

# On caring for the future under risk of collapse

Changes+ Colloquium

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**Wolfram Barfuss**

[barfuss@mis.mpg.de](mailto:barfuss@mis.mpg.de)





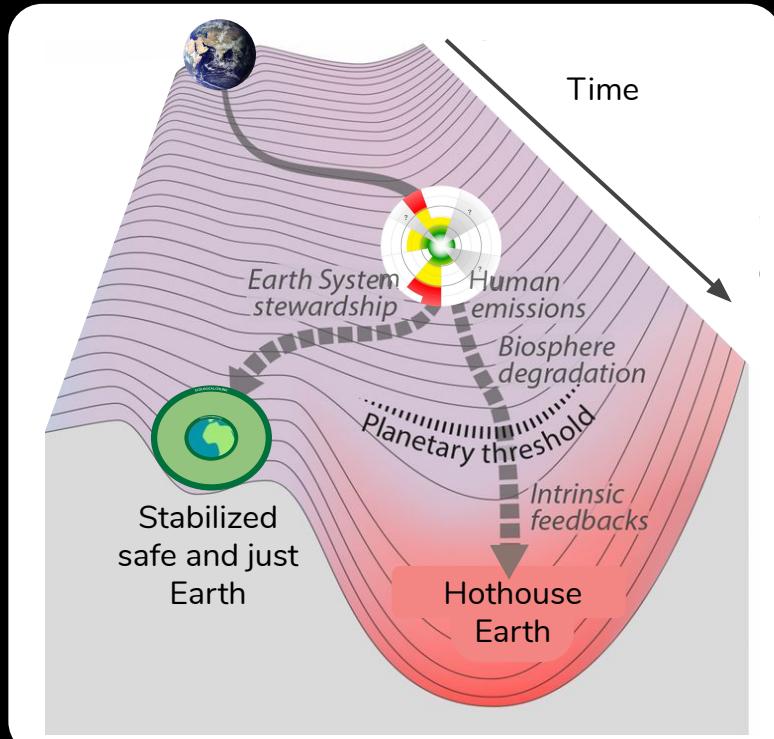
WHY

# The sustainability challenge

**"Collective action required" for long-term sustainability under risk of collapse**



**Research Challenge**  
What are the preconditions for successful collective action?



Steffen et al. (2018), PNAS (modified)

# Public good

N agents,  
individual costly contribution c  
 $\Rightarrow$  mutual benefit b

**The Tragedy of the Commons**

The population problem has no technical solution; it requires a fundamental extension in morality.

Garrett Hardin

**Tragedy of the commons aka Social Dilemma**

At the end of a thousand years the future of nuclear war (1) concluded that the arms race are . . . a dilemma of steadily increasing power and steadily decreasing security. It is our considered professional judgment that this dilemma has no technical solution. If the great powers continue to look for solutions in the area of science and technology only, the result will be to worsen the situation."

I would like to focus your attention not on the subject of the article (national security in a nuclear world) but on the kind of conclusion they reached, namely that there is no technical solution to the problem. An implicit and almost universal assumption of discourse

**What Shall We Maximize?**

Population, as Malthus said, naturally tends to grow "geometrically," or, as we would now say, exponentially. In a finite world this means that the per capita share of the world's goods must steadily decrease. Is ours a finite world?

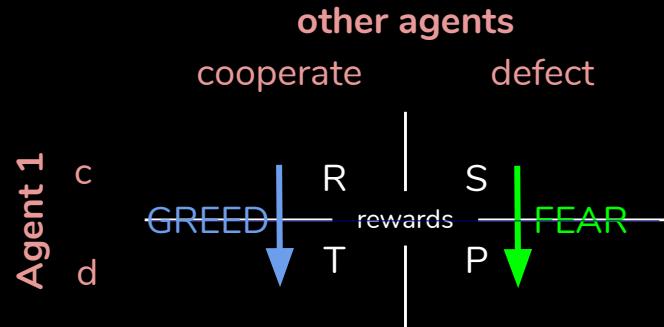
A fair defense can be put forward for the view that the world is infinite; or that we do not know that it is not. But, in terms of the practical problems that we must face in the next few generations with the foreseeable technology, it is clear that we will *already* increase during the next thousand years so that the world human population has no escape

It is easy to show that the class is not a null class. Recall the game of tick-tack-toe. Consider the problem, "How can I win the game of tick-tack-toe?" It is well known that I cannot, if I assume (in keeping with the conventions of game theory) that my opponent understands the game perfectly. Put another way, there is no "technical solution" to the problem. I can win only by giving a radical meaning to the word "win." I can win only by changing the rules of the game.

and, more specifically, with the identification and discussion of one of these. It is easy to show that the class is not a null class. Recall the game of tick-tack-toe. Consider the problem, "How can I win the game of tick-tack-toe?" It is well known that I cannot, if I assume (in keeping with the conventions of game theory) that my opponent understands the game perfectly. Put another way, there is no "technical solution" to the problem. I can win only by giving a radical meaning to the word "win." I can win only by changing the rules of the game.

the or perpetual wide fluctuations above and below zero is a trivial variant that need not be discussed.) When this condition is met, what will be the situation of mankind? Specifically, can Bentham's goal of "the greatest good for the greatest number" be realized?

No—for two reasons, each sufficient by itself. The first is a theoretical one. It is not mathematically possible to maximize for two (or more) variables at the same time. This was clearly stated by von Neumann and Morgenstern (3), but the principle is implicit in the theory of games.



Reward: Nb-c  
 Temptation: (N-1)b  
 Sucker: b-c  
 Punishment: 0

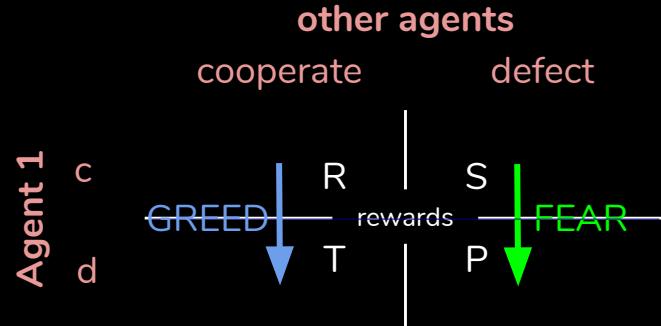
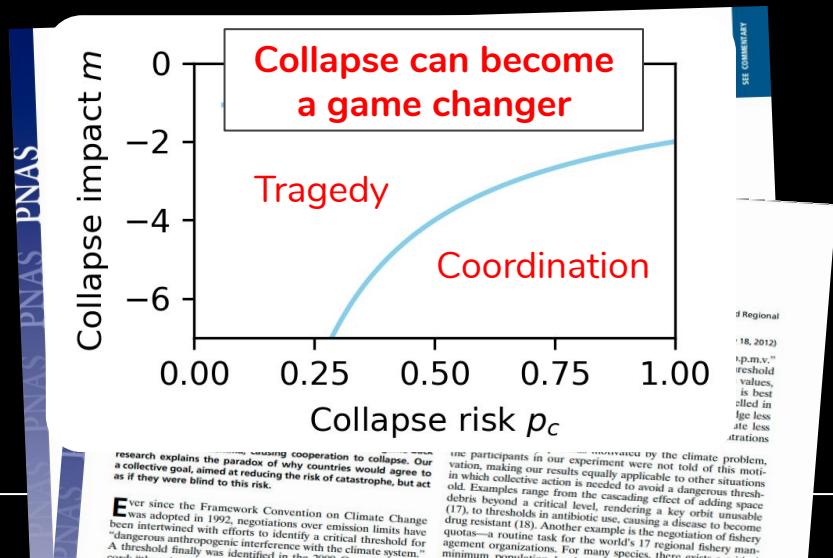
DILEMMA:  $R > P, R > S, 2R > T + S$   
 GREED:  $T > R$   
 FEAR:  $P > S$

# Threshold public good

e.g. Milinski et al. 2008, PNAS, Barrett & Dannenberg 2012, PNAS;

N agents,  
individual costly contribution  $c$   
 $\Rightarrow$  mutual benefit  $b$

risky negative collapse impact  $p_c m$  ( $m < 0$ )  
if not all actors contribute

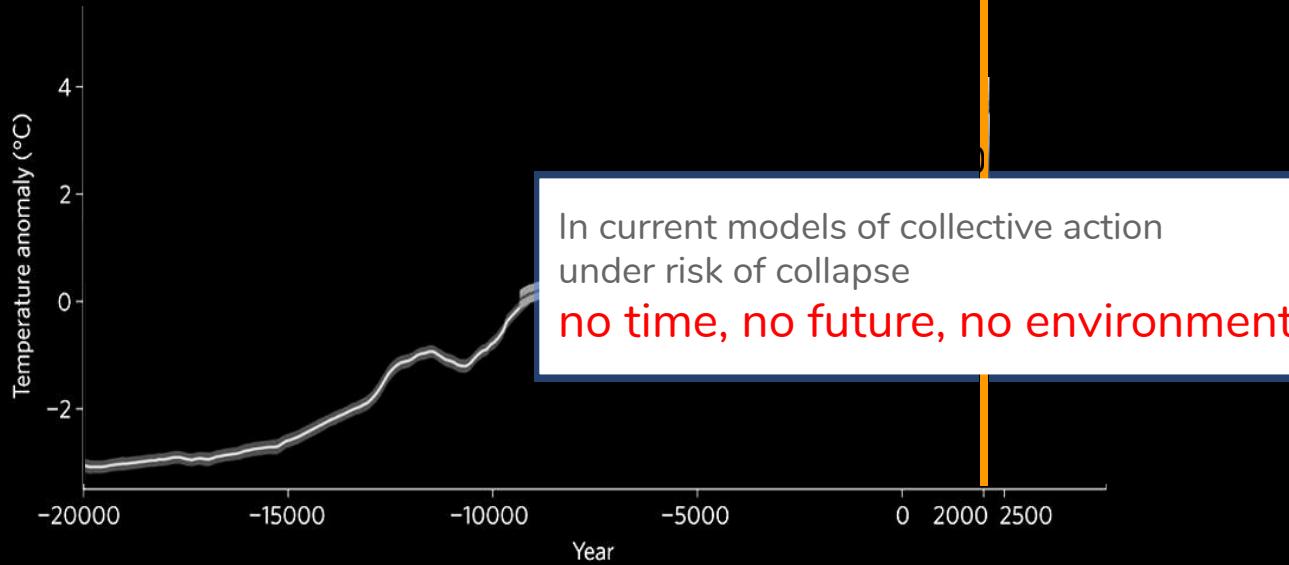


Reward:  $Nb - c$   
 Temptation:  $(N-1)b + p_c m$   
 Sucker:  $b - c + p_c m$   
 Punishment:  $0 + p_c m$

DILEMMA:  $R > P, R > S, 2R > T + S$   
 GREED:  $T > R$   
 FEAR:  $P > S$

In 50 years we tipped from  
10,000 years Holocene to the Anthropocene

What we do the next 50 years  
will determine the next 10,000 years





HOW

# Ecological public good

N agents with discount factor  $\gamma$ ,  
2 states: prosperous and degraded

at prosperous state:

individual costly contribution  $c$

$\Rightarrow$  mutual benefit  $b = fc/N$

(contributions multiplied by  $f$  and equally distributed)

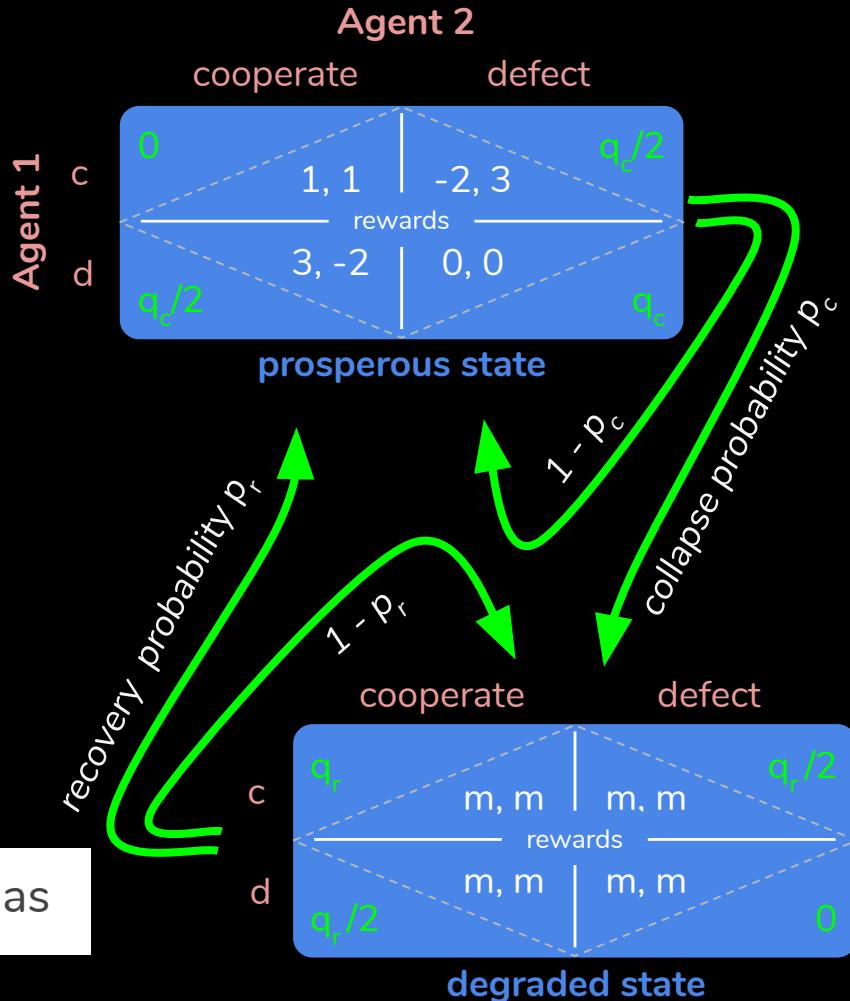
marginal collapse risk  $q_c$  for defection

at degraded state:

negative collapse impact  $m < 0$

marginal recovery chance  $q_r$  for cooperation

Social dilemmas  $\Rightarrow$  Social-ecological dilemmas



# How do time preferences influence collective action under risk of collapse?

3 components:

- i) time scales  $q_c, q_r$  and time preferences  $\gamma$
- ii) the magnitude of the collapse impact  $m < 0$
- iii) the size of the collective  $N$

A nighttime satellite view of Earth from space, showing city lights and auroras.

WHAT

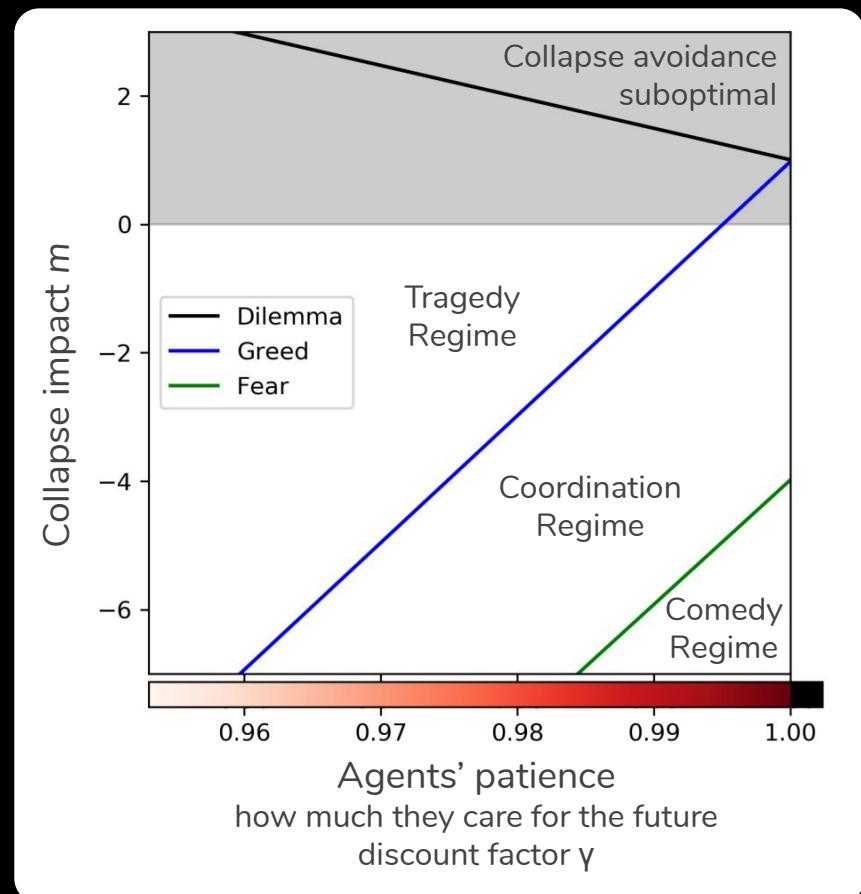
# Caring for the future can turn tragedy into comedy

... if collapse impact is sufficiently severe

Model exhibits the full **drama of the commons** (Ostrom et al., 2002).

Caring for the future is normative.

⇒ Polarization threatens climate agreements.



# Caring for the future more important at slower time scales

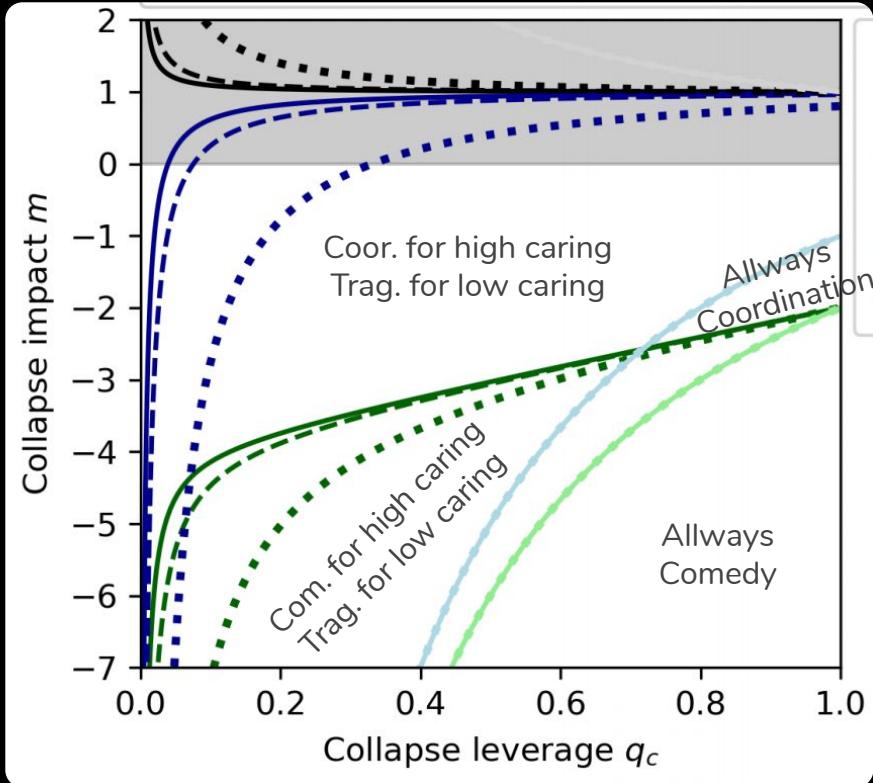
Changes between three regimes  
possible only at slow time scales

Recovery influential if it  
can happen fast

Recovery is ignored by  
myopic actors

- Dilemma at  $\gamma = 0.99$
- Greed at  $\gamma = 0.99$
- Fear at  $\gamma = 0.99$
- Dilemma at  $\gamma = 0$
- Greed at  $\gamma = 0$
- Fear at  $\gamma = 0$

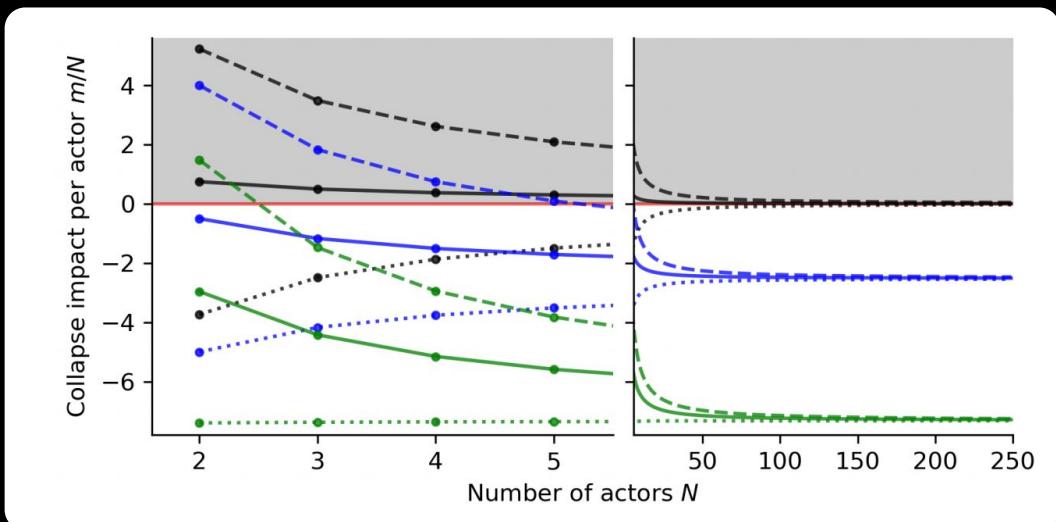
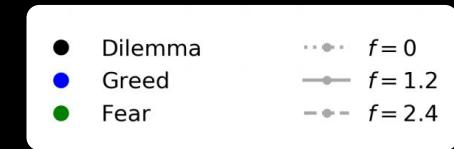
—  $q_r = 0.0001$     - - -  $q_r = 0.01$     - · - · -  $q_r = 0.1$



# Diffusion of responsibility under increasing number of actors

Impact scales with size of the collective  $N$ , independent of the public good's enhancement factor

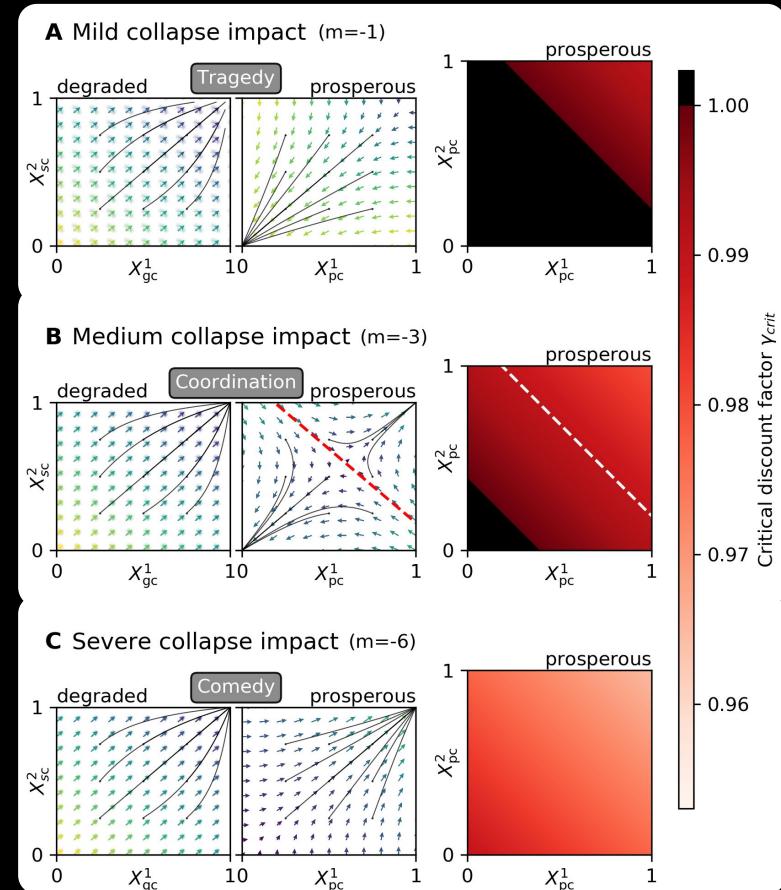
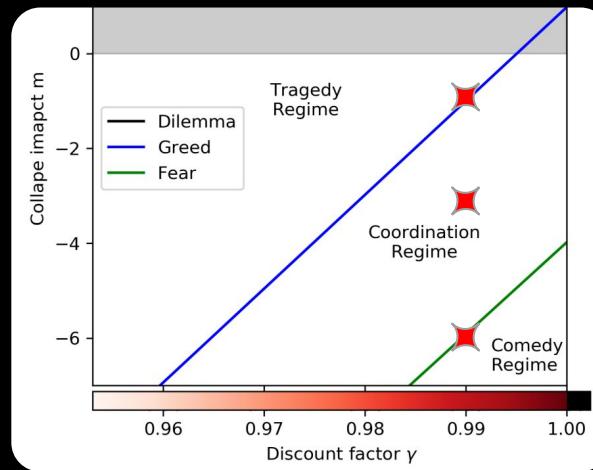
At large  $N$ , the game is dominated by prospects of collapse



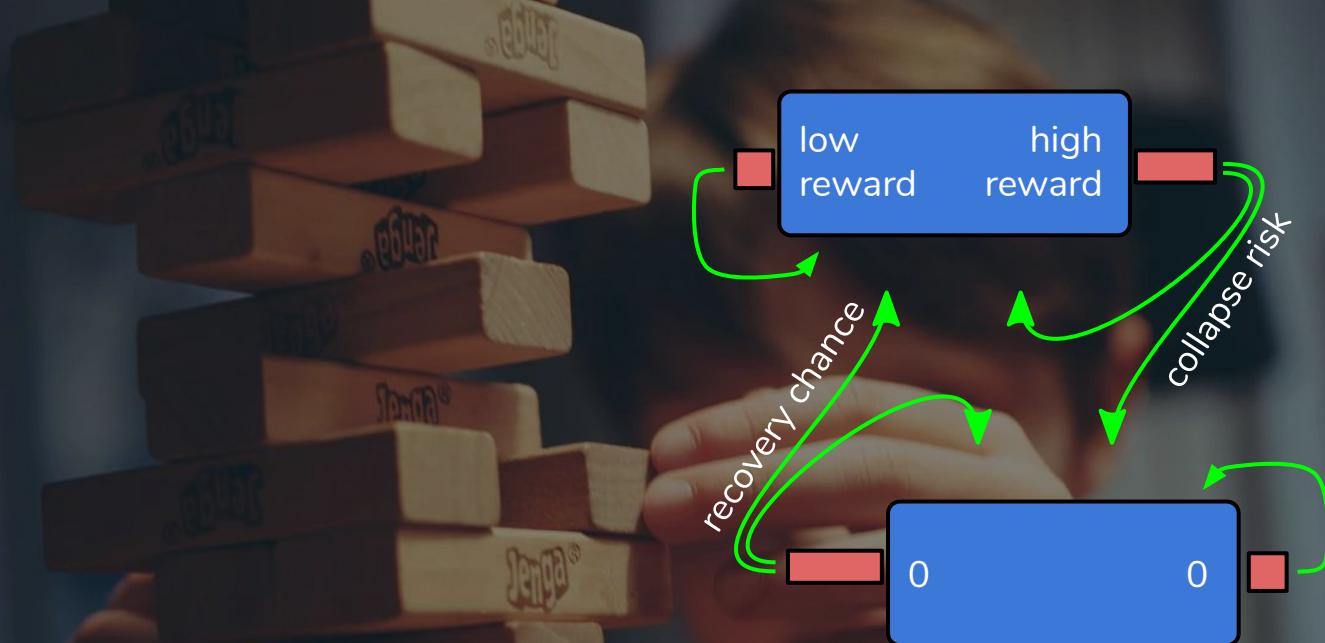
# Learning dynamics micro-found regimes

Cooperation cannot be learned even by most future-caring actros from black hole regime in strategy space

Black hole exists when game regime is not a comedy



# Decision problem under risk of collapse

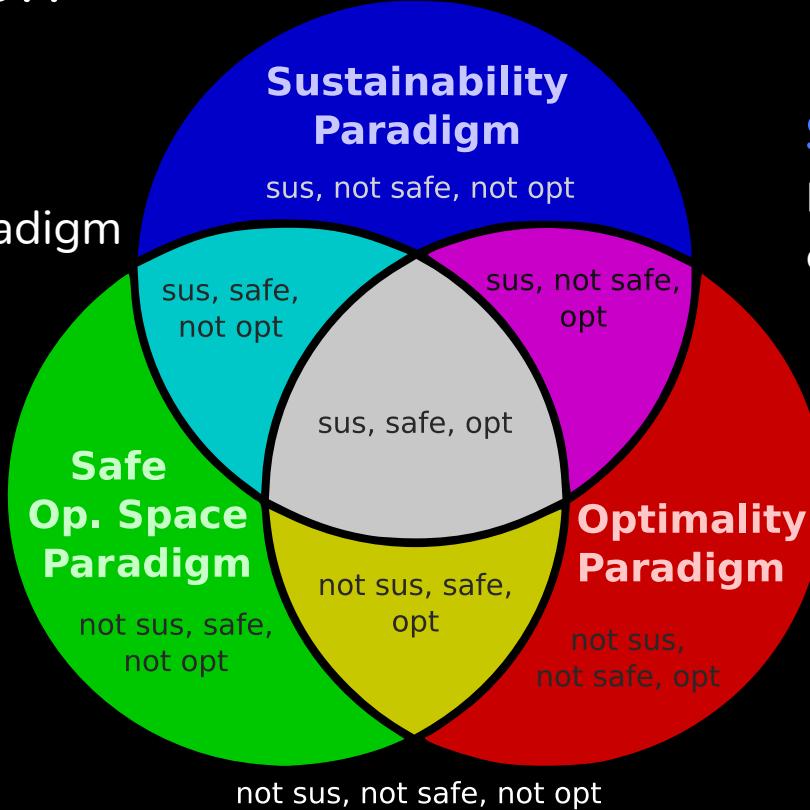


# Three decision paradigms

without a master paradigm

## Safe Operating Space

Be always in  
safe conditions



## Sustainability

Be always in acceptable  
conditions

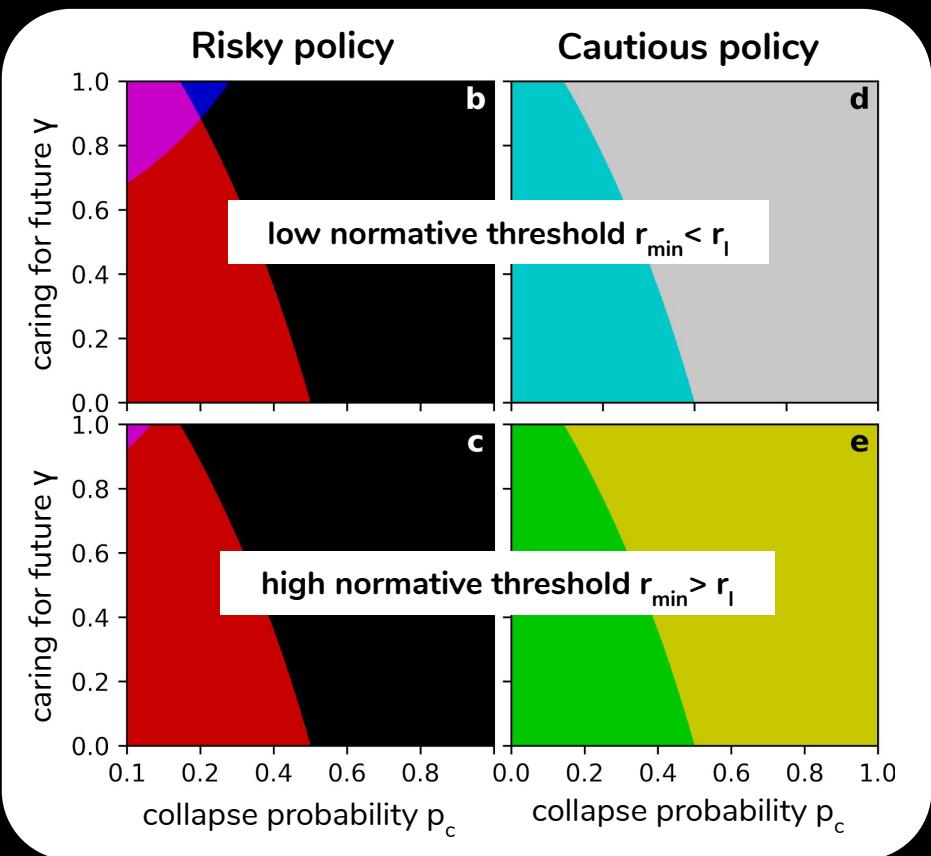
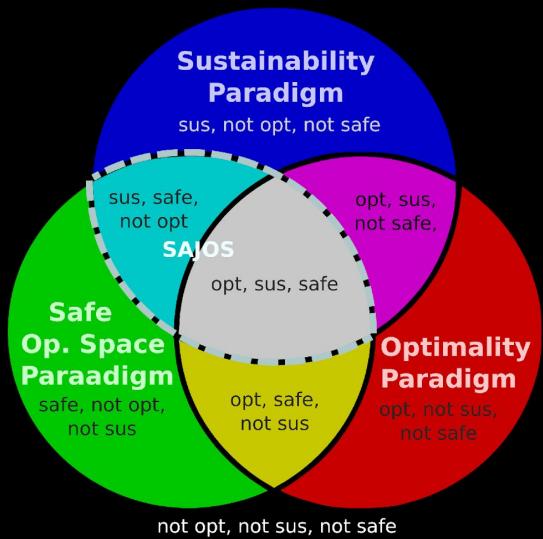


## Optimization

Maximize  
economic welfare



# Three decision paradigms in parameter space without a master paradigm

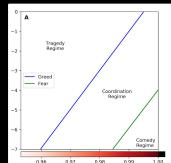




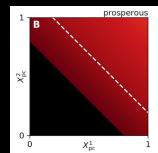
SUM

# Summary

How do time preferences influence collective action under risk of collapse?



Caring for the future can turn tragedy into comedy for sufficiently severe and distant collapse impacts.



For a large number of actors, the collective action challenge is dominated by the prospects of collapse and experiences a diffusion of responsibility.

Learning dynamics able to micro-found equilibrium regimes and reveal a black hole regime in strategy space.

Optimization can lead to sustainable and safe policies, but is not guaranteed to do so. This trade-off does not vanish under sufficient caring for the future.



# Thank You



Wolfram Barfuss  
[barfuss@mis.mpg.de](mailto:barfuss@mis.mpg.de)



Max Planck Institute for  
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