On caring for the future under risk of collapse

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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 ⇒ mutual benefit b

The Tragedy of the Commons

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

Gottfried H. Hardy

At the end of a talk on the future of mankind in New York (!) I concluded that the arms race could continue only if the means of mutual destruction were steadily decreasing in effectiveness. It is our considered professional judgment that this dilemma has no technical solution. If the means of mutual destruction are steadily decreasing in effectiveness, then the arms race cannot continue. The arms race is not a self-sustaining cycle. It is an inescapable fact of human nature that the arms race cannot continue. If the means of mutual destruction are steadily decreasing in effectiveness, then the arms race cannot continue.

I would like to focus your attention on the subject of the article (which is in my opinion the most important issue facing us in the 21st century) and to point out that the solution of the problem lies not in technical solutions but in the understanding of the problem. To understand the problem, you need to understand the nature of the solution. To understand the solution, you need to understand the nature of the problem.

Tragedy of the commons aka Social Dilemma

<table>
<thead>
<tr>
<th>Cooperate</th>
<th>Defect</th>
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<td>Rewards</td>
<td>Sucker</td>
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<tr>
<td>Punishment</td>
<td>FEAR</td>
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Agent 1

What Shall We Measure?

Population, as wellbeing, 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 this a finite world?

A fair person can be put forward for the view that the world is infinite; or that we do not know that it is not. But, in either case, there is a practical problem that we must face in the next few generations with the forecasts of the future. We are faced with the problem of how to use the resources of the world. We must make a choice between the alternative of using the resources of the world or not using them. The choice is not between using the resources of the world and not using them. The choice is between using the resources of the world and not using them. The choice is not between using the resources of the world and not using them. The choice is between using the resources of the world and not using them.

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

The core of the tragedy of the commons is the problem of how to use the resources of the world. The problem is not how to use the resources of the world, but how to use the resources of the world in a way that is acceptable to all. The problem is not how to use the resources of the world, but how to use the resources of the world in a way that is acceptable to all. The problem is not how to use the resources of the world, but how to use the resources of the world in a way that is acceptable to all. The problem is not how to use the resources of the world, but how to use the resources of the world in a way that is acceptable to all. The problem is not how to use the resources of the world, but how to use the resources of the world in a way that is acceptable to all.
Threshold public good

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

N agents, individual costly contribution c ⇒ mutual benefit b

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

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

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

In current models of collective action under risk of collapse:

no time, no future, no environment
Intertemporal collective action under risk of collapse

HOW
Ecological public good

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

at prosperous state:
individual costly contribution $c$
⇒ 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 ⇒ 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 $N$
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
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

Barfuss et al. (2019), Phys. Rev. E, 99, 043305,
Decision problem under risk of collapse

- Low reward
- High reward
- Recovery chance
- Collapse risk
Three decision paradigms

- **Sustainability**
  - Be always in acceptable conditions

- **Safe Operating Space**
  - Be always in safe conditions

- **Optimality**
  - Maximize economic welfare

Barfuss et al. (2018), Nature Communications 9, 2354
Three decision paradigms in parameter space without a master paradigm.
What mathematical framework to use?
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

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