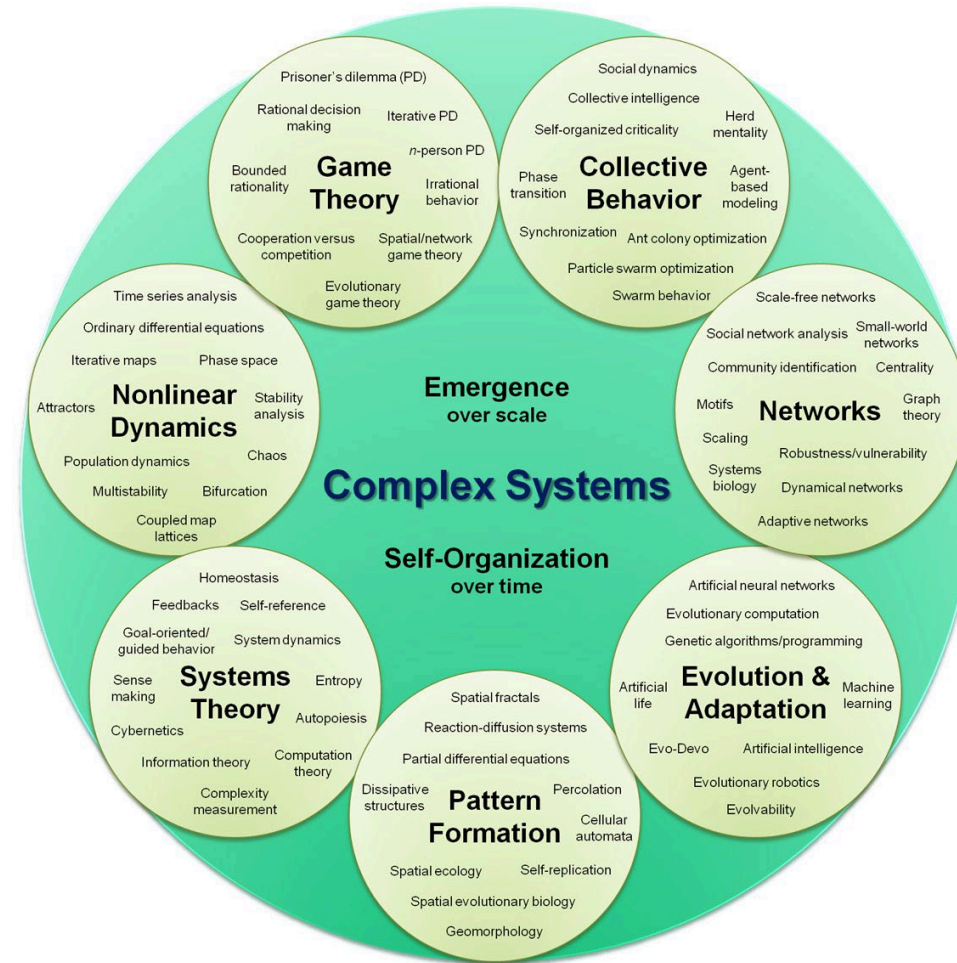


Wie leert denken in systemen, leert de wereld begrijpen



Dorrih Pennink
Lerarenopleider natuurkunde
Hogeschool van Amsterdam
d.h.m.pennink@hva.nl

Samenhang in Science



Denkwijzen

- patronen
- schaal, verhouding en hoeveelheid
- oorzaak en gevolg
- systeem en systeemmodellen
- behoud, transport en kringloop van energie en materie
- structuur en functie
- stabiliteit en verandering
- duurzaamheid
- risico's en veiligheid



Werkwijzen

- modelontwikkeling en gebruik
- onderzoeken
- ontwerpen
- informatievaardigheden
- redeneervaardigheden
- waarderen en oordelen
- rekenkundige en wiskundige vaardigheden

bètaburgerschap



Visionairen

Een ode aan de 'Crazy Ones'



Donella Meadows



Johan Rockström

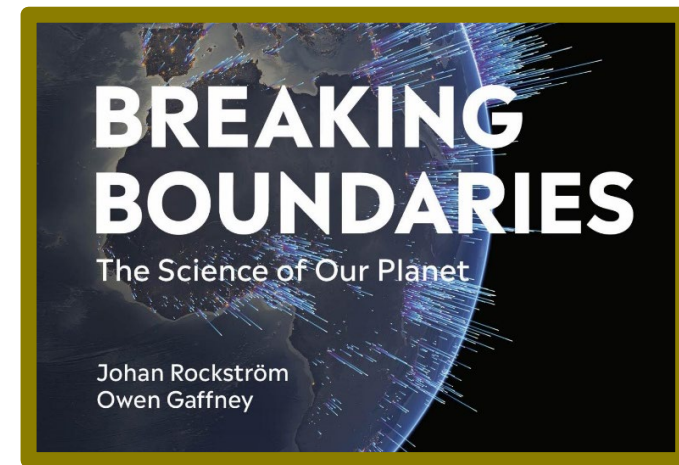
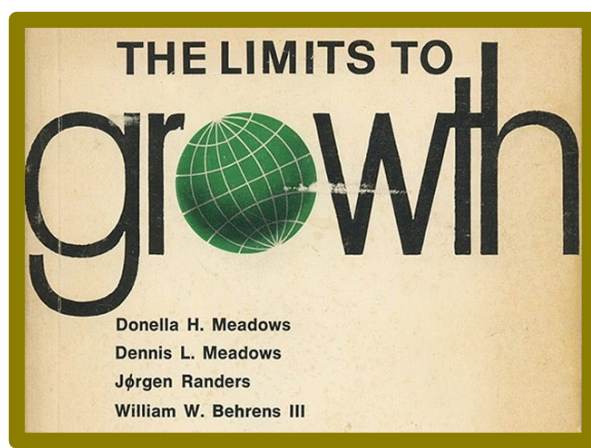


Kate Raworth

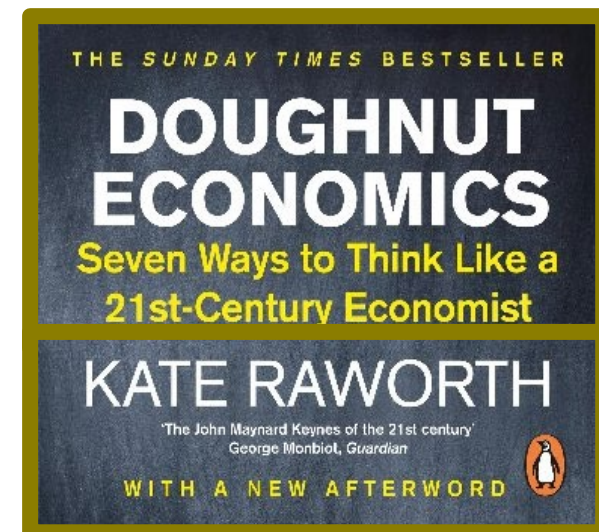
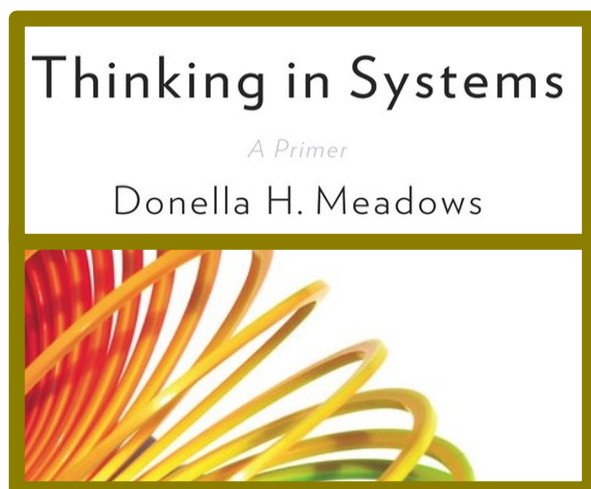


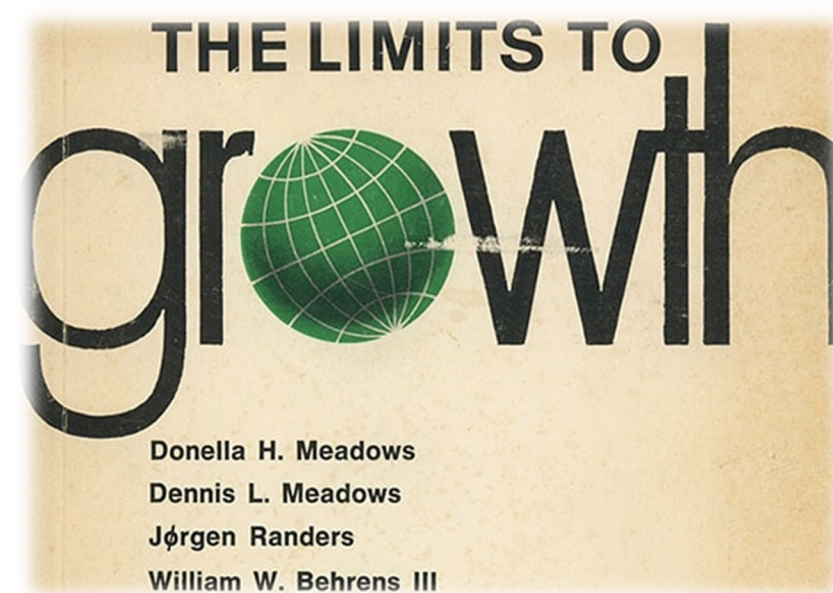
Think different.

Filmfragment Apple reclame



The Limits to Growth brengt de problematiek aan het licht.
Thinking in Systems biedt de taal om de complexiteit te begrijpen.
Breaking Boundaries levert de empirische concretisering.
Doughnut Economics schetst de ethisch-sociaal-economische oplossing.





	Type model	Focus	Mensbeeld	Uitkomst
Limits to Growth (1972)	Systeemdynamisch simulatiemodel (World3)	Scenario's verkennen van voortzetten van mondiale trends.	Mens als component in een systeem	Waarschuwing voor de gevolgen van exponentiele groei: aanzetten tot mondiale reflectie en beleidsverandering.

Figure 26 THE WORLD MODEL

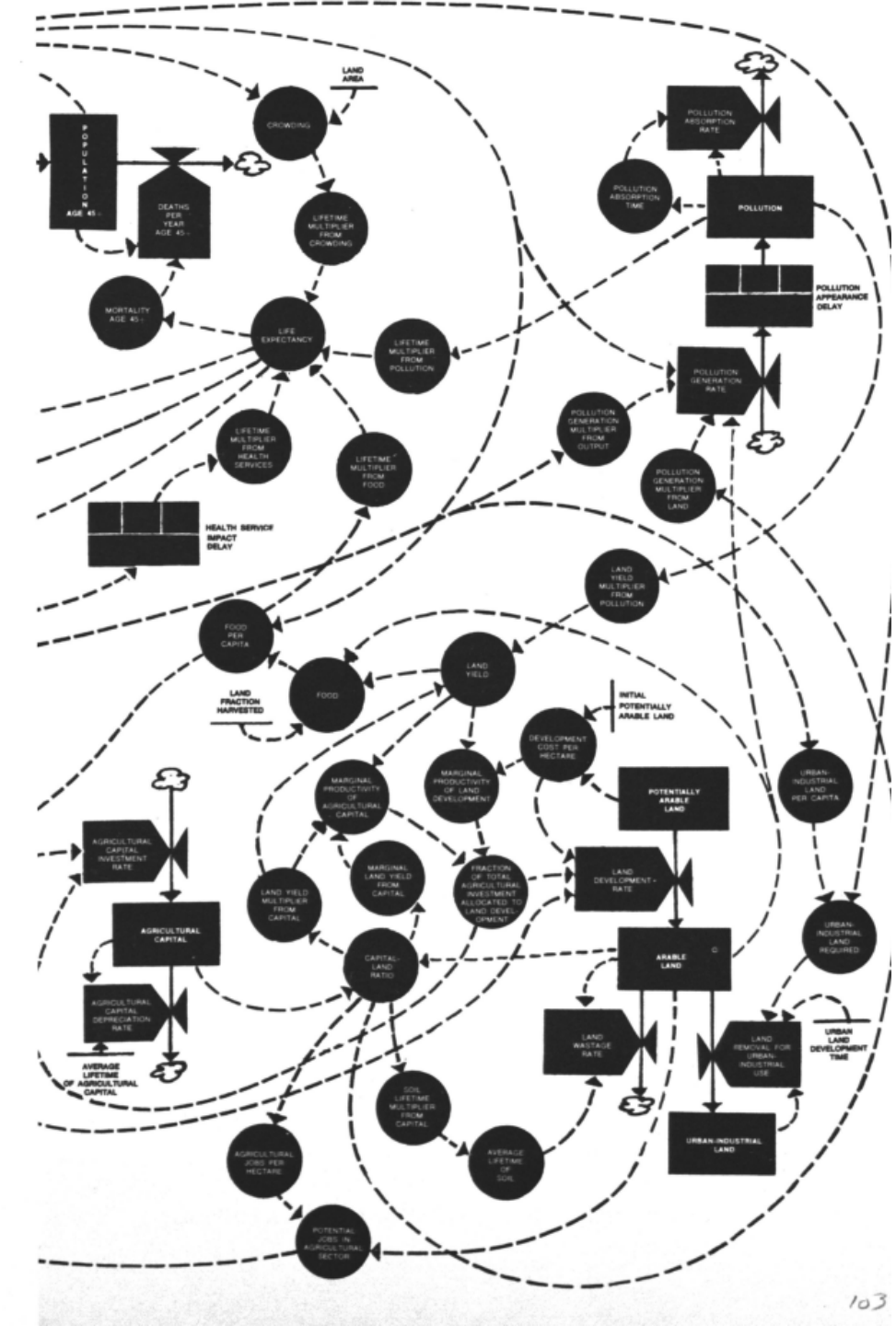
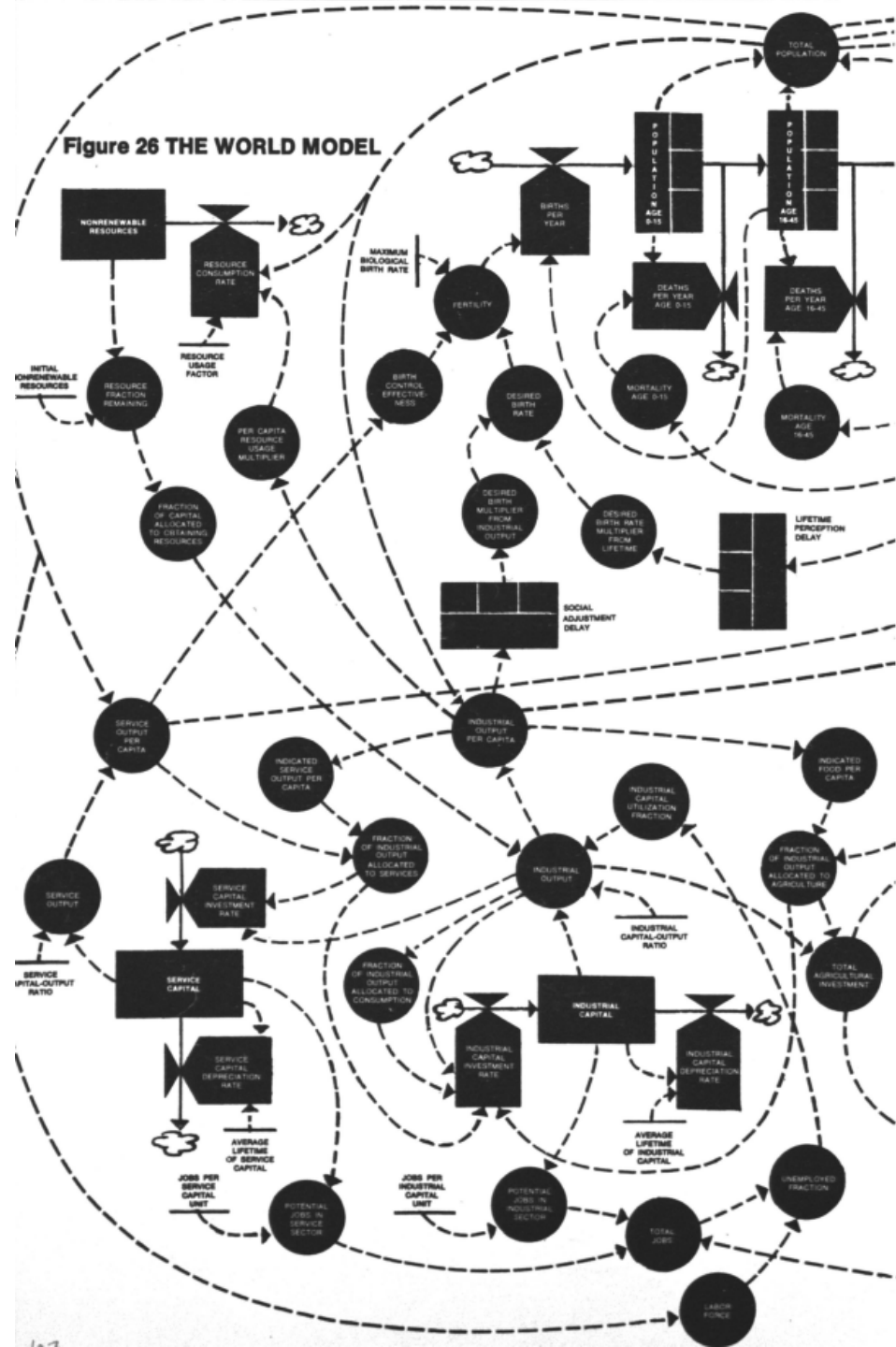
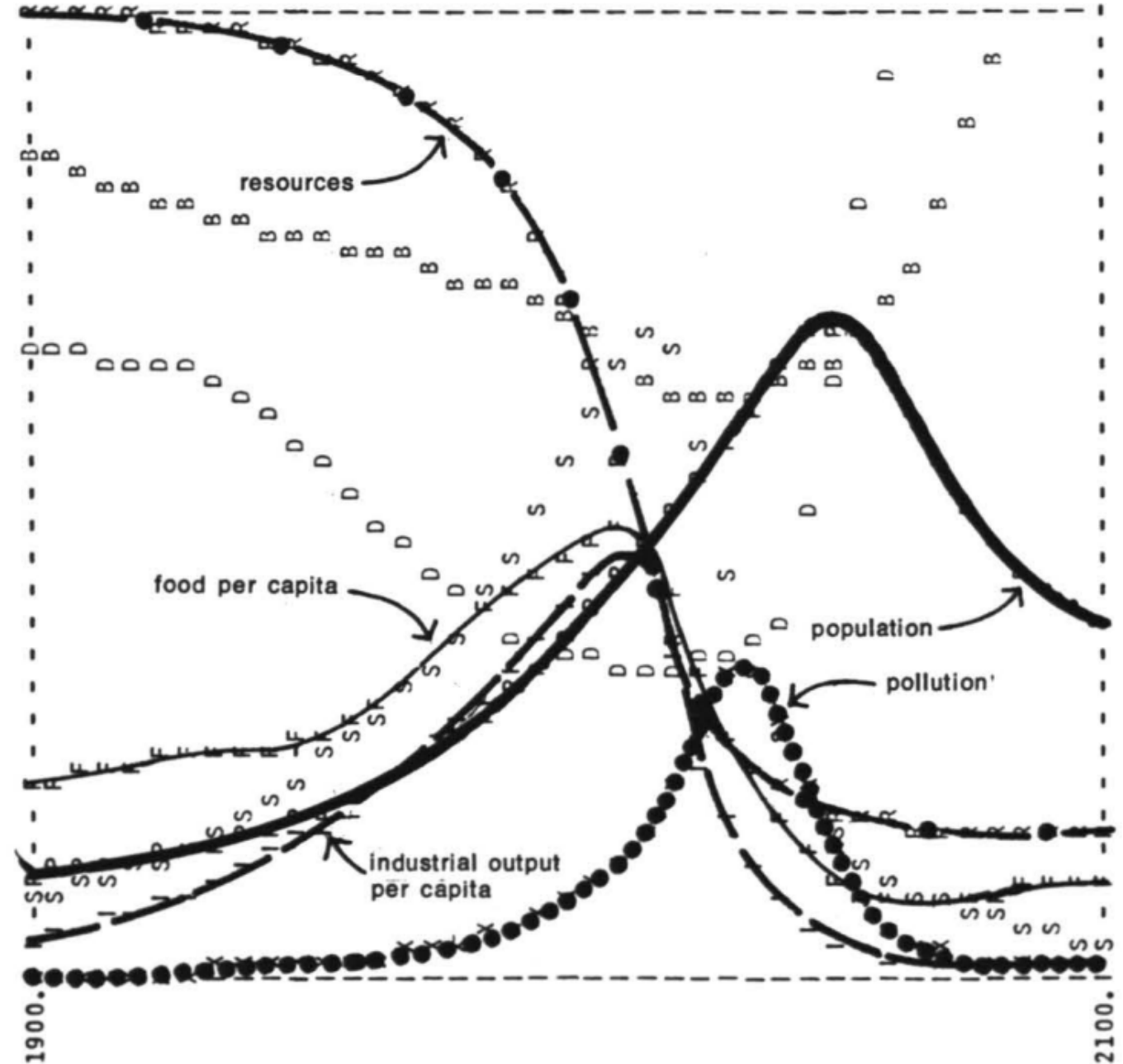


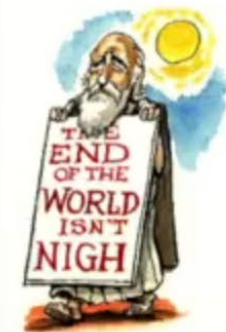
Figure 35 WORLD MODEL STANDARD RUN

1. Er zijn grenzen aan de groei.
2. Als we doorgaan op de huidige voet, worden die in de volgende eeuw bereikt, gevolgd door een snelle (dramatische) ineenstorting.
3. We kunnen deze trend tegenhouden en in een stabiele situatie belanden.
4. Als we nu beginnen (1972), duurt het ongeveer 50-100 jaar om dit evenwicht te bereiken.
5. Ieder jaar dat we wachten wordt het bereiken van dit evenwicht moeilijker en kostbaarder.



Plenty of gloom

Forecasters of scarcity and doom are not only invariably wrong, they think that being wrong proves them right



In 1798 Thomas Robert Malthus inaugurated a grand tradition of pessimism with his bestselling pamphlet on population. Malthus argued with his usual precision that since population tended to increase geometrically (1, 2, 3, 4...), the starvation of Great Britain was inevitable. He was wrong.

Empty imaginations

In 1972 the Club of Rome published a highly influential study, *Limits to Growth*. To many in the environmental movement it was a beacon of sense in the foolish world of economic growth. It was borne out?

"Limits to Growth" said total global oil reserves would last for 50 years. "We could use up all of the proven reserves of oil in the next decade," said President Jimmy Carter in 1980. Between 1970 and 1990 the world used 600 billion barrels of oil. The Club of Rome, reserves should have been exhausted by 1990. In fact, by 1990 unexploited reserves are estimated at 550 billion barrels.

Christmas Specials

Dec 20th 1997 edition >

Dec 18th 1997

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FEATURE

The Dustbin of History: Limits to Growth

According to Darwinism, species that adapt to their environment thrive; those that fail to evolve face extinction. The same is true for ideas. Marxism evolved from a primordial swamp of the Industrial Revolution but lies gasping for relevance in the collapse of the Soviet Union. Asian values — fashionable when South Korea and Thailand were ...

By Bjorn Lomborg and Olivier Rubin

NOVEMBER 9, 2006, 9:56 PM

Are these ideas really doomed to oblivion? Or, for all their flaws, do they still have some relevance? Can they make a comeback? FOREIGN POLICY has invited six notable minds to sort through the dustbin of history and share what they found.

In the book of Genesis, God decreed that there were limits to growth by never allowing the Tower of Babel to reach the sky. In modern times, the task of delineating human aspirations fell to the Club of Rome, which in its 1972 study, *Limits to Growth*, declared that in a world of finite resources, unlimited economic expansion and prosperity are impossible to pursue.

The international scientists, who at the invitation of Italian industrialist Aurelio Peccei came together in the late 1960s to form the Club of Rome, meant well. They were united by their conviction that enormous ecological problems faced humankind and called for extraordinary political measures. At the time of its release, *Limits to Growth* had a profound impact, spawning alarmist headlines such as "A Computer Looks Ahead and Shudders" and "Scientists Warn of Global Catastrophe." The subsequent 1973 oil crisis, prompted in part by the Arab embargo, made the study seem eerily prescient.

10 MINUTE READ 02.01.2007 04:20 PM

The Doomsayer

The environment is going to hell, and human life is doomed to only get worse, right? Wrong. Conventional wisdom, meet Julian Simon, the Doomslayer.

THIS IS THE litany: Our resources are running out. The air is bad, the water is polluted, the planet's species are dying off — more exactly, we're killing them — at the staggering rate of 100,000 per year, a figure that works out to almost 2,000 species per week, 10 per hour, another dead species every six minutes. We're trashing the planet, washing away the topsoil, paving over our farmlands, systematically deforesting wildernesses, decimating the biota, and ultimately killing ourselves.

The world is getting progressively poorer, and it's all because of population, or, precisely, overpopulation. There's a finite store of resources on our pale blue spaceship Earth, our small and fragile tiny planet, and we're fast approaching its ultimate carrying capacity. The limits to growth are finally upon us, and we're borrowing time. The laws of population growth are inexorable. Unless we act now, the final result is written in stone: mass poverty, famine, starvation, and death.

Time is short, and we have to act now.

That's the standard and canonical litany. It's been drilled into our heads so far, so forcefully that to hear it yet once more is ... well, it's almost reassuring. It's comically consoling — at least we're face to face with the enemies: consumption, and mindless growth. And we know the solution: cut back, contract, make do with it. "Live simply so that others may simply live."

There's just one problem with The Litany, just one slight little wee imperfection: It isn't that dim and dreary recitation, each and every last claim, is false. Incoherence with the truth.

Not the way it is, folks.

Thus saith The Doomsayer, one Julian L. Simon, a neither shy nor retiring nor particularly mild-mannered professor of business administration at a middling seaboard state university: Simon paints a somewhat different picture of the human condition circa 1997.

"Our species is better off in just about every measurable material way," he says, "and about every important long-run measure of human material welfare shows improvement over the decades and centuries, in the United States and the rest of the world. Raw materials — all of them — have become less scarce rather than more in the US and in other rich countries is irrefutably safer to breathe. Water cleanliness has improved. The environment is increasingly healthy, with every prospect of further improvement."

The Political Quarterly, Vol. 76, No. 4, October-December 2007

Growthism and the Green Backlash

RICHARD DOUGLAS

Every limit appears as an obstacle to be overcome. (Karl Marx, *Grundrisse*)

Introduction

A CERTAIN industry of media campaigners has sprung up in recent years, dedicated to combating what they like to portray as the myths of environmentalism. Their frequent claim is that environmental groups, and even the most senior scientists, frequently exaggerate the evidence for phenomena such as global warming, in effect crying wolf in order to attract funding and to advance their own political views. In the UK these arguments recently received a very prominent airing in the Channel 4 documentary, *The Great Global Warming Swindle*, screened in spring 2007.

Many environmentalists have pointed out the political motivation of many of the speakers of this movement, who are often sympathetic to the arguments of, if not funded by, large and polluting corporations at risk of facing increased regulation. Many have also pointed to the factual errors and philosophical howlers that litter much of this movement's publications.

But what has not been given much attention is the philosophy that underlies it. This is a subject well worth digging into. To do so would help to describe both the common outlook of most of its individual columnists and spokesmen (thereby making this more understandable as a coherent movement) and the ideological nature of their beliefs (thereby explaining why it is that they so often make such skewed, even

irrational, arguments—and with such vociferousness). Exposing the main motivations for their arguments should also help to dispel the natural suggestion that if a group of people are saying these things, then there must be something in them; that they must be the honest product of significant counter-arguments found by reason or observation.

This is not to say that prominent 'environmental sceptics' never make any valid points, either about scientific uncertainty or about alarmist campaigning by NGOs. Nor is it to say that everybody who raises doubts as to the scientific evidence behind various environmental scares is ideologically motivated. But it is to suggest that there is an ideological motivation behind most such comments, when made in the mass media. This suspicion is reinforced by the frequent example of commentators who continually seek to poke holes in environmentalist arguments in different fields; by those who switch positions as new evidence becomes accepted, but in every case find a new 'sceptical' position; and those who do not apply their scepticism consistently, but vary it rather according to the political connotations of the suggested policy measures to take in response.

The other reason for exposing the underlying philosophy of this movement is to make it easier not just to understand but to attack. Currently, the contemporary media convention that there must be balance in coverage of every news item means that if a group is willing, and perhaps well-funded enough, to argue an alternative case, then it is often given equal coverage, almost regardless of the relative substance of the two sides'

Looking Back on the Limits of Growth

Forty years after the release of the groundbreaking study, were the concerns about overpopulation and the environment correct?

By Mark Strauss
SMITHSONIAN MAGAZINE | [SUBSCRIBE](#)
APRIL 2012

Recent research supports the conclusions of a controversial environmental study released 40 years ago: The world is on track for disaster. So says Australian physicist Graham Turner, who revisited perhaps the most groundbreaking academic work of the 1970s, *The Limits to Growth*.

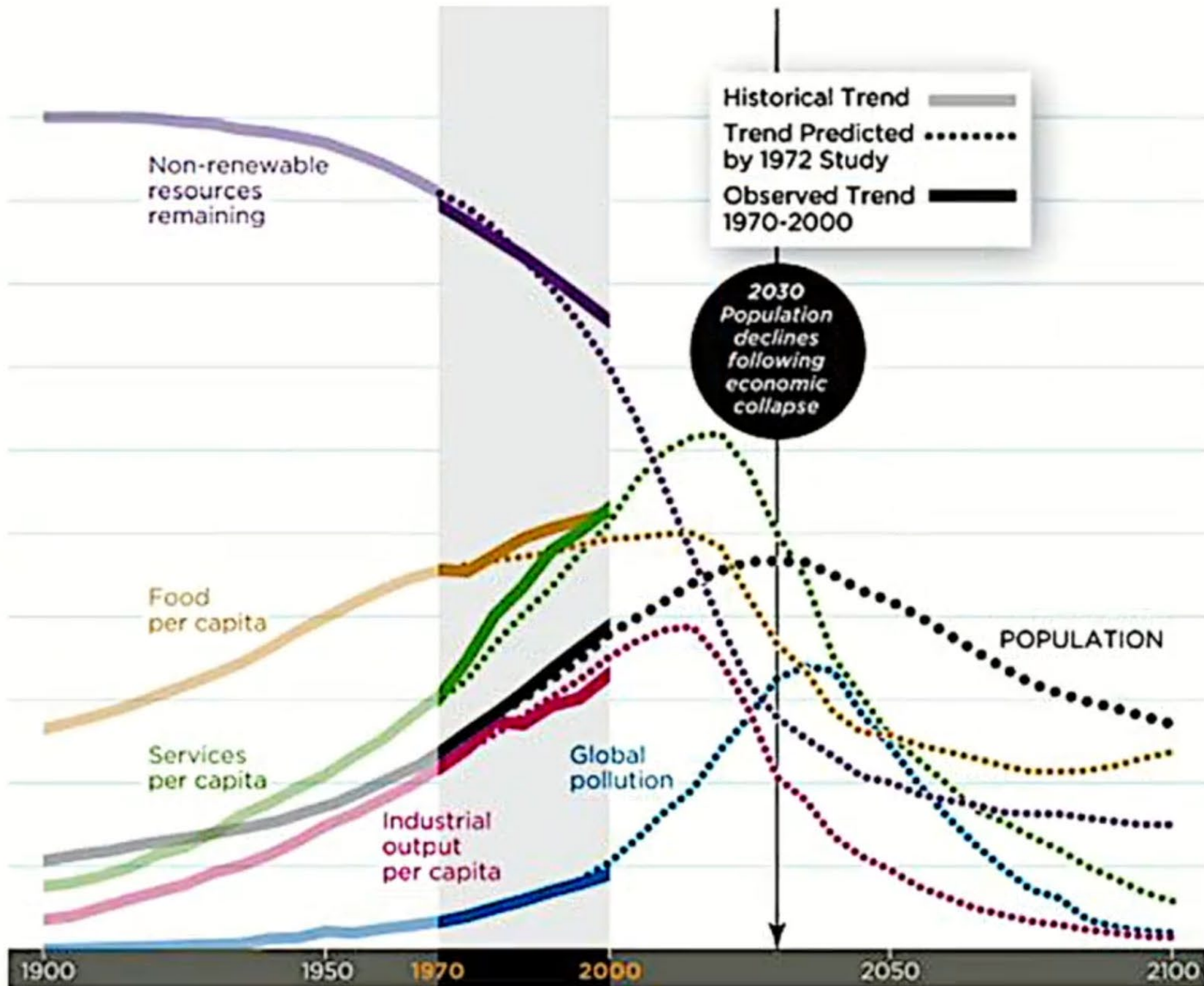
Written by MIT researchers for an international think tank, the Club of Rome, the study used computers to model several possible future scenarios. The business-as-usual scenario estimated that if human beings continued to consume more than nature was capable of providing, global economic collapse and precipitous population decline could occur by 2030.

However, the study also noted that unlimited economic growth was possible, if governments forged policies and invested in technologies to regulate the expansion of humanity's ecological footprint. Prominent economists disagreed with the report's methodology and conclusions. Yale's Henry Wallich opposed active intervention, declaring that limiting economic growth too soon would be "consigning billions to permanent poverty."

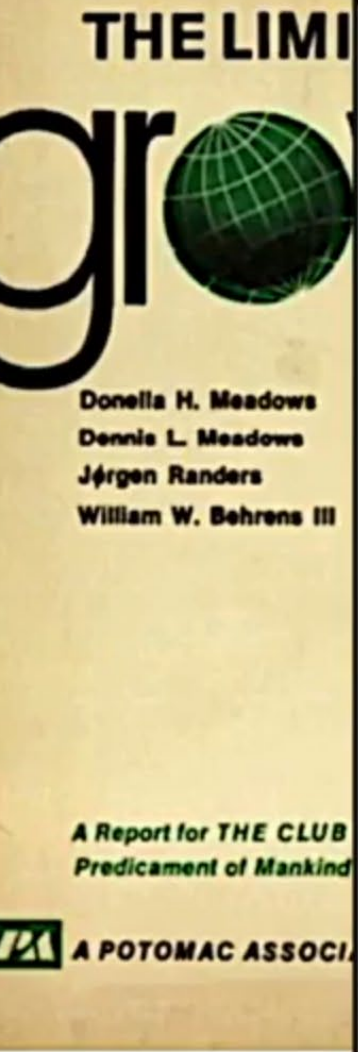
Turner compared real-world data from 1970 to 2000 with the business-as-usual scenario. He found the predictions nearly matched the facts. "There is a very clear warning bell being rung here," he says. "We are not on a sustainable trajectory."

Next in Futurism: [How to Become the Engineers of Our Own Evolution](#)

Smithsonian Magazine
April 2012



THE LIMITS TO GROWTH



Donella H. Meadows
Dennis L. Meadows
Jørgen Randers
William W. Behrens III

A Report for THE CLUB
Predicament of Mankind

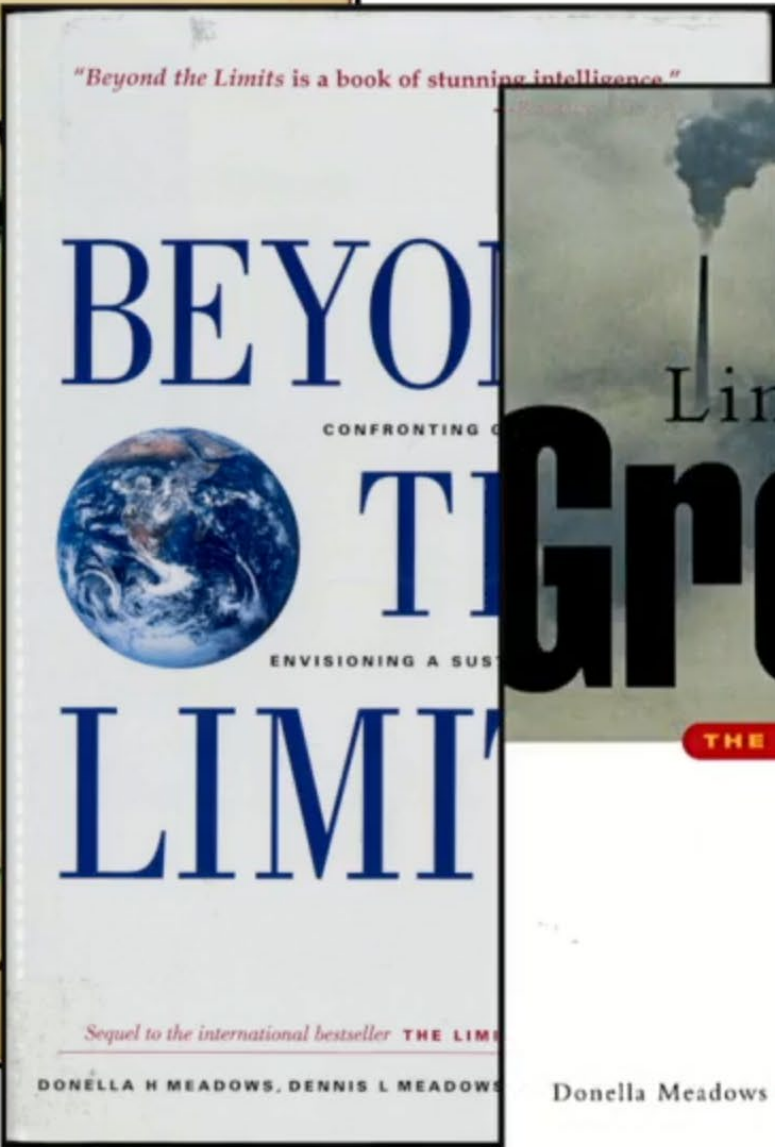
A POTOMAC ASSOCIATION

1972

1992

"Beyond the Limits is a book of stunning intelligence."

BEYOND THE LIMITS TO GROWTH



CONFRONTING OUR LIMITS
ENVISIONING A SUSTAINABLE FUTURE

Sequel to the international bestseller **THE LIMITS TO GROWTH**

DONELLA H. MEADOWS, DENNIS L. MEADOWS

2004

Limits to Growth

2004

THE 30-YEAR UPDATE

Donella Meadows • Jørgen Randers



2012

A Global Warming
for the Next Fifty Years


2012

Jørgen Randers



2022

50 years on from *The Limits to Growth*,
what did we learn and what's next?



EDITED BY UGO BARDI & CARLOS ALVAREZ PEREIRA

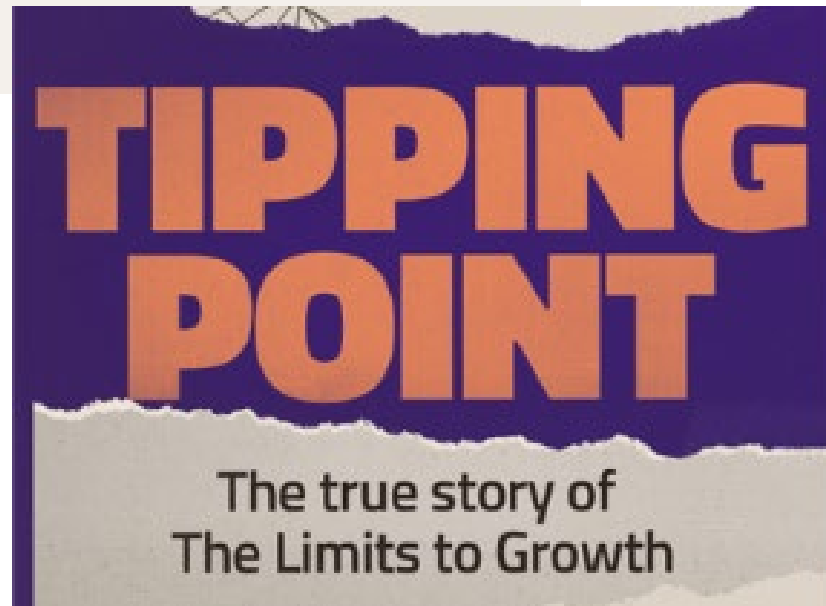
Limits and Beyond

With essays from the original *The Limits to Growth* authors
Dennis Meadows and **Jørgen Randers** and many more.

A REPORT TO THE CLUB OF ROME

50 years ago, they told us what was coming. Why were they ignored?

A podcast about the true-crime story of "The Limits to Growth": The study, the backlash – and its legacy



Honestly it's an amazing series.



Dr. Aaron Thierry



If you listen to one thing this year, make sure it's the stunning "Tipping Point".



Dave Vetter

Forbes Sustainability Senior Contributor



Don't miss this brilliant, gripping podcast that traces the Limits to Growth from its inception in the 1970s to its influence today.



Kate Raworth

@KateRaworth

- <https://tippingpoint-podcast.com/>

Donella Meadows

Thinking in Systems

A Primer

Donella H. Meadows



- *Limits to Growth, Thinking in Systems*
- *14 tips in Dancing with Systems*
- *9 System Traps*
- *12 Leverage Points*
- Oprichter van de 'Academy for Systems Change'

“ We can't control systems or figure them out. But we can dance with them! ”



Thinking in Systems

A Primer

Donella H. Meadows



	Type model	Focus	Mensbeeld	Doel
Thinking in Systems (2009)	Systeemdynamica met feedback loops, vertragingen en niet-lineaire effecten	Begrijpen van complexiteit	Lerend, adaptief en wisselwerkend	Ontwikkelen van systemic literacy. Wie in systemen leert denken, ontwikkelt wijsheid in handelen.

Begrijp het ritme

Luister naar de wijsheid van het systeem

Houd vast aan het doel van goedheid

1.

2.

14.

3.

Leg je mentale modellen bloot

Vier complexiteit

13.

Blijf bescheiden, blijf leren

4.

Verruim de grenzen van zorg

12.

Omgaan met systemen

Eer en bescherm informatie

5.

Verruim je denkhorizon

11.

Zoek verantwoordelijkheid in het systeem

6.

Verruim je tijdshorizon

10.

Maak feedbackbeleid voor feedbacksystemen

7.

Ga voor het welzijn van het geheel

9.

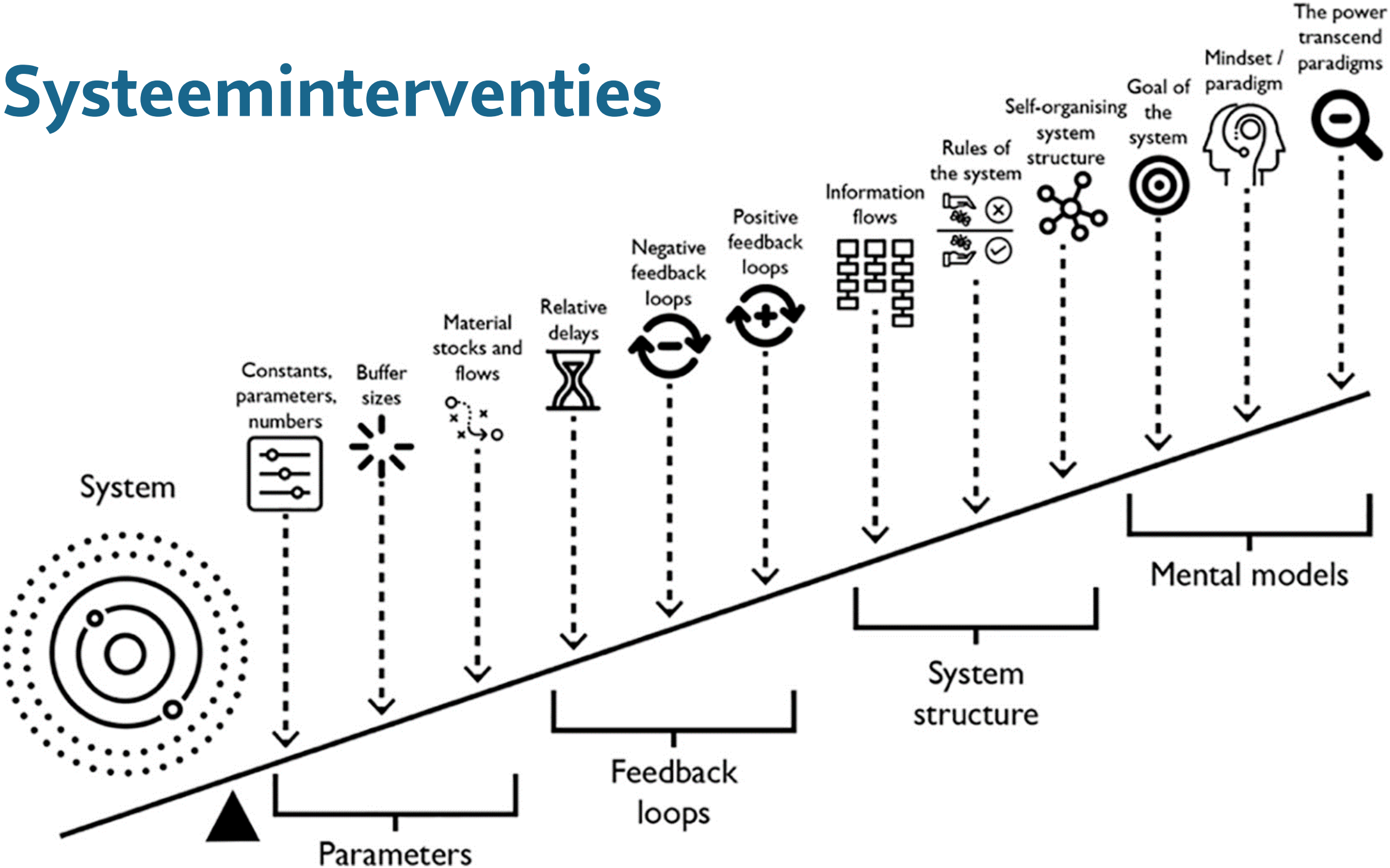
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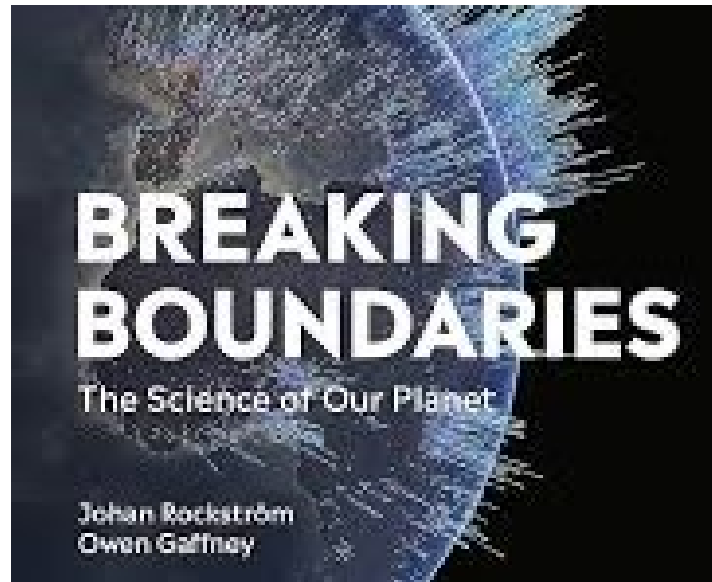
Kijk naar wat belangrijk is, niet alleen meetbaar

Systemvalkuilen

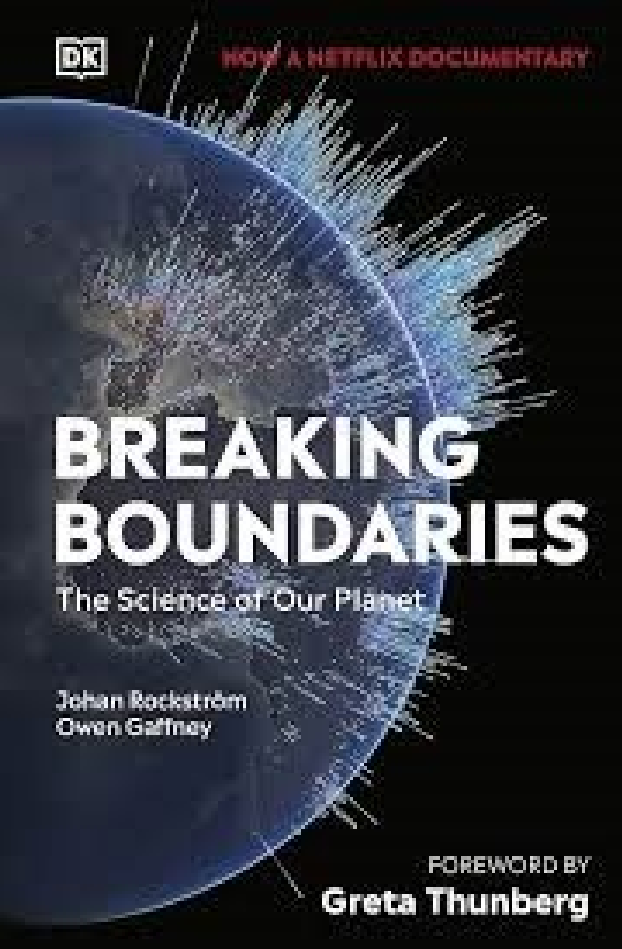
System Trap	Core Issue	Way Out
Policy Resistance	Counteracting goals	Align goals, enhance communication
Tragedy of the Commons	Overuse of shared resource	Manage commons, set limits
Drift to Low Performance	Gradual standard decline	Set strong goals, monitor trends
Escalation	Competing feedback loops	Break loop, redefine competition
Success to the Successful	Unequal resource flow	Equalize opportunities, rebalance
Shifting the Burden	Short-term fixes dominate	Strengthen root solutions
Rule Beating	Exploiting loopholes	Redesign rules, clarify purpose
Seeking the Wrong Goal	Misaligned metrics	Redefine goals, focus on purpose

Systeminterventies





	Type model	Focus	Mensbeeld	Doel
Breaking Boundaries (2021)	Wetenschappelijk ecosysteem	Ecologische grenzen van het aardsysteem	Antropogene stressfactor	Bewaken van planetaire stabiliteit



Johan Rockström

- *Breaking Boundaries*
- 9 planetaire grenzen

“We've moved from a small world on a big planet to a big world on a small planet.”



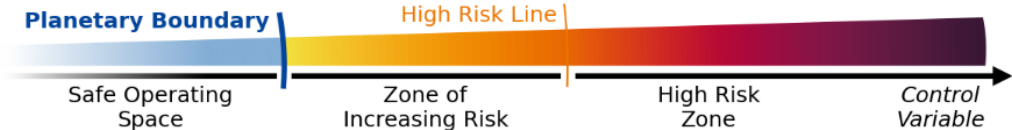
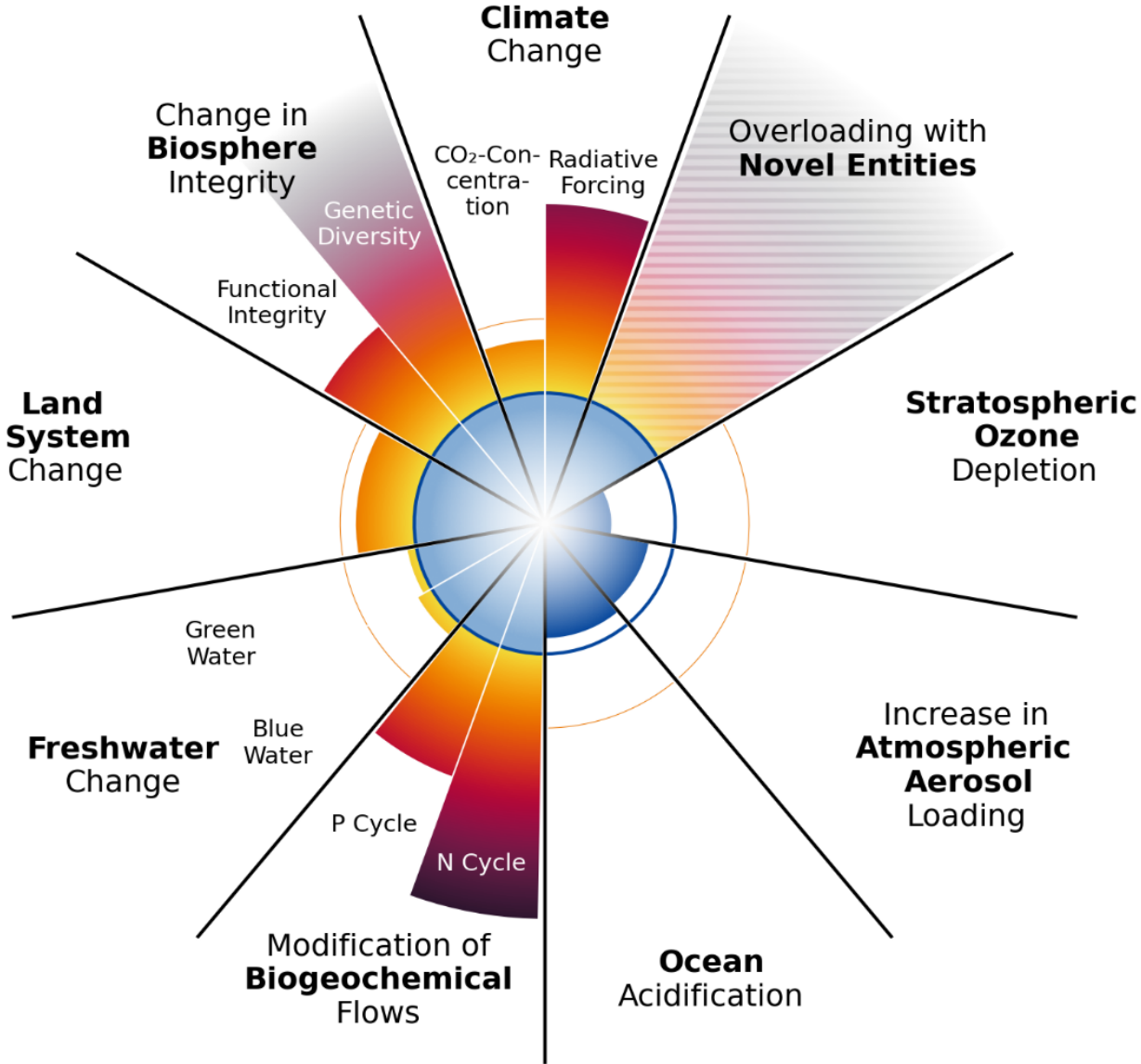


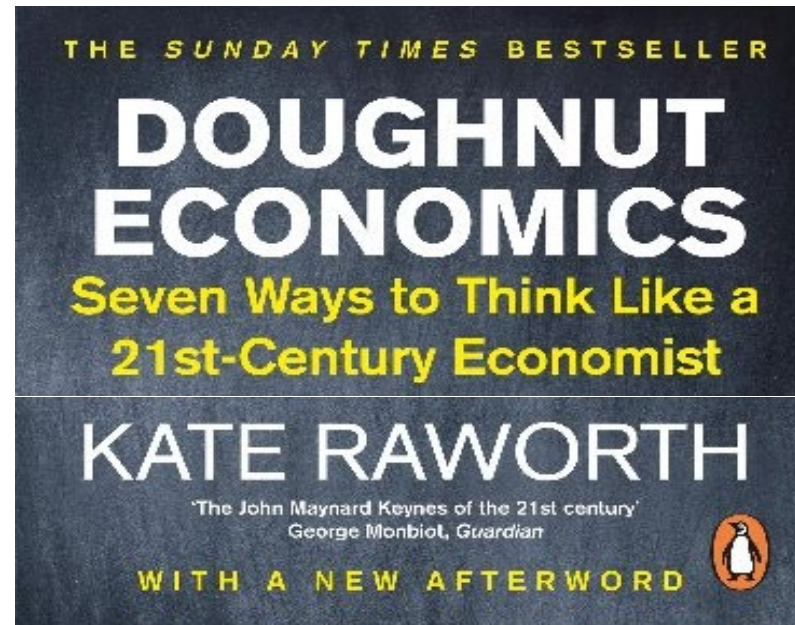
Trailer Breaking Boundaries

NETFLIX

Planetaire grenzen

Bron: <https://www.pik-potsdam.de/en/output/infodesk/planetary-boundaries/images>





	Type model	Focus	Mensbeeld	Doel
Doughnut Economics (2017)	Normatief en integraal socio-ecologisch model	Evenwicht tussen sociale behoeften en ecologische plafonds	Ingebedde, relationele actor die floreert binnen ecologische en sociale grenzen.	Ontwerpen van rechtvaardige regeneratieve economieën

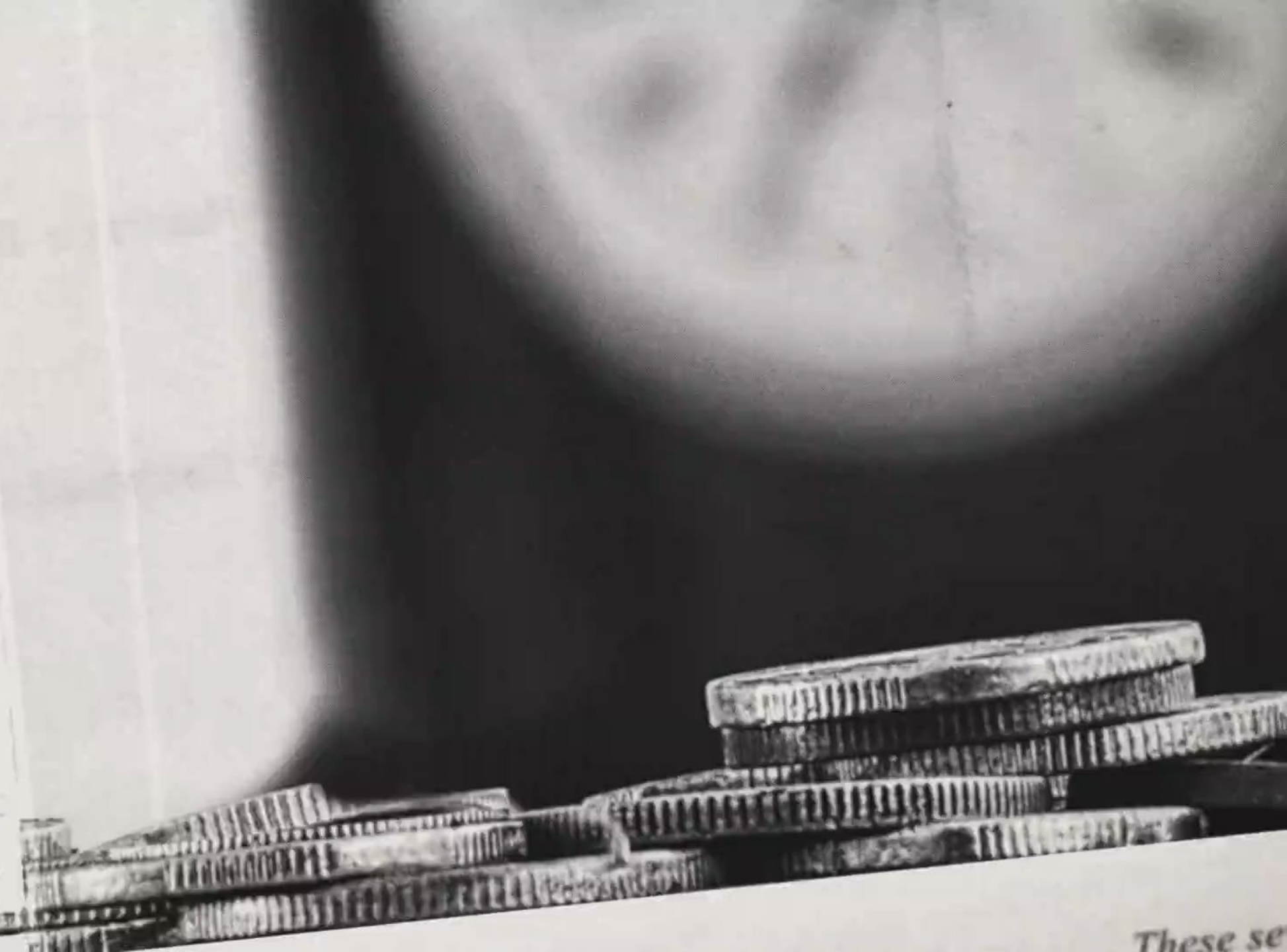
Kate Raworth



- Brits econome
- *Doughnut Economy: Seven Ways to Think Like a 21st-Century Economist*
- Oxford University: Environmental Change Institute
- (Hogeschool van Amsterdam)
- Lid van de Club van Rome

“Get savvy with systems”

1 €	1,25%
1 €	1,25%
2 €	1,20%
5 €	0,90%
76 €	0,89%
63 €	0,88%
70 €	0,88%
	0,69%
850 €	0,55%
145 €	0,59%

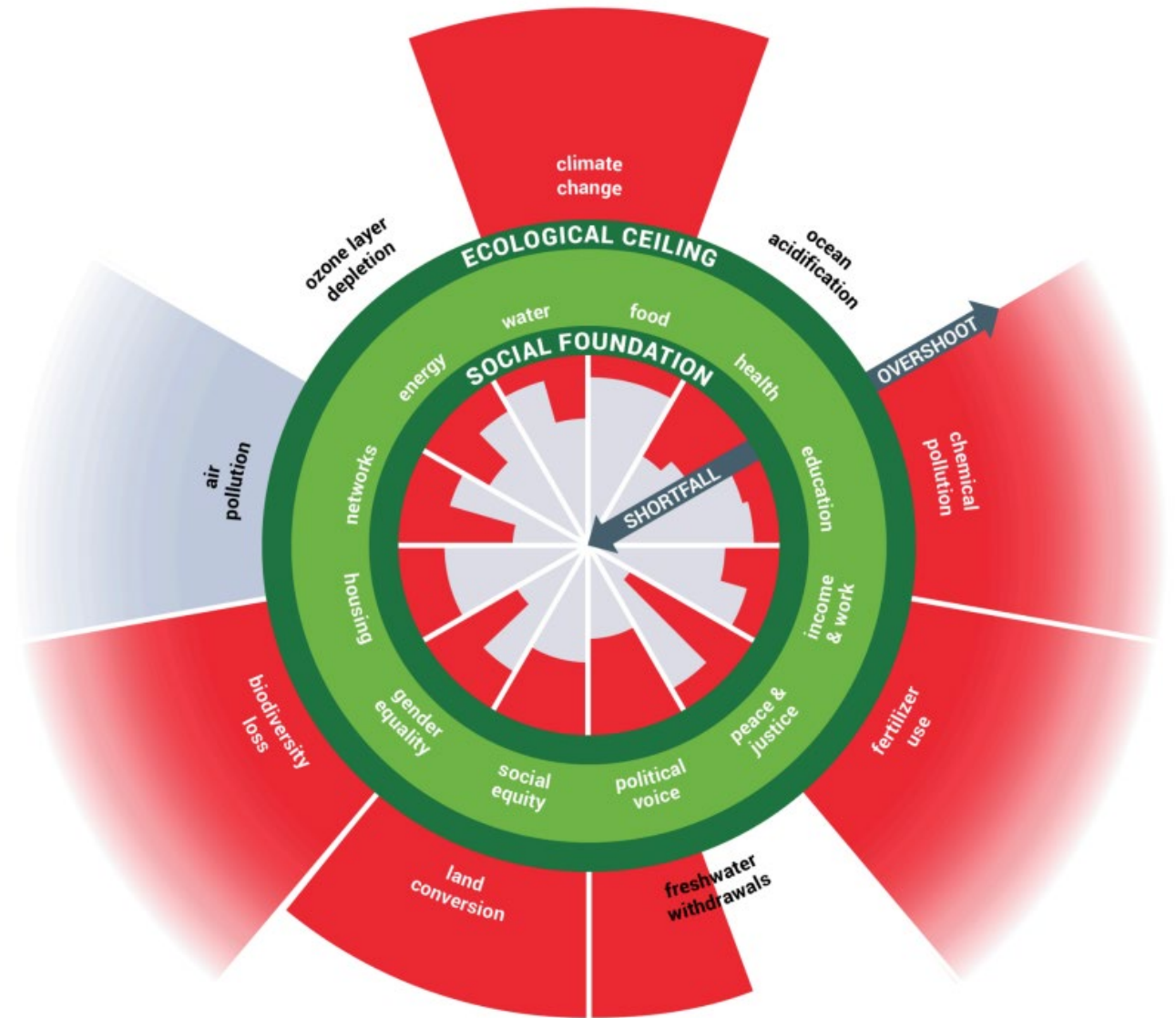


These se

Donuteconomie

Voorzien in de behoeften van alle mensen ...
(sociaal fundament)

... binnen de grenzen van de draagkracht van de levende planeet
(ecologisch plafond)

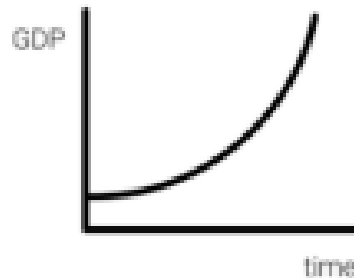


Seven ways to think

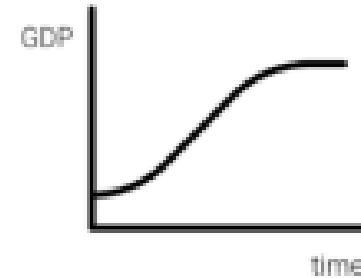
From 20th century economics

To 21st century economics

7 Be agnostic about growth



growth addicted

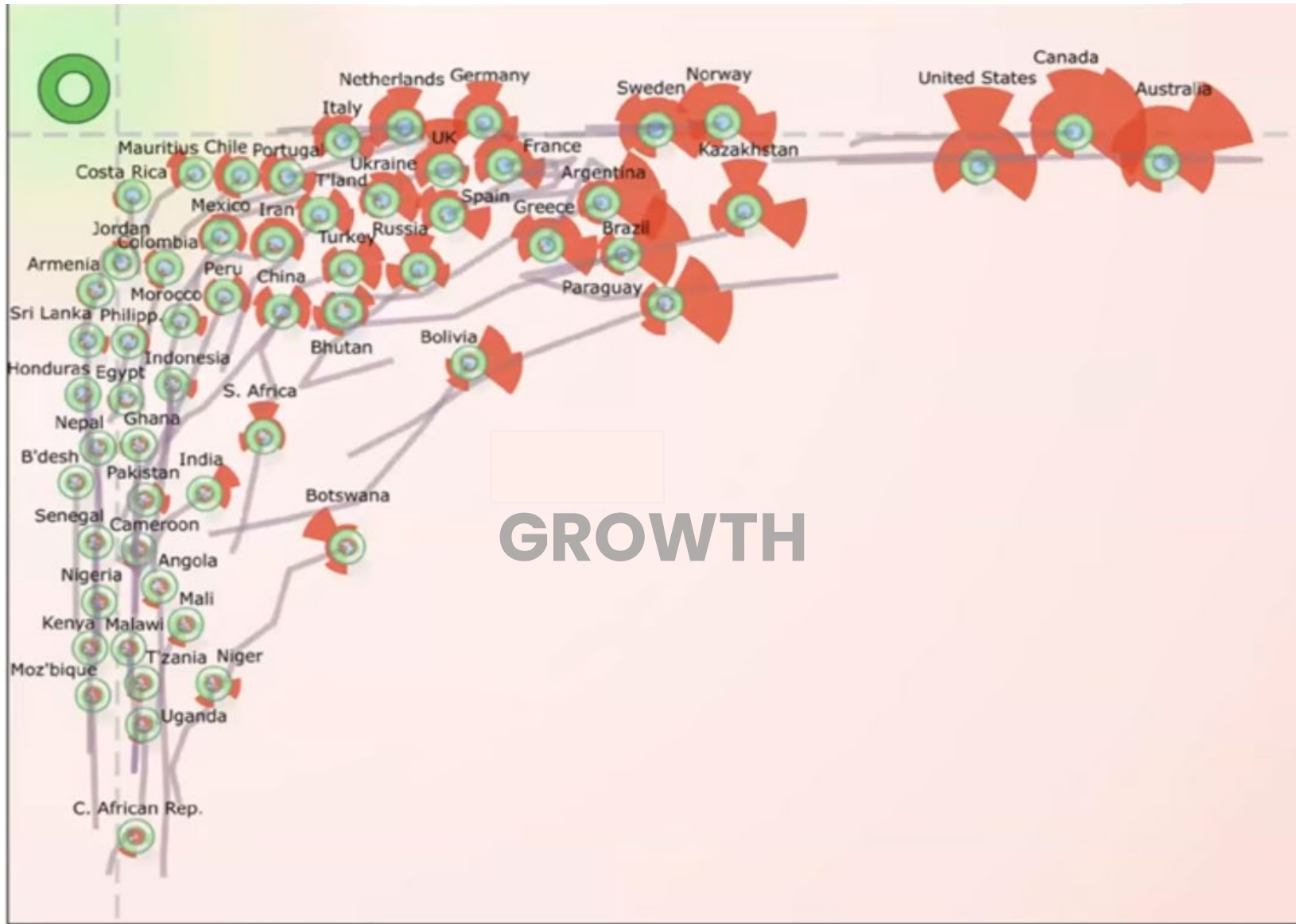


growth agnostic

“We need to move from economies that grow whether or not they make us thrive, to economies that make us thrive whether or not they grow.”

— *Kate Raworth, Doughnut Economics (2017)*

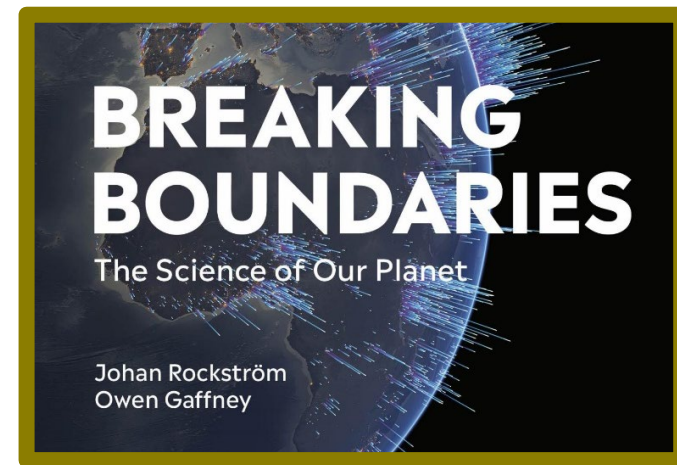
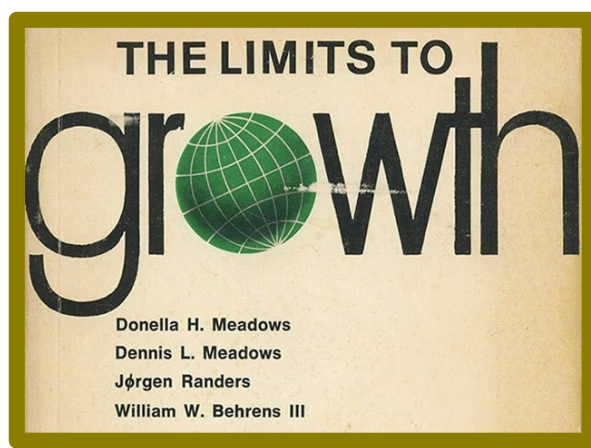
Meeting the needs of all people



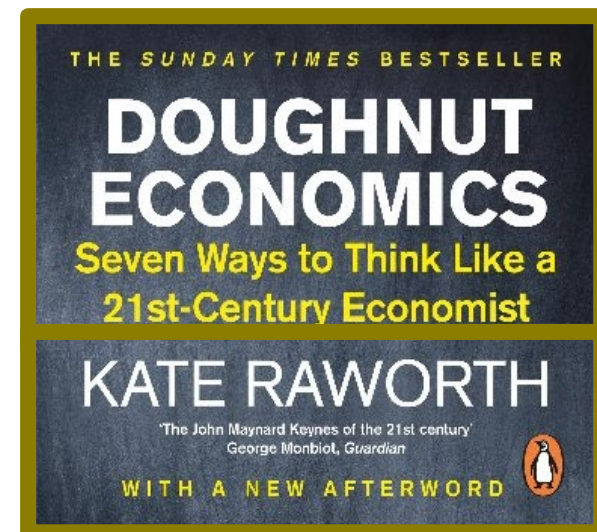
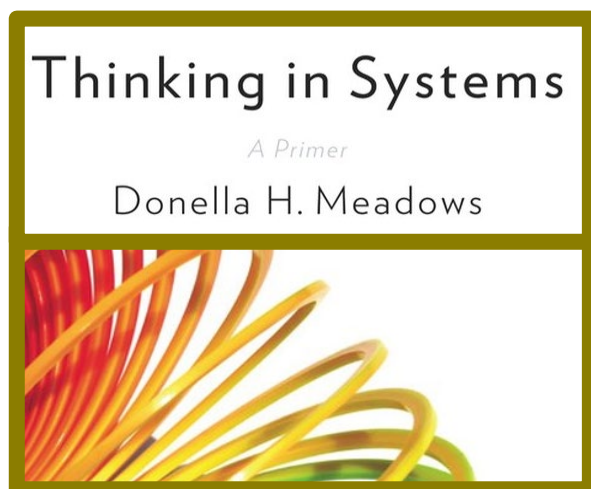
← Within the means of the living planet

4. Get Savvy With Systems - 4/7 Doughnut Economics

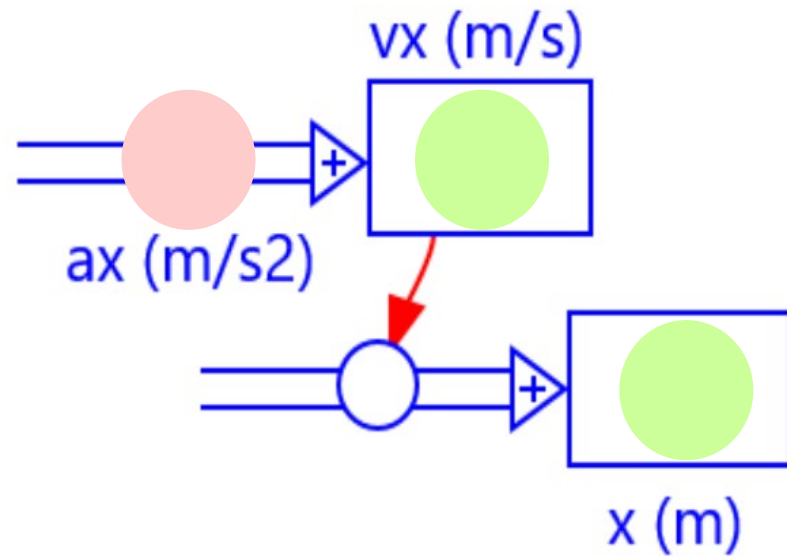




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Thinking in Systems biedt de taal om de complexiteit te begrijpen.
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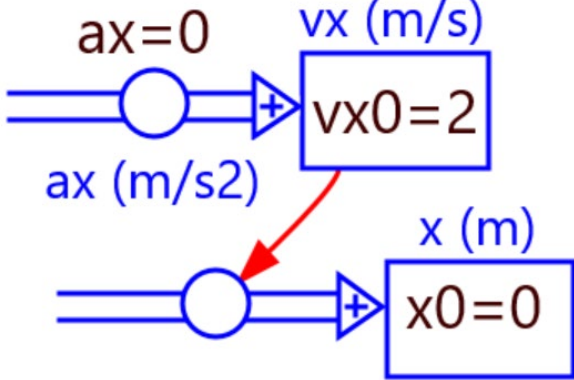
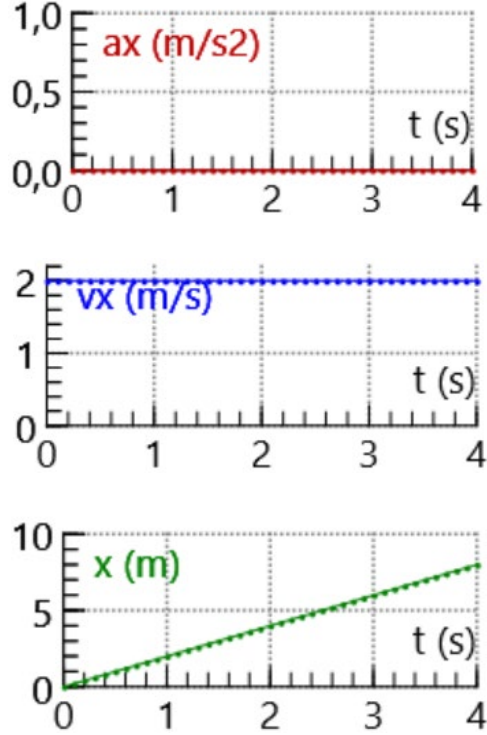
Generiek systeendiagram beweging 1D



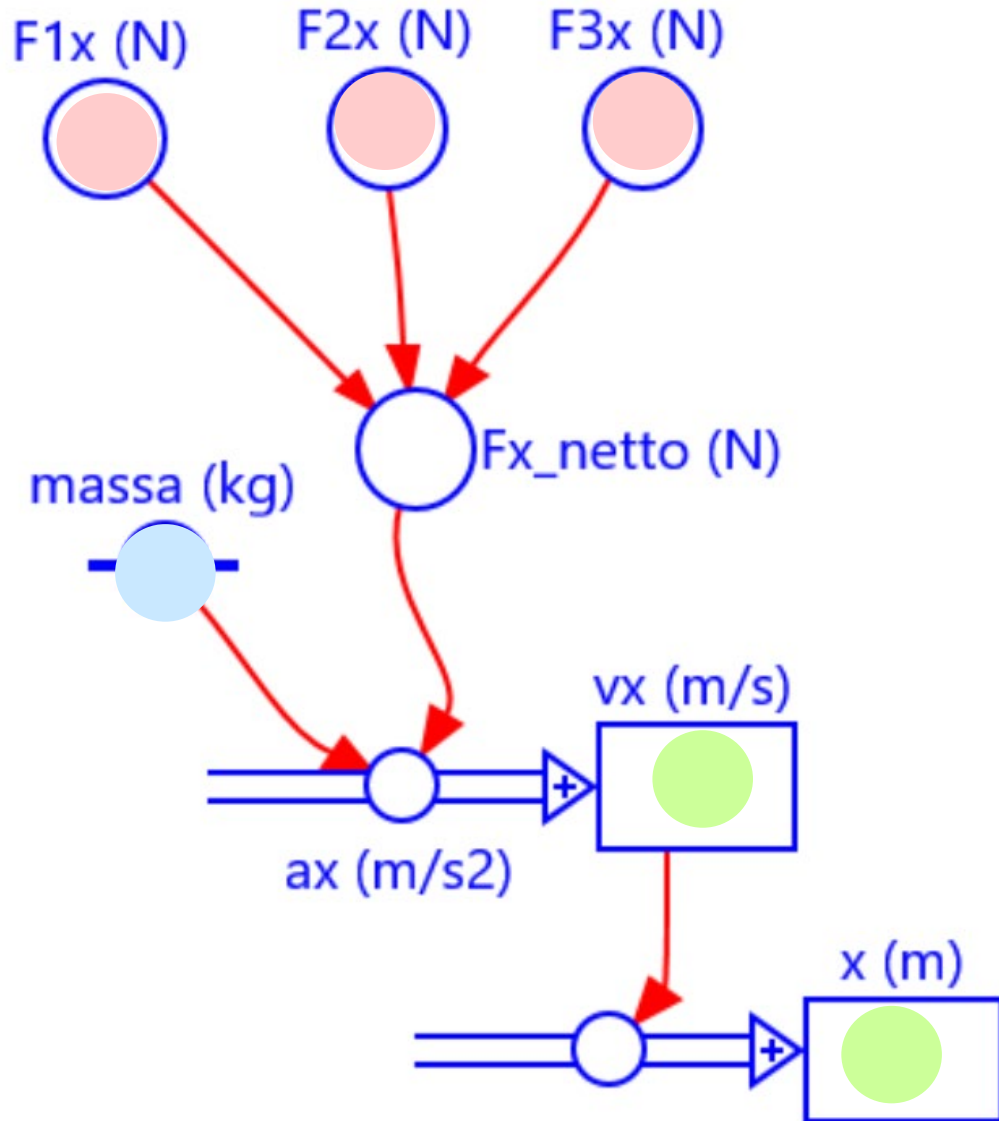
Systeendiagram voor beweging; geldt voor alle rechte bewegingen

“Als je de **startwaarden** van **positie** en **snelheid** kent en je kent de **versnelling als functie van de tijd**, dan ken je de beweging.”

Heen-en-weer denken tussen representaties

verhaal	actie	sys.diagram	tabel	grafieken																
<p>Je loopt met een constante snelheid van 2 m/s. Op $t = 0$ s passeer je het punt $x = 0$ m</p>			<table border="1"> <tbody> <tr> <td>t</td> <td>0</td> <td>1</td> <td>2</td> </tr> <tr> <td>ax</td> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td>vx</td> <td>2</td> <td>2</td> <td>2</td> </tr> <tr> <td>x</td> <td>0</td> <td>2</td> <td>4</td> </tr> </tbody> </table>	t	0	1	2	ax	0	0	0	vx	2	2	2	x	0	2	4	
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ax	0	0	0																	
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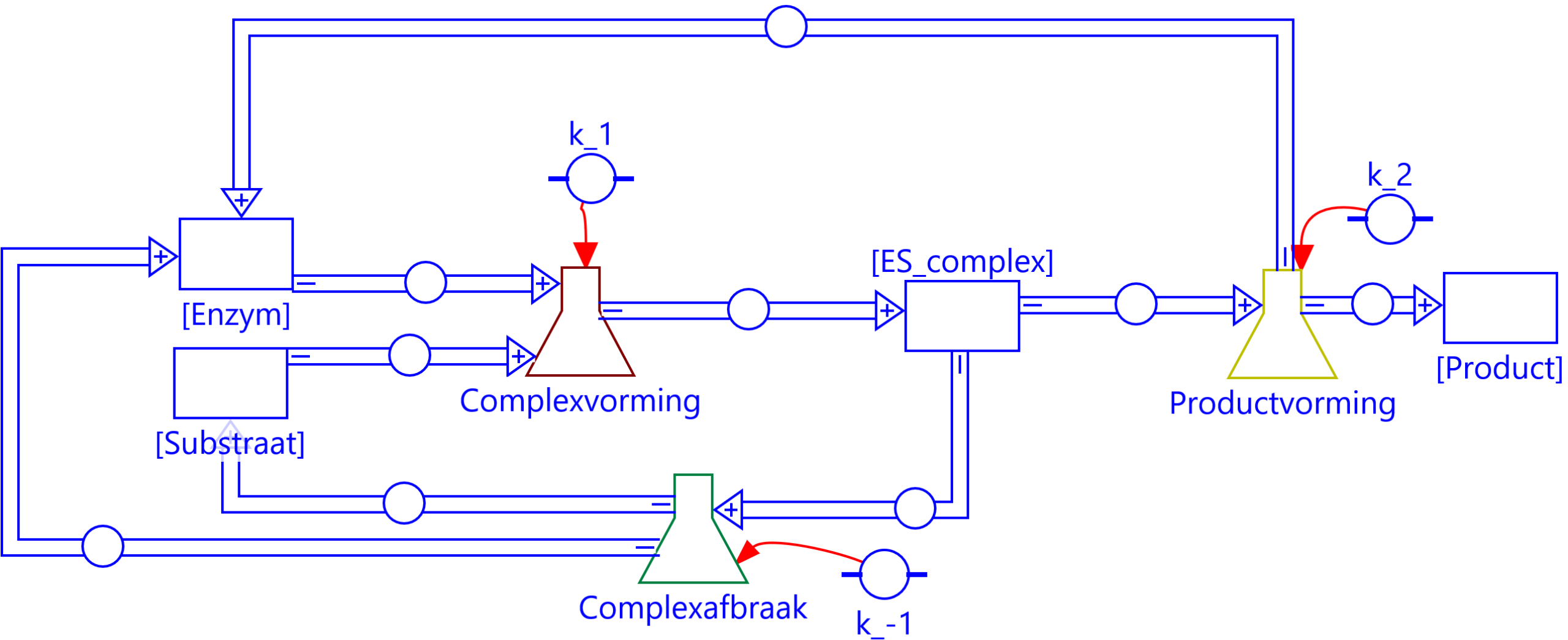
Systeendiagram Kracht en beweging 1D

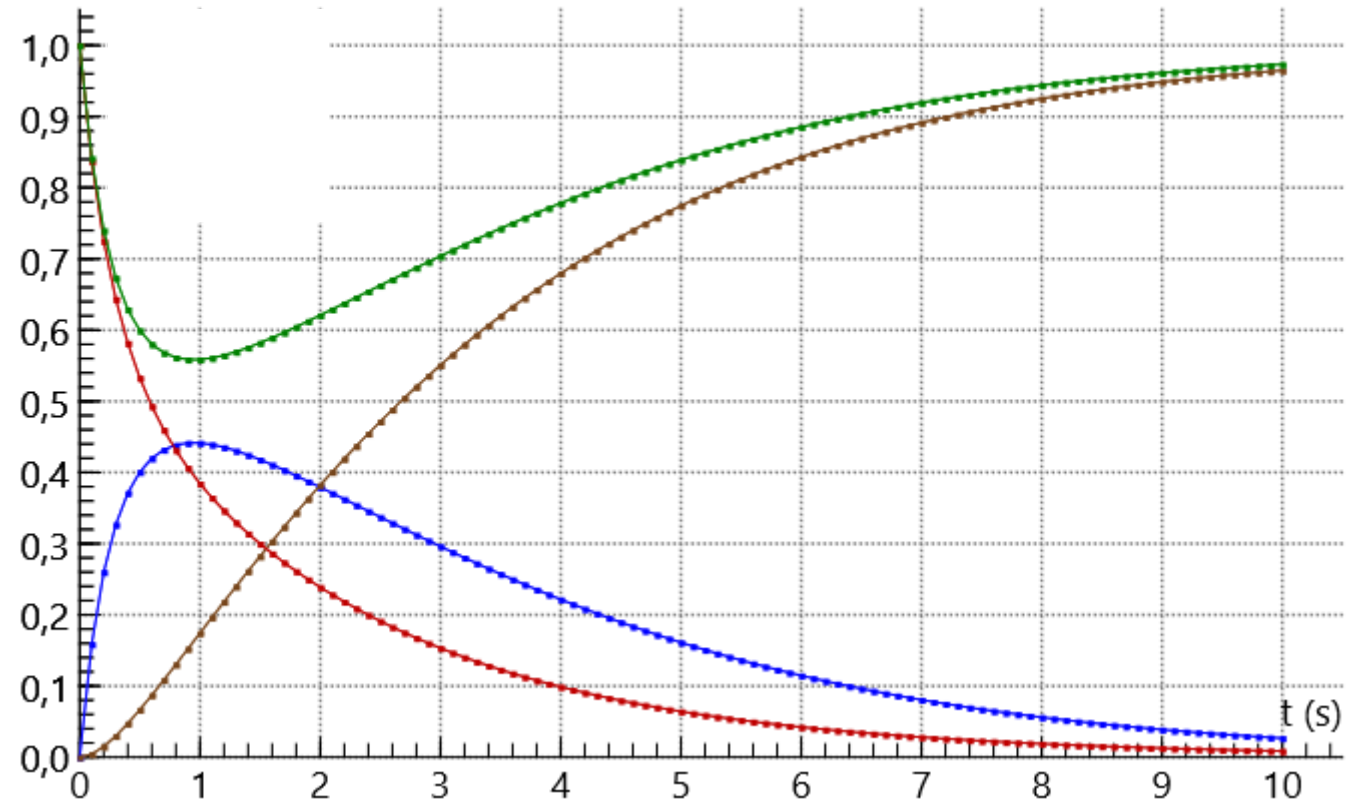
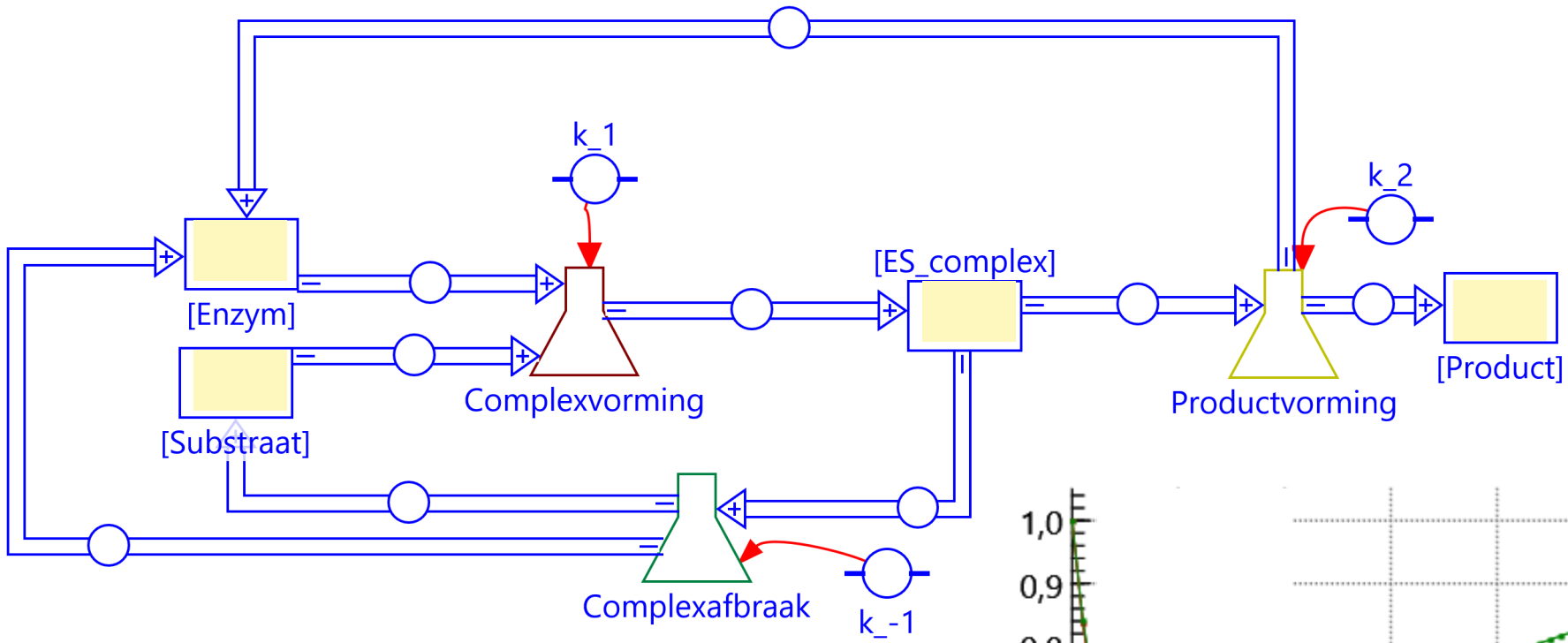


SD 'kracht & beweging';
geldt voor alle situaties waarin beweging en
kracht in 1D gekoppeld worden

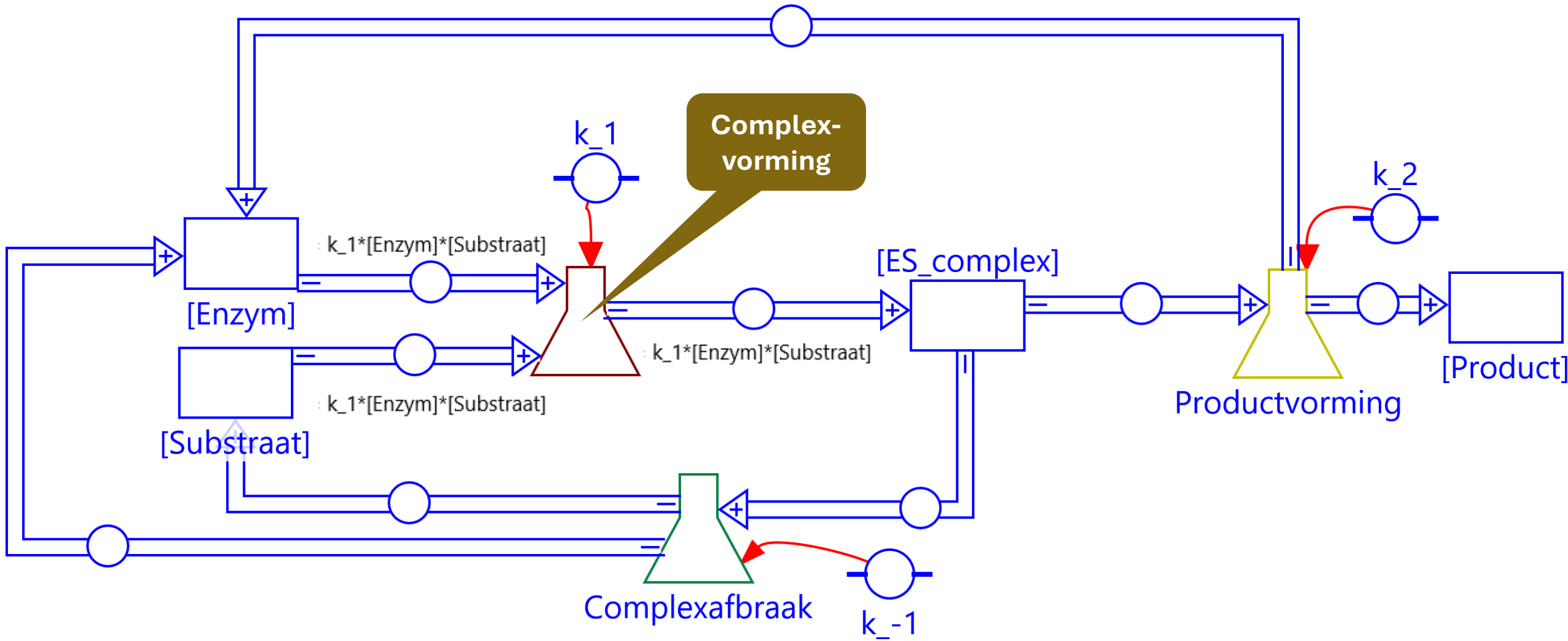
Als je **startwaarden** van **positie** en **snelheid**
kent, de **massa** en **de afzonderlijke krachten**,
dan ken je de beweging.

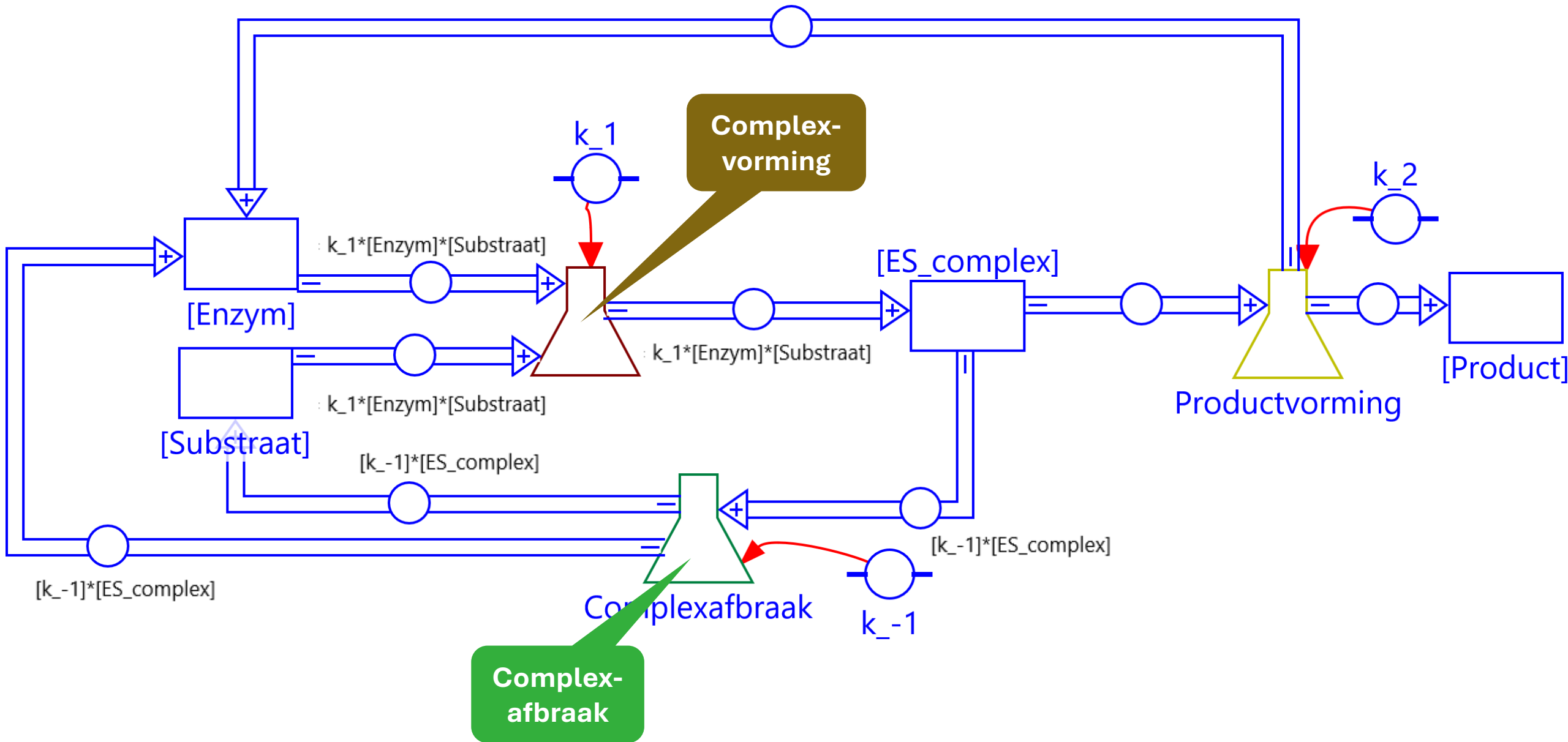
Enzymkinetiek

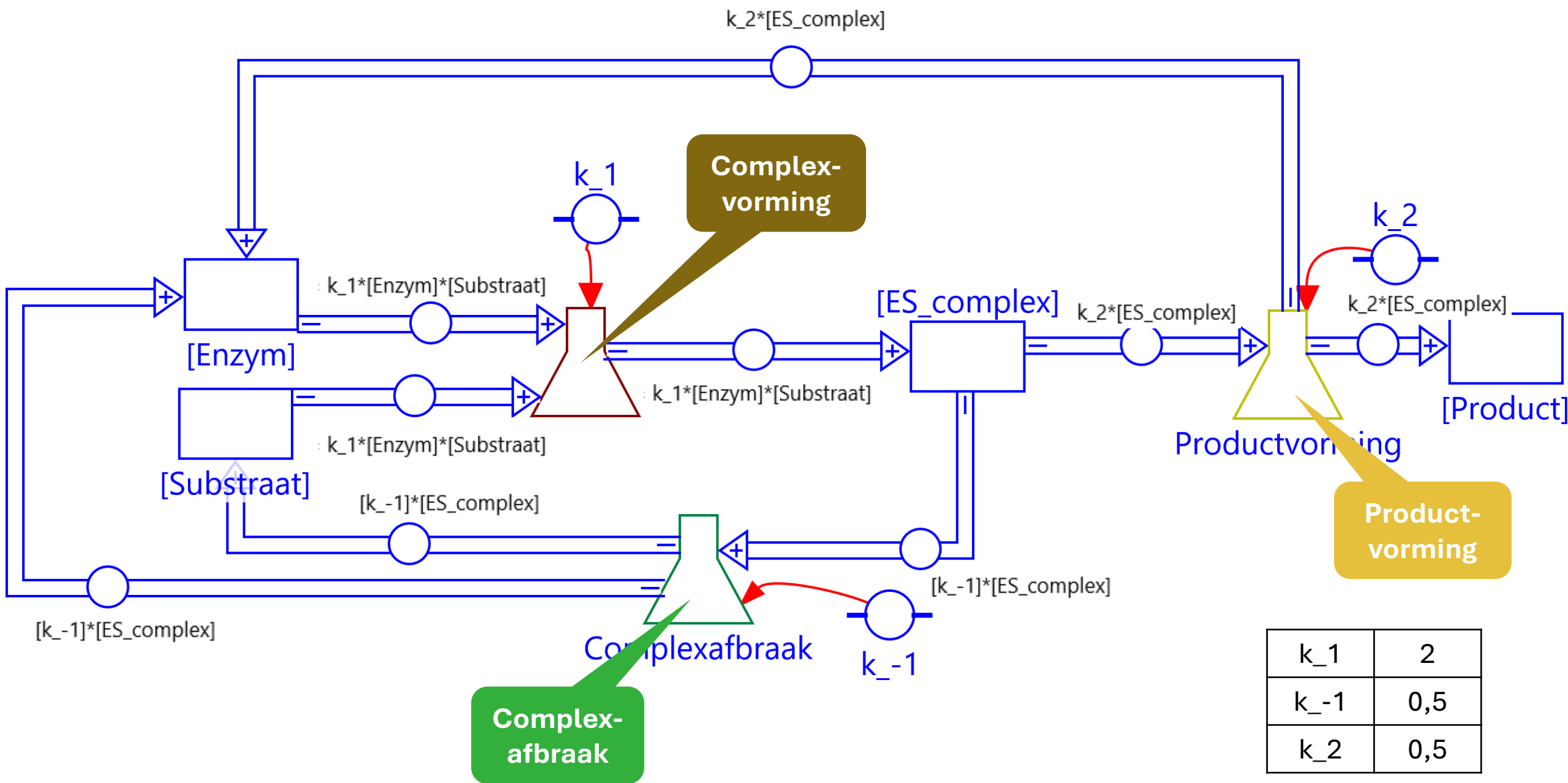


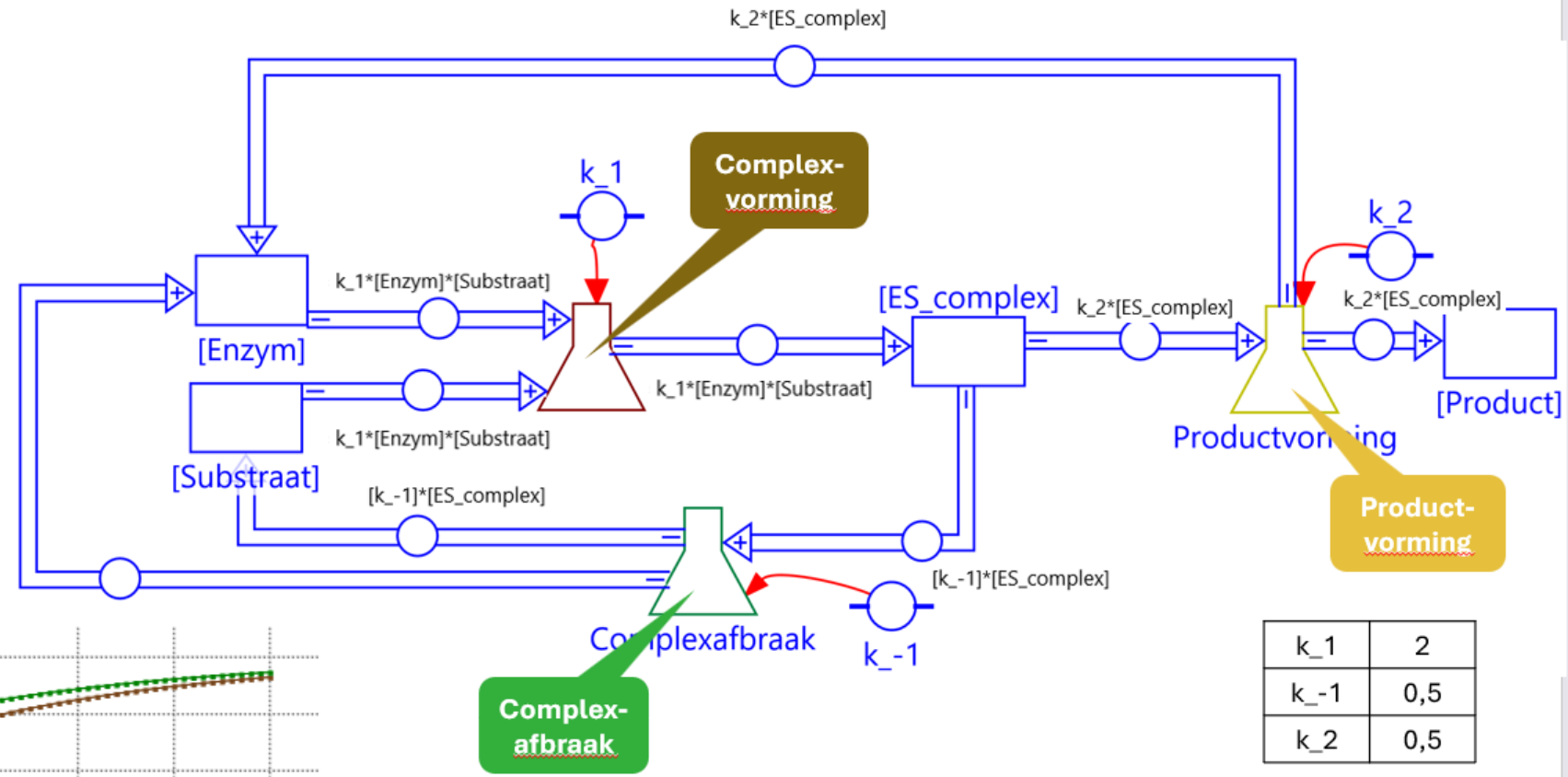


Startwaarden (mol / L)	
[Enzym]	1
[Substraat]	1
[ES_Complex]	0
[Product]	0









k_1	2
k_{-1}	0,5
k_2	0,5

