

Renewable Resources  
Solar Energy  
Synthetic Fuels and Biofuels  
Tidal and Wave Power  
Wind Energy

---

**TOURISM** – See ECOTOURISM

---



---

**TOWNS AND CITIES** – See URBAN ECOLOGY,  
URBAN GEOLOGY; URBANIZATION, URBAN  
PROBLEMS

---



---

## TRAGEDY OF THE COMMONS

---

Ecologist Garrett Hardin's 'tragedy of the commons' (Hardin, 1968) has proven a useful concept for understanding how we have come to be at the brink of numerous environmental catastrophes. People face a dangerous situation created not by malicious outside forces but by the apparently appropriate and innocent behaviors of many individuals acting alone.

Hardin's parable involves a pasture 'open to all.' He asks us to imagine the grazing of animals on a common ground. Individuals are motivated to add to their flocks to increase personal wealth. Yet, every animal added to the total degrades the commons a small amount. Although the degradation for each additional animal is small relative to the gain in wealth for the owner, if all owners follow this pattern the commons will ultimately be destroyed. And, being a rational actor, each owner adds to his flock:

Therein is the tragedy. Each man is locked into a system that compels him to increase his herd without limit – in a world that is limited. Ruin is the destination toward which all men rush, each pursuing his own interest in a society that believes in the freedom of the commons (Hardin, 1968).

Despite its reception as revolutionary, Hardin's tragedy was not a new concept: its intellectual roots can be traced back to Aristotle (*q. v.*) who noted that 'what is common to the greatest number has the least care bestowed upon it' (see Ostrom, 1990) as well as to Hobbes and his leviathan (see Feeny *et al.*, 1990). William Forster Lloyd identified in 1833 the problems resulting from property owned in common (1977). Yet if all that was at stake here was grazing land in the 1800s this would be an issue for historians alone. Hardin immediately recognized that this concept applies in its broader sense to a great many modern environmental problems (e.g., overgrazing on federal lands, acid precipitation, ocean dumping, atmospheric carbon dioxide discharges, firewood crises in less developed countries, over-fishing). Simply stated, we face a serious dilemma – an instance where individual rational behavior (i.e., acting without restraint to maximize personal short-term gain) can cause long-range harm to the environment, others and ultimately oneself.

### Is the tragedy inevitable?

With a clear definition of a commons tragedy, researchers have focused on explaining the conditions under which it is most

likely to arise. It is noteworthy that not all resource management situations lead to a tragedy. Certain fundamental conditions must exist before a tragedy can emerge. The first condition involves the nature of the resource itself. One must distinguish between a public good and a commons, or what has come to be called a common-pool resource (CPR). Public goods have the attribute of being non-consumptive. One's use of a public crop forecast does not reduce the availability of that forecast to others. In fact, users of a public good care little about who else uses it. Likewise all users benefit from the maintenance of a public resource (such as a weather forecasting computer) whether or not they help pay for the maintenance. Ostrom (1990) has contrasted these attributes of public goods to those of a CPR where the resource is subtractable (one's consumption deprives others of use) and able to be overused. Furthermore, the individuals who contribute to the maintenance of a CPR care enormously about who else is using it and how much they are consuming even if these others help maintain the resource.

Yet, not all use of subtractable resources will inevitably lead to catastrophe. The second fundamental condition focuses on access to the resource. A tragedy is more likely to emerge in a situation where restraining access to the resource is costly, impractical or impossible (Feeny *et al.*, 1990). Hardin's predictions for the inevitable over-exploitation of a commons were based solely on consideration of open-access situations. And in fact case studies document that tragedies do occur when an open-access system supplants a pre-existing successful CPR management system. Thus, while a tragedy is not inevitable it is a more likely outcome if one is dealing with a CPR that is subtractable, able to be overused, and experiencing unrestrained, open access.

### Averting the tragedy

Unfortunately, knowing the conditions that lead to a tragedy does not insure one can easily avoid it. Clearly, the nature of a resource is fixed. While one can limit withdrawal of resource units to a sustainable rate for renewables and a repairable rate for those that physically deteriorate, a subtractable resource cannot be made non-subtractable. Furthermore, managing access involves the complex task of excluding others from using the resource. Thus averting a tragedy involves restraining both consumption and access.

### Restraint by coercion through outside agents

It was argued by Hardin and others that the most straightforward way to achieve restraint is through coercion, generally administered by outside agents. In its most extreme formulation this prescription involves the centralized authoritarian control of a resource (e.g., direct management by a government agency). Another approach involves privatization of the commons which, while less severe, also involves external actors and the force of law to defend the rights of the private enterprises to manage the commons as they see fit. Following this prescription, governments have intervened to impose centralization or privatization on specific CPRs. Unfortunately, neither of these approaches is certain to prevent a tragedy. Privatization does not insure sustainability. There will always remain the temptation exhaustively to harvest a resource and bank the money obtained, particularly if the money grows faster than the resource. Furthermore, it is argued that centralized solutions that employ powerful coercion fail to reckon

**Table T2** Conditions exhibited by durable CPR institutions (after Orstrom, 1990)

- (a) *Clearly defined boundaries.* Individuals or households who have rights to withdraw resource units from the CPR must be clearly defined, as must the boundaries of the CPR itself.
- (b) *Congruence between rules and local conditions.* Rules restricting time, place, technology, or quantity of resource units are related to local conditions. There should be a small set of simple rules related to the access and resource use patterns agreed upon by the appropriators, rules easy to learn, remember, use and transmit.
- (c) *Collective-choice arrangements.* Most individuals affected by the operational rules can participate in modifying these operational rules. There is a need to remain adaptable, to be able to modify the rules with regard to membership, access to and use of the CPR and to remain responsive to rapid exogenous changes.
- (d) *Monitoring.* Monitors, who actively audit CPR conditions and appropriator behaviors, are accountable to the appropriators or are the appropriators. The enforcement of the rules is shared by all appropriators, sometimes assisted by 'official' observers and enforcers.
- (e) *Graduated sanctions.* Appropriators who violate operational rules are likely to be assessed graduated sanctions (depending on the seriousness and context of the offense) by other appropriators, by officials accountable to these appropriators, or by both.
- (f) *Conflict-resolution mechanisms.* Appropriators and their officials have rapid access to low-cost local arenas to resolve conflicts among appropriators or between appropriators and officials. There is also the need to adapt the rules to changing conditions and apply different rules to different problems and scales of problems.
- (g) *Minimal recognition of rights to organize.* The rights of appropriators to devise their own institutions are not challenged by external governmental authorities. Appropriators must be able to legally sustain their ownership of the CPR. Furthermore, their organization must be perceived as legitimate by the larger set of organizations in which it is nested (Orstrom, 1992).
- (h) *Nested enterprises.* For CPRs that are part of a larger system, the appropriation, provision, monitoring, enforcement, conflict resolution, and governance activities are organized in multiple layers of nested enterprises.

with the general human phenomenon of reactance against compulsion (De Young and Kaplan, 1988). Forced involvement in compulsory systems without consent motivates people to want the forbidden and creatively resist the demanded. Another concern is the ability of centralized, authoritarian approaches to commit a large percentage of available resources to what is judged to be a vital project. While the urgency of certain CPR crises would seem to demand such a response, it entails considerable risk. There is the danger of making large-scale resource allocation errors. In fact, the potential for grave errors may be a major risk of the authoritarian approach.

#### Self-organized management of CPRs

A considerable amount of interdisciplinary work has been produced examining CPR institutions (see Martin, 1992). The most exciting finding to arise is the capacity of the individuals involved in situations ripe for tragedy to have enough insight to coordinate their efforts and manage a CPR without external intervention. Ostrom (1990) documents examples of self-organizing and self-governing commons systems that have worked well and endured for centuries including grazing and

forest institutions in Switzerland and Japan, and irrigation systems in Spain and the Philippines. The conditions necessary for the development of durable, self-initiated and self-managed CPR institutions are being extracted from the analysis of CPR case studies. No single set of conditions seems essential. Instead, the mix of necessary conditions varies within limits according to the specific attributes of the biological, physical, psychological, political and economic contexts. Ostrom (1990, 1992) has brought clarity to these findings by organizing the conditions conducive to the long-term survival of a CPR institution into eight themes (see Table T2).

One final issue involves finding ways to encourage the formation of self-organized CPR institutions. The costs of exploring and initializing CPR management options are high. Without a supportive procedure, crafting and exploring alternatives will prove too risky for small groups of individuals. One approach to creating CPR institutions is called 'adaptive muddling' (De Young and Kaplan, 1988). This is a form of muddling through that emphasizes not small steps but small experiments. It offers a way of simultaneously exploring several possible solutions thus avoiding the sluggishness that plagues one-solution-at-a-time approaches. People are empowered to apply local or personal knowledge to a situation. Different people applying different knowledge to the same situation creates a variety of potential solutions. It is just such enhanced and diverse creativity that is needed. Furthermore, as conceived, adaptive muddling contains a stability component that not only reduces the costs of failure for individuals but also makes highly improbable any unchecked and disorienting change and the widespread implementation of untested solutions.

However one crafts workable CPR management institutions, the urgency of the task is clear. For while the tragedy of the commons is not an inevitable outcome, it is a conceivable risk whenever resources are being consumed.

Raymond K. DeYoung

#### Bibliography

- De Young, R., and Kaplan, S., 1988. On averting the tragedy of the commons. *Environ. Manage.*, **12**, 273-83.
- Feeny, D. et al., 1990. The tragedy of the commons - 22 years later. *Human Ecol.*, **18**, 1-19.
- Hardin, G., 1968. The tragedy of the commons. *Science*, **162**, 1243-8.
- Lloyd, W.F., 1977. On the checks to population. In Hardin, G., and Baden, J. (eds), *Managing the Commons*. San Francisco, Calif.: W.H. Freeman, pp. 8-15.
- Martin, F., 1992. *Common Pool Resources and Collective Action: A Bibliography*, Volume 2. Workshop in Political Theory and Policy Analysis. Bloomington, Ind.: Indiana University.
- Ostrom, E., 1990. *Governing the Commons: the Evolution of Institutions for Collective Action*. New York: Cambridge University Press.
- Ostrom, E., 1992. The rudiments of a theory of the origins, survival, and performance of common-property institutions. In Bromley, D.W. (ed.), *Making the Commons Work: Theory, Practice and Policy*. San Francisco, Calif.: ICS Press.

#### Cross-references

Conservation of Natural Resources  
 Cost-Benefit Analysis  
 Debt-for-Nature Swap  
 Earth Resources  
 Environmental Economics  
 Natural Resources  
 Nonrenewable Resources  
 Precautionary Principle  
 Renewable Resources  
 Raw Materials

ENCYCLOPEDIA OF EARTH SCIENCES SERIES

ENCYCLOPEDIA  
*of* ENVIRONMENTAL  
SCIENCE

*edited by*

**DAVID E. ALEXANDER**  
University of Massachusetts

*and*

**RHODES W. FAIRBRIDGE**  
NASA – Goddard Institute for Space Studies



**KLUWER ACADEMIC PUBLISHERS**  
DORDRECHT | BOSTON | LONDON

SCI  
GE  
10  
.E525  
1999

A C.I.P. Catalogue record for this book is available from the Library of Congress.

ISBN 0-412-74050-8

---

Published by Kluwer Academic Publishers  
PO Box 17, 3300 AA Dordrecht, The Netherlands

Sold and distributed in North, Central and South America  
by Kluwer Academic Publishers, PO Box 358,  
Accord Station, Hingham, MA 02018-0358, USA

In all other countries, sold and distributed  
by Kluwer Academic Publishers  
PO Box 322, 3300 AH Dordrecht, The Netherlands

*Printed on acid-free paper*

The cover illustration of a valley in the Dolomite Prealps of northern Italy shows the harmony that a well-balanced community can achieve with its surrounding environment. Upland pastures studded with barns are interspersed with evergreen forests against a backdrop of pale grey dolomitic limestone mountains. However, tourism has caused a risk of overdevelopment, which threatens the delicate equilibrium of this high altitude ecosystem and increases local susceptibility to avalanche and rockfall damage.

Photo Credit: David Alexander

Every effort has been made to contact the copyright holders of the figures and tables which have been reproduced from other sources. Anyone who has not been properly credited is requested to contact the publishers, so that due acknowledgement may be made in subsequent editions.

All Rights Reserved

© 1999 Kluwer Academic Publishers

No part of this publication may be reproduced or utilized in any form or by any means, electronic, mechanical, including photocopying, recording or by any information storage and retrieval system, without written permission from the copyright owner.

Printed and bound in Great Britain by MPG Books, Bodmin, Cornwall.