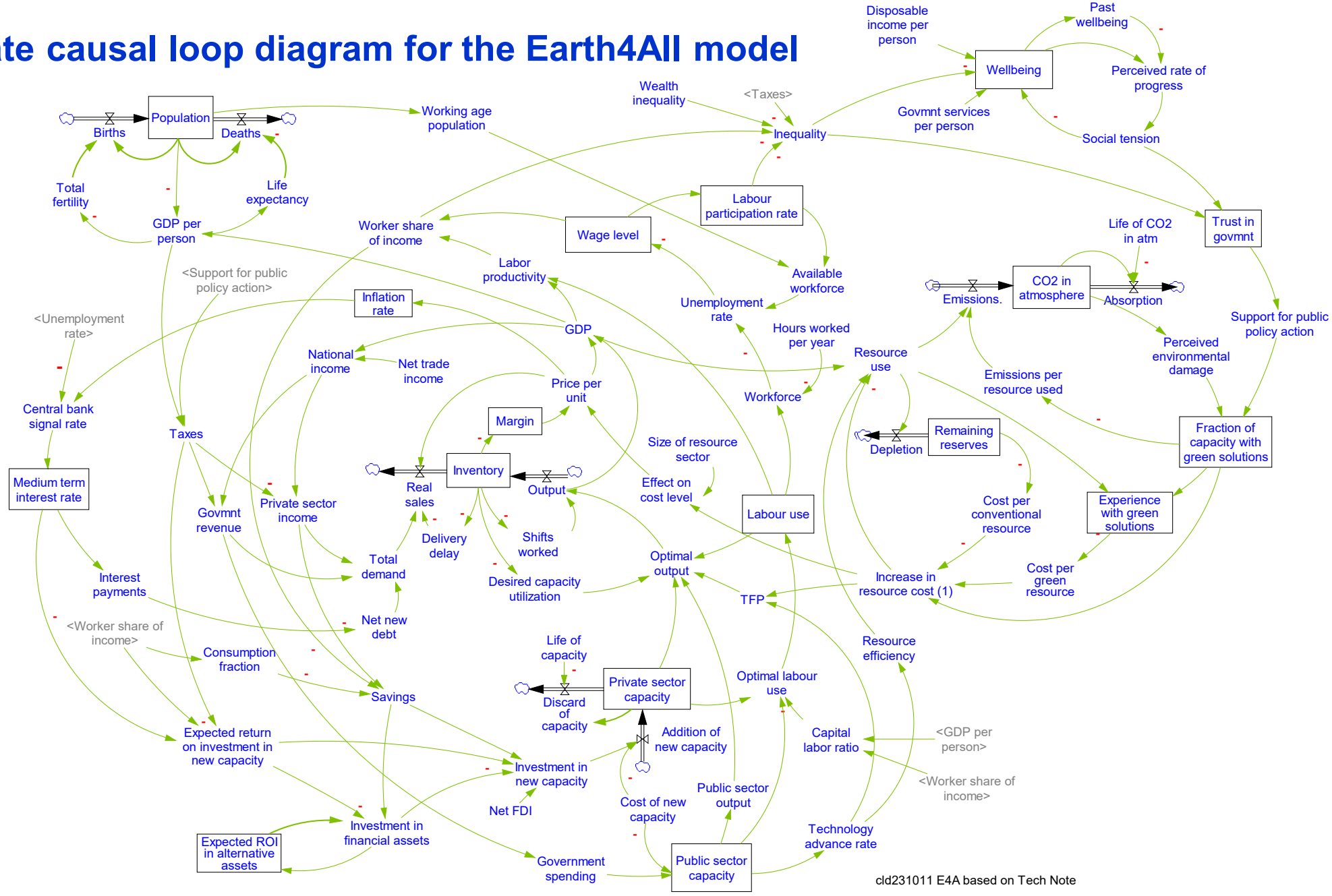
**System dynamics (SD) could become the mainstream guide to better policy but is fiercely resisted by neoclassical theory (NCT).**

# Dynamic Macroeconomics for a Finite Planet – point 13

**13. The strength of system dynamics paradigm is illustrated by the *Earth4All* model of human wellbeing on a finite planet towards 2100.**

**The model helps clarify the consequences of radical policy to stop the decline in human wellbeing.**

# Aggregate causal loop diagram for the Earth4All model



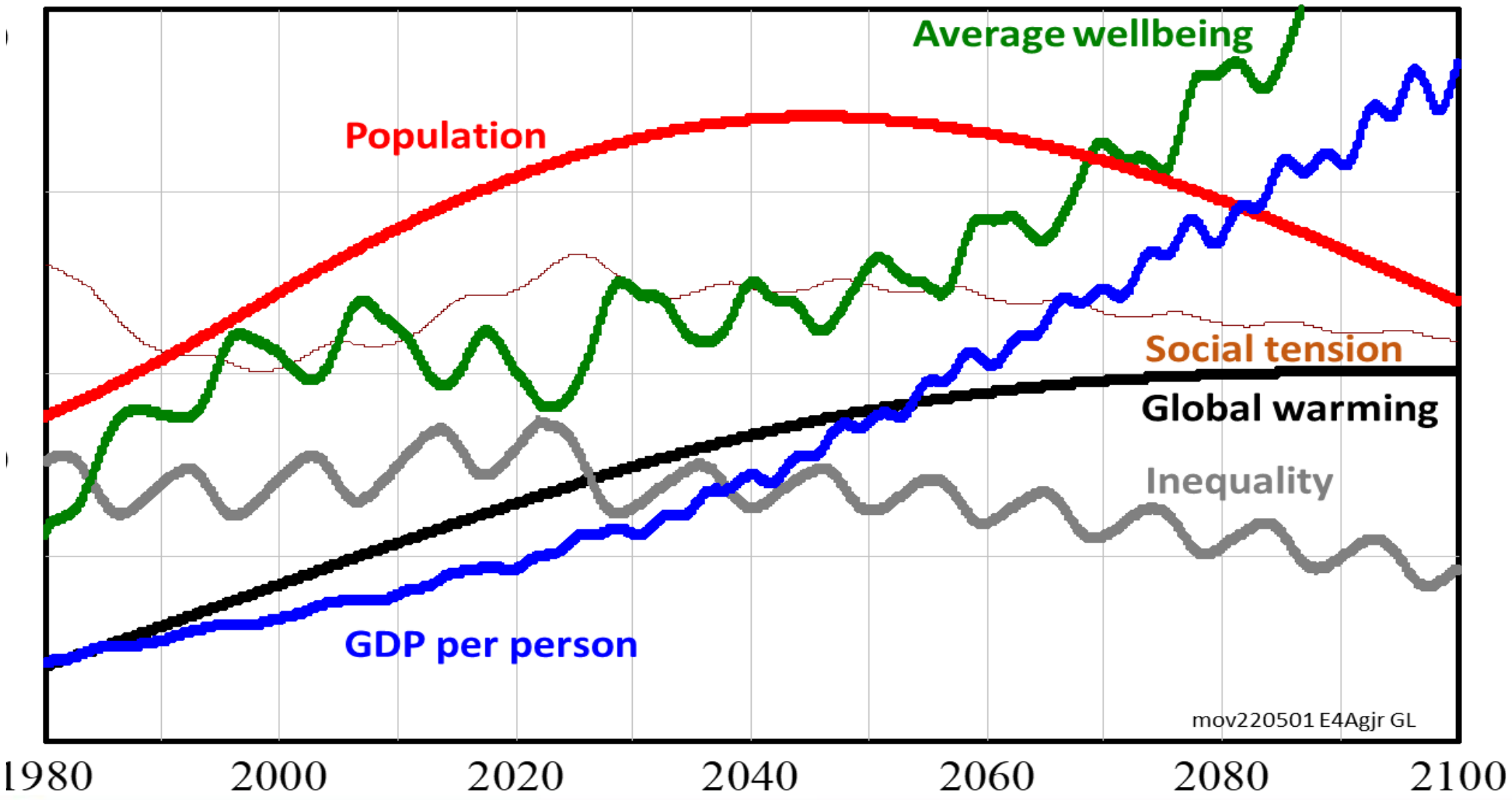

cld231011 E4A based on Tech Note

# 5 Turnarounds to increase wellbeing

## "THE SUSTAINABILITY TRANSFORMATION"

1. **Eliminate global poverty**
   Use new growth models: more plan less market
2. **Reduce inequality**
   Tax the rich to pay for higher wellbeing for the working majority
3. **Empower women**
   Free education, health, contraception and opportunity to all
4. **Halt biodiversity decline**
   Shift to carbon-positive agriculture to protect remaining forests
5. **Stop climate change**
   Replace fossil energy with sun, wind, efficiency, and CCS

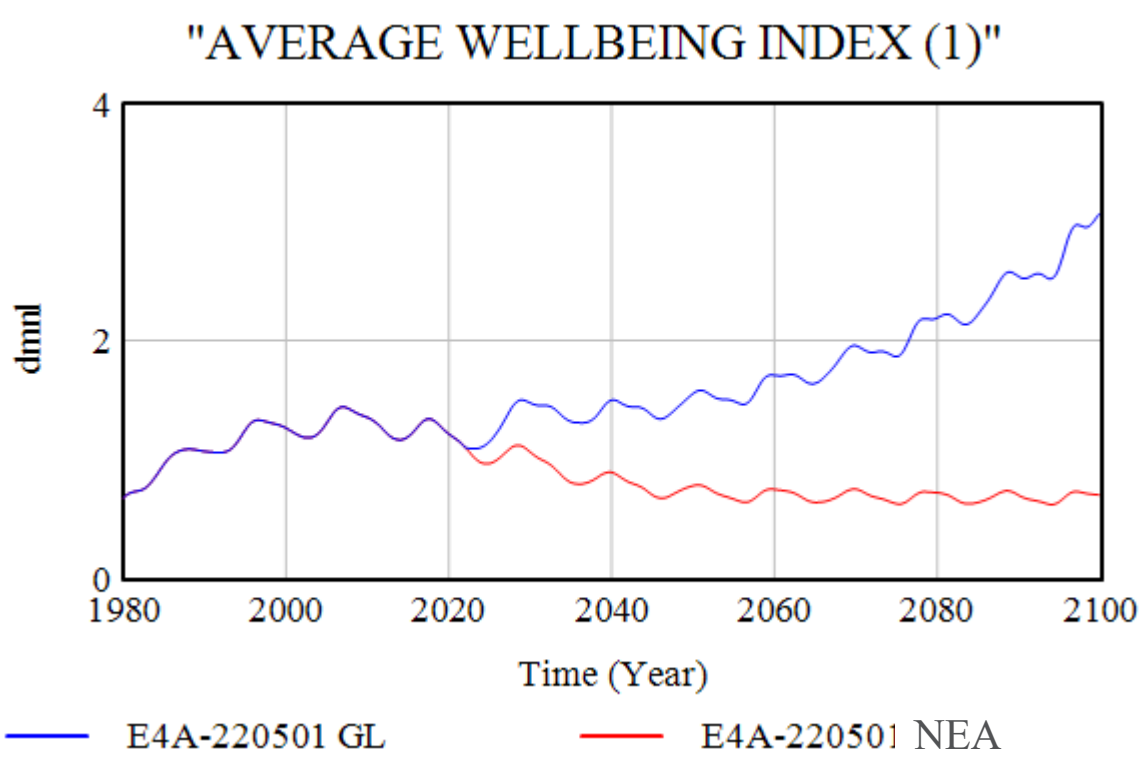
# Main trends in global development – «Giant Leap»

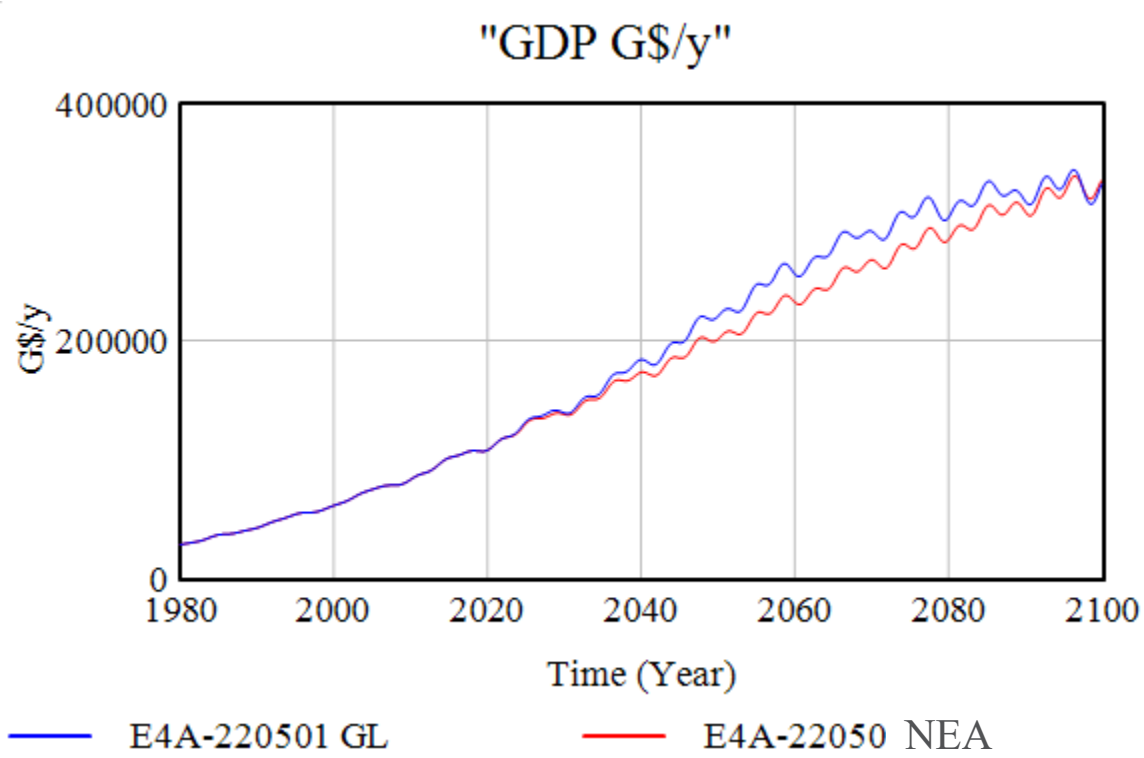





Source: www.earth4all.life/the-science

# Comparing “Giant Leap” and “No Extraordinary Action”



# Dynamic Macroeconomics for a Finite Planet – point 14

**14. Neoclassical theory is not suited to describe the real world in a manner which is useful for long-term policy making.**

**System dynamics simulation models can help.**

# Dynamic Macroeconomics for a Finite Planet – points 15 - 18

**15. The best way forwards is peaceful coexistence between SD and NCT**

**16. Promising sign 1: Increased willingness to deviate from NCT dogma**

**17. Promising sign 2: Theoretical innovation led by practical policy making.**

**18. We may live to see the introduction of system dynamics as a competing paradigm for global policy making.**

# We need a good tool for reliable policy analysis