The Tragedy of the Commons

THE ECONOMIC THEORY OF A COMMON-PROPERTY RESOURCE: THE FISHERY[1]

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I. INTRODUCTION

THE chief aim of this paper is to examine the economic theory of natural resource utilization as it pertains to the fishing industry. It will appear, I hope, that most of the problems associated with the words "conservation" or "depletion" or "overexploitation" in the fishery are, in reality, manifestations of the fact that the natural resources of the sea yield no economic rent. Fishery resources are unusual in the fact of their common-property nature; but they are not unique, and similar problems are encountered in other cases of common-property resource industries, such as petroleum production, hunting and trapping, etc. Although the theory presented in the following pages is worked out in terms of the fishing industry, it is, I believe, applicable generally to all cases where natural resources are owned in common and exploited under conditions of individualistic competition.

II. BIOLOGICAL FACTORS AND THEORIES

The great bulk of the research that has been done on the primary production phase of the fishing industry has so far been in the field of biology. Owing to the lack of theoretical economic research,[2] biologists have been forced to extend the scope of their own thought into the economic sphere and in some cases have penetrated quite deeply, despite the lack of the analytical tools of economic theory.[3] Many others, who have paid no specific attention to the economic aspects of the problem have nevertheless recognized that the ultimate question is not the ecology of life in the sea as such, but man's use of these resources for his own (economic) purposes. Dr. Martin D. Burkenroad, for example, began a recent article on fishery management with a section on "Fishery Management as Political Economy," saying that "the Management of fisheries is intended for the benefit of man, not fish; therefore effect of management upon fishstocks cannot be regarded as beneficial *per se*."[4] The

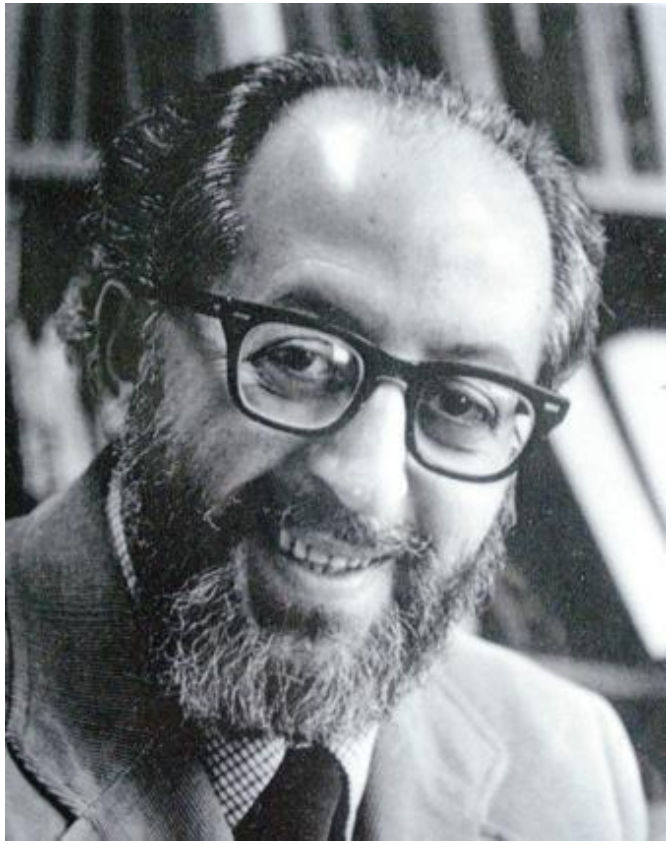
[1] I want to express my indebtedness to the Canadian Department of Fisheries for assistance and co-operation in making this study; also to Professor M. C. Urquhart, of Queen's University, Kingston, Ontario, for mathematical assistance with the last section of the paper and to the Economists' Summer Study Group at Queen's for affording opportunity for research and discussion.

[2] The single exception that I know is G. M. Gerhardsen, "Production Economics in Fisheries," *Revista de economia* (Lisbon), March, 1952.

[3] Especially remarkable efforts in this sense are Robert A. Nesbit, "Fishery Management" ("U.S. Fish and Wildlife Service, Special Scientific Reports," No. 18 [Chicago, 1943]) (mimeographed), and Harden F. Taylor, *Survey of Marine Fisheries of North Carolina* (Chapel Hill, 1951); also R. J. H. Beverton, "Some Observations on the Principles of Fishery Regulation," *Journal du conseil permanent international pour l'exploration de la mer* (Copenhagen), Vol. XIX, No. 1 (May, 1953); and M. D. Burkenroad, "Some Principles of Marine Fishery Biology," *Publications of the Institute of Marine Science* (University of Texas), Vol. II, No. 1 (September, 1951).

[4] "Theory and Practice of Marine Fishery Management," *Journal du conseil permanent international pour l'exploration de la mer*, Vol. XVIII, No. 3 (January, 1953).

1954



Scott H. Gordon (Economist)

The Tragedy of the Commons

The Tragedy of the Commons

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

Garrett Hardin

At the end of a thoughtful article on the future of nuclear war, Wiesner and York (*1*) concluded that: "Both sides in the arms race are . . . confronted by the dilemma of steadily increasing military power and steadily decreasing national 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 discussions published in professional and semipopular scientific journals is that the problem under discussion has a technical solution. A technical solution may be defined as one that requires a change only in the techniques of the natural sciences, demanding little or nothing in the way of change in human values or ideas of morality.

In our day (though not in earlier times) technical solutions are always welcome. Because of previous failures in prophecy, it takes courage to assert that a desired technical solution is not possible. Wiesner and York exhibited this courage; publishing in a science journal, they insisted that the solution to the problem was not to be found in the natural sciences. They cautiously qualified their statement with the phrase, "It is our considered professional judgment. . . ." Whether they were right or not is not the concern of the present article. Rather, the concern here is with the important concept of a class of human problems which can be called "no technical solution problems," 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 hit my opponent over the head; or I can drug him; or I can falsify the records. Every way in which I "win" involves, in some sense, an abandonment of the game, as we intuitively understand it. (I can also, of course, openly abandon the game—refuse to play it. This is what most adults do.)

The class of "No technical solution problems" has members. My thesis is that the "population problem," as conventionally conceived, is a member of this class. How it is conventionally conceived needs some comment. It is fair to say that most people who anguish over the population problem are trying to find a way to avoid the evils of overpopulation without relinquishing any of the privileges they now enjoy. They think that farming the seas or developing new strains of wheat will solve the problem—technologically. I try to show here that the solution they seek cannot be found. The population problem cannot be solved in a technical way, any more than can the problem of winning the game of tick-tack-toe.

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 greatly increase human misery if we do not, during the immediate future, assume that the world available to the terrestrial human population is finite. "Space" is no escape (*2*).

A finite world can support only a finite population; therefore, population growth must eventually equal zero. (The case of 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 partial differential equations, dating back at least to D'Alembert (1717–1783).

The second reason springs directly from biological facts. To live, any organism must have a source of energy (for example, food). This energy is utilized for two purposes: mere maintenance and work. For man, maintenance of life requires about 1600 kilocalories a day ("maintenance calories"). Anything that he does over and above merely staying alive will be defined as work, and is supported by "work calories" which he takes in. Work calories are used not only for what we call work in common speech; they are also required for all forms of enjoyment, from swimming and automobile racing to playing music and writing poetry. If our goal is to maximize population it is obvious what we must do: We must make the work calories per person approach as close to zero as possible. No gourmet meals, no vacations, no sports, no music, no literature, no art. . . . I think that everyone will grant, without

The author is professor of biology, University of California, Santa Barbara. This article is based on a presidential address presented before the meeting of the Pacific Division of the American Association for the Advancement of Science at Utah State University, Logan, 25 June 1968.

13 DECEMBER 1968

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1968

Garret Hardin (Biologist)

(1915 - 2003)

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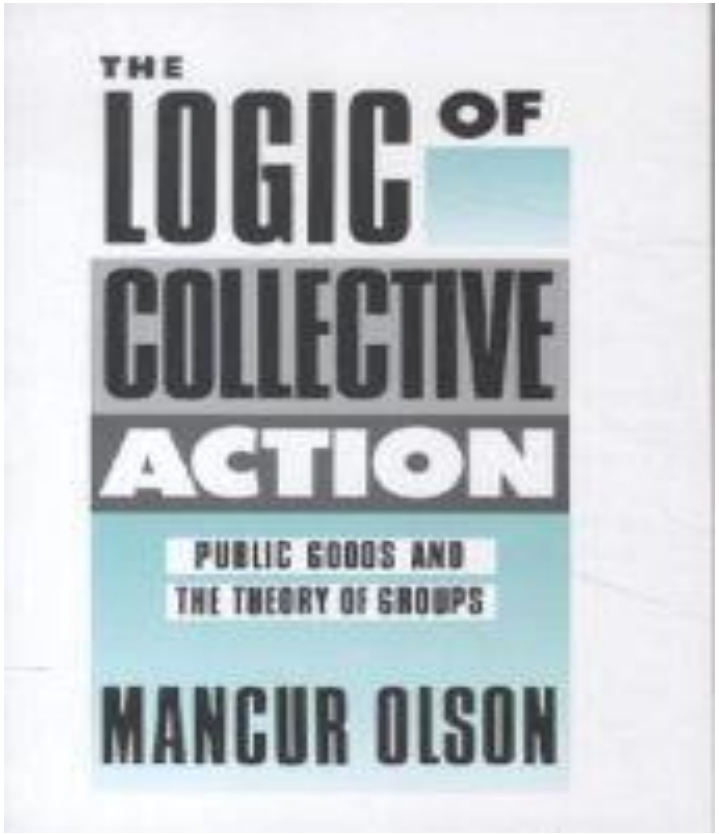

1968

Mancur Olson
(Sociologist/ Economist)

(1932-1998)

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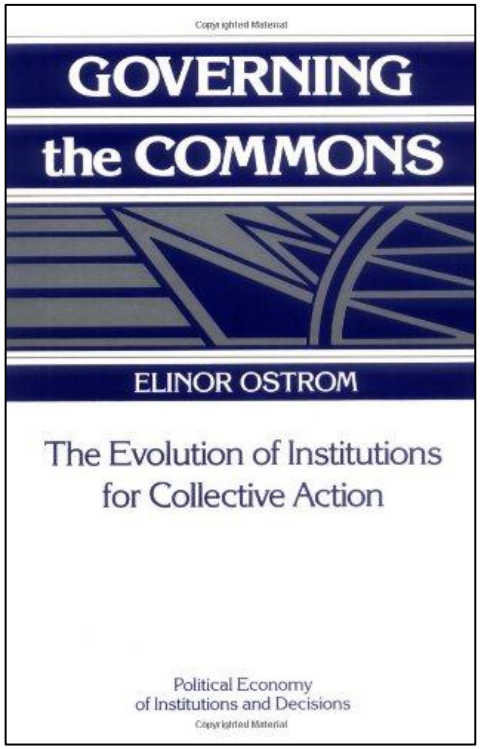

1990

Elinor Ostrom (Anthropologist)
(1933-2012)

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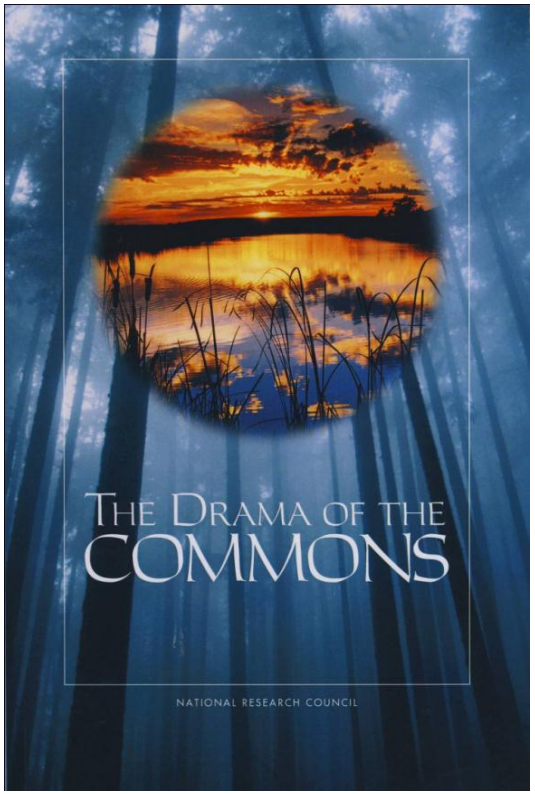

2002

http://www.ulrich-menzel.de/lehre/literaturliste_wasservorlesung.pdf

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The 4 kinds of goods

		Rivalry	
		Yes	No
Exclusion	Yes	Private goods **1**	Club goods **3**
	No	Common goods **4**	Public goods **2**

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Aspects of the 4 kinds of goods

Property 1: Individual
Property 2: State
Property 3: Group
Property 4: free access

Allocation 1: private entrepreneurs
Allocation 2: State
Allocation 3: Club
Allocation 4: Nature

Regulation instance1: Market/ Prices
Regulation instance 2: State/Laws/ Ordinances
Regulation instance 3: Club/ Rules/ Constitution
Regulation instance 4: depends on who has access to it

1 = Private goods
2 = Public goods
3 = Club goods
4 = Common goods

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Examples for "common goods"

National

- Grassland (alpine pastures)
- Forest (charcoal, firewood, timber, hunting, etc.)
- Water (fishing, irrigation, hydraulic energy, transport)
- mountains above the timberline
- Ore (e.g. rural mining and furnaces in Sweden)
- Salinas

International

- Open sea (fishing, whaling, sealing, seabed mining, shipping, seawater desalination, ocean dumping)
- Sun
- Air, Rain
- trans border river systems
- Polar regions

The Tragedy the Commons

The Drama of the Commons occurs when a natural resource (maritime ecological system, atmosphere, forest, water system) to which a lot of people/states have uncontrolled access, is depleted.

Every user has to decide: How much can/ am I allowed to use?

If everybody contains himself the natural resource can be sustained.

If I contain myself, but the others do not, the system will collapse and I would not have had any short-term profit of the using.

This is the users dilemma.

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Why does a user not behave sustainable ?

1) Because there is a difference between maximizing the economic gain and maximizing the sustainable gain in using natural resources without control of access. Every fisher considers only his individual costs, but not the effect on others

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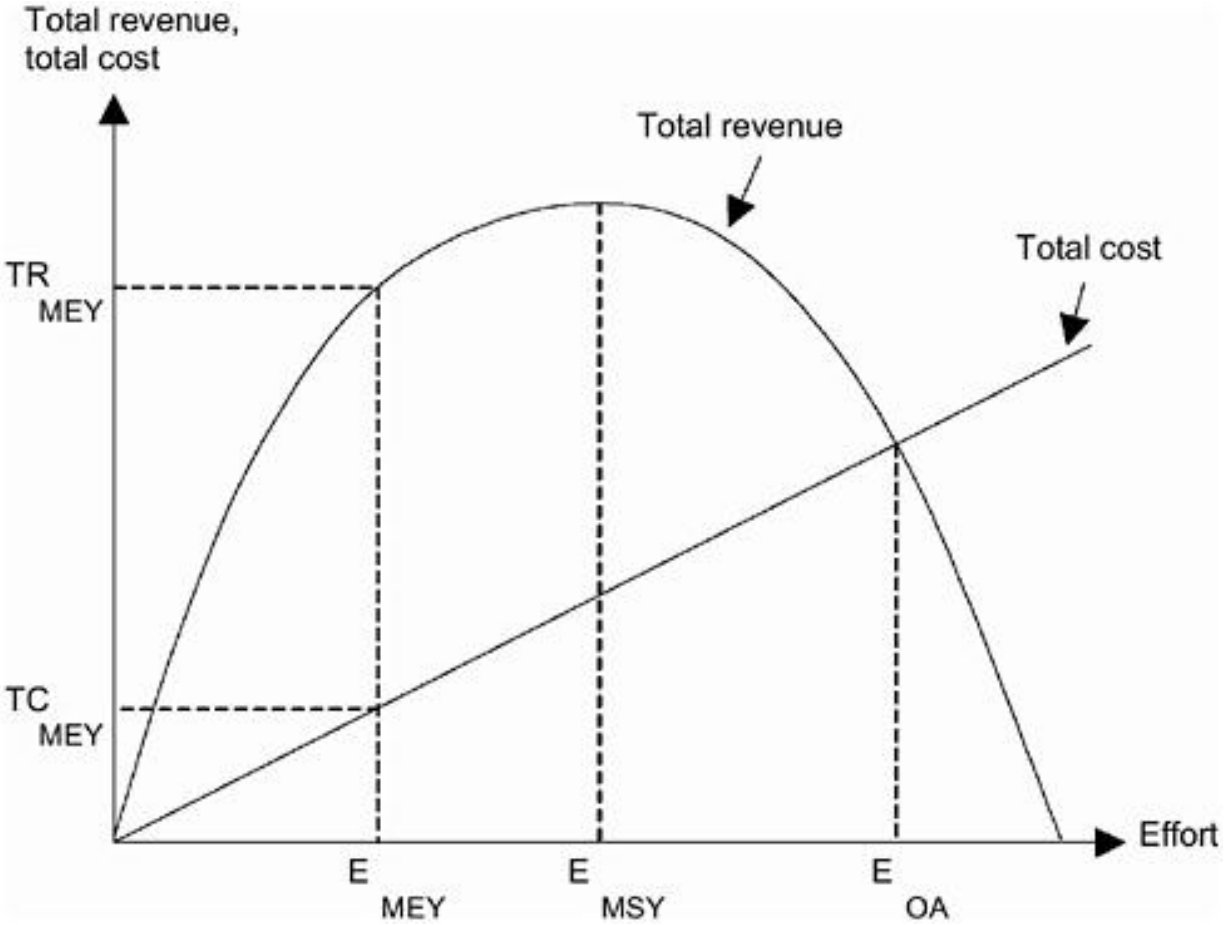
Gordon/Schaefer- Model



Relationships among fishing effort, cost, and revenue.

NOTE: Total revenue, TR; total cost, TC; level of fishing effort; E; maximum economic yield, MEY; maximum sustainable yield; MSY; open access, OA. Profit is revenue minus cost and is represented by the vertical distance between the total revenue and total cost curves at any particular level of effort.

[Source: National Research Council. *The Drama of the Commons* . Washington, DC: The National Academies Press, 2002. S. 10]

The Tragedy of the Commons

2) Because users follow their individual rationality. The gain of using a common good belongs to the individual. The disadvantage of depletion is spread to everyone. As long as the individual advantage is bigger than the share of the collective disadvantage, it is rational to act in that way.
   The sum of the individual rational behaviors ends in a common tragedy and not in the wealth of nations.

3) Because of the constellation modeled by the Prisoners Dilemma.

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Prisoners Dilemma

A \ B	**B1 deny**	**B2 confess**
A1 deny	0.5 / 0.5	0 / 10
A2 confess	10 / 0	5 / 5

Numbers = degree of punishment in years

Decision rule:
Minimize the Maximum

Result because of two-way mistrust :
5 : 5

With cooperation (=denying) 0,5 : 0,5 would be possible

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Hardin´s herdsman game as Prisoners Dilemma

Herdsman A \ Herdsman B	Limit number of animals	maximize number of animals
Limit number of animals	10 / 10	11 / -1
Maximize number of animals	-1 / 11	0 / 0

Numbers= profit items

Result because of two-way mistrust: 0:0
With cooperation 10:10 could be possible

The Tragedy of the Commons

4) As they follow the free rider-argumentation.

   The effect of my behavior is that low in comparison to the high number of fishers, water users, herdsmans etc. that it rarely counts. If I would cooperate, the effect for the community would rarely be countable, but my personal disadvantage would be very high.
   Olson argues: The bigger a group, the stronger the free rider behavior.

5) Pioneer-Latecomer-Problematic: The contemporary threshold and developing countries argue that the wealth of the industrialized countries results (also) of the depletion of nature. Would these countries contain themselves, the development gap would maintain. Industrialized countries want to uphold their wealth.

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Consequence for Hardin et. al:

Privatization of the common pool resource. The depletion affects everyone completely, so that he has an economical appeal to use it sustainable.

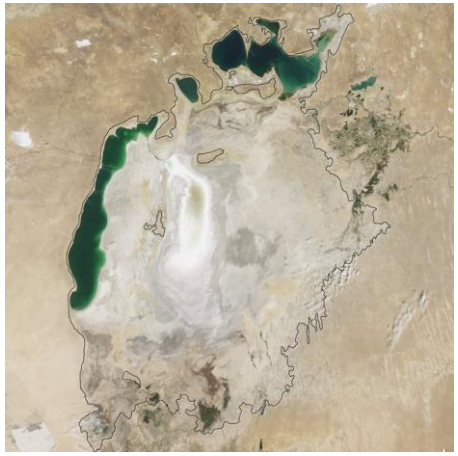
Example: Enclosures in England in 18th century. Communal land was privatized and used for individual sheep farming.
Consequence: Agricultural growth, displacement of the agrarian poor to the urban areas, where they belonged to the industrial proletariat in the beginning of the Industrial Revolution.

The Tragedy of the Commons

Or: Nationalization of the Common good

The State decides the extent and the rules of using natural resources.

Example:
Cotton cultivation in the Central Asian Soviet Republics since the 1950s by using artificial irrigation. The inflows of the Aral Sea are used with the consequence, that the Aral Sea dries out and a salt desert remains. The salinization of the landscape affected the cotton cultivation. (Tragedy of the Aral Sea)



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The opposite position is represented by Elinor Ostrom. Empirical studies on how common goods were used. Groups of farmers, fishers, user etc. are able to develop rules for sustainable use, to enforce compliance to rules of behavior and to sanction the violation of rules.

Hardin mixes common property with free access.
Common goods are often club goods.

Examples:

Collective use of the alpine pastures in Switzerland and Austria. Although the milk and cheese belongs to every single farmer.

Using the mountains and waters for ski runs, cable cars, snow-making equipment, huts.

All members of the valley club get a share of the profit.
Sustainability?

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The Tragedy of the Commons is not inevitable, it depends

- on the human behavior pattern
  (homo economicus, homo sociologicus, homo psychologicus)
- on the kind of common pool resource (local, national, international, global)
- on the group size of the users (local, national, international, global)
- on the homogeneity/ inhomogeneity of the group (hegemon?)
- on the kind of use (e.g. in case of water: fishing, water power, irrigation, transport, garbage dump, cooling)
- on the rules of using, trust between the users, the possibilities to control and to sanction the violations of rules

The Tragedy of the Commons

Functional Classification of Variables from the Commons Literature with Examples within Each Type

Interventions (Independent Variables)

Institutional arrangements regarding resource base (e.g., property rights regime for resource, simplicity of rules, graduated sanctions, accountability of monitors, coordination with institutions at other scales or in other regions)

Other institutional arrangements (e.g., development, tax, investment policy; political representation rules)

Technology choices (e.g., decision to adopt new monitoring technology)

Contingencies (Moderator Variables)

Resource system characteristics (e.g., size, boundaries, mobility of resource, storage, predictability)

User characteristics (e.g., population, boundaries, social capital, leadership, heterogeneities, prevalence of honesty, interdependence, poverty)

Relationships between characteristics of resources and users

Institutional forms at other scales or in other regions (e.g., state support for local rules, nesting of institutions, international regimes)

Available technology (e.g., cost of technology for exclusion, monitoring)

Integration of resource base into global markets

Mediators (Intervening Variables)

Adherence of users to shared norms

Ease/cost of monitoring users' behavior

Ease/cost of monitoring state of resource

Ease/cost of enforcing rules

Users' understanding of rules and sanctions

Outcomes (Dependent Variables)

Sustenance of the resource system (sustainability)

Durability of resource management institutions

Economic output of the resource system (e.g., productivity, efficiency)

Distribution of the economic output (equity)

Democratic control

[Source: National Research Council. *The Drama of the Commons* . Washington, DC: The National Academies Press, 2002. S. 455]