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Chapter 12

An illustration of the tragedy of the commons: The demise of the Aral Sea

Introduction

The source of many environmental and natural resource problems lies in ill-defined property rights. In this chapter, we explain how the tragedy of the commons can result from existing types of ownership/property rights regimes and examine the consequences. The implications for policy-making are also briefly discussed. The dire consequences of the tragedy are illustrated by the case of the Aral Sea.

Defining core concepts

The tragedy of the commons is a type of social trap, often economic, that involves a conflict over finite resources between individual interests and the common good. The tragedy results when a group of people is responsible for the management of a resource for which no one holds exclusive rights. Thus, the resource can be exploited on a first-come, first-serve basis. The tragedy affects common pool resources (CPR). In economics, the tragedy of the commons is used as an example of the prisoner's dilemma where players gain if they co-operate to use the resources in a sustainable manner and lose if they do not. The dominant outcome of this game is that the players choose not to co-operate and all end up losing.

Box 12.1. Defining some core concepts

A **common pool resource** is a resource that multiple people can use and that is subject to rivalry (i.e. an agent's consumption reduces the benefits available to other users). It may be private property, government property, common property, or open access.

A **common property resource** is a resource owned as common property by some group of appropriators – and not exclusively by one agent or source. Examples are groundwater, fisheries and communal forests.

The characteristic of an **open access** resource is that no one has the right to exclude others from using this resource. Examples include the ocean, open-sea fisheries and atmospheric air.

Subtractability implies that an agent's consumption of a resource reduces the amount available to others.

Source: Ciriacy-Wantrup and Bishop (1975), Ostrom (1990)

Hardin's contribution

Ecologist Garrett Hardin (1968) popularised the concept 'tragedy of the commons' to explain problems of overuse and degradation of natural resources. He used the hypothetical example of a commonly owned pasture to illustrate such a problem. Herders typically wish to maximise yield by increasing the size of their herd. The addition of each animal to the herd has both positive and negative consequences. On the positive side, the herder receives more proceeds due to each additional animal. However, each animal will also contribute to some extent to degradation of the pasture land. While the herder alone gains from adding each animal to the herd, the cost of overgrazing is an externality shared by all the herders. As a rational actor, each herder would like to add to her flock. Therein lies 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).

If all herders follow this pattern, the commons will ultimately be destroyed. Hardin recognised that this concept could be applied in a broader sense to many environmental problems including acid precipitation, ocean dumping, atmospheric carbon dioxide discharges, firewood crises in less-developed countries and over-fishing. The tragedy arises where individual rational behaviour (i.e. acting without restraint to maximise personal short-term gain) can cause long-range harm to the environment, others, and, ultimately, oneself.

The common's dilemma is analogous to the prisoner's dilemma derived from non-cooperative game theory where participants are trapped in a process leading them to take sub-optimal decisions (see illustrative example in Box 12.2). In this context, external authorities are presumably needed to impose external rules and regulations on users since the latter cannot come up with effective agreements to preserve the commons in a sustainable manner. From Box 12.2, a community would have difficulty in self-managing the commons due to incentives to cheat on agreements.

Box 12.2. CPR Management: An example of the prisoner's dilemma

		Agent A	
		Co-operate	Do not co-operate
Agent B	Co-operate	20 20	30 0
	Do not co-operate	0 30	3 3

Agents A and B are faced with two possible courses of action: 'co-operate' to manage the commons in a sustainable manner or 'do not co-operate'. Each agent is assumed to

behave independently and to take decisions on the optimum strategy to follow contingent upon expectations that he/she has about the other agent's behaviour.

The pay-off matrix shows changes in the welfare of agents A and B in the event that they select a particular strategy. It is clear from the above that the highest welfare gain to society would occur where both agents decide to co-operate (agent A gains 20 and agent B gains 20). If both decide not to co-operate, each would gain only 3 due to degradation of the commons.

As a rational decision-maker, agent A forms two types of expectations about agent B: agent B can co-operate and abide by the rules of sustainable CPR or agent B can decide not to co-operate or cheat on the agreement. If agent A believes that agent B will co-operate, agent A would gain 20 by co-operating but would gain a higher amount (30) by not co-operating. Thus, the optimum strategy would be 'not co-operate' if agent B co-operates. However, if agent A assumes that Agent B would not co-operate, agent A would have zero benefits by co-operating and would gain 3 units by not co-operating. Here again the optimum strategy is not to co-operate.

'Not co-operate' is a dominant strategy selected by each of the players irrespective of the expectations that they form about each other's behaviour. This situation contributes to the tragedy of the commons where players have an incentive to cheat on agreements to manage CPRs in a sustainable manner.

Is the tragedy of the commons unavoidable?

Not all CPRs will necessarily lead to the tragedy. Hardin's predictions apply mainly to open access resources rather than common pool resources (Ciriacy-Wantrup and Bishop, 1995; Bromley, 1991, 1992). Under open access any individual can use the resource, while under common property access is restricted to a group of appropriators. In the economics literature, the difference between the two can be described in terms of lost rents. Open access is a key condition for total rent dissipation associated with the tragedy of the commons (Gordon, 1954). In the absence of exclusivity, profit-maximising agents are not motivated to use the CPR in a sustainable manner benefiting themselves in the future or coming generations. They perceive that if they do not use the resource now, others will do so. Each agent therefore operates in a static framework and extracts resources from the common pool till the point where their short-run profits are maximised. Entry in the industry occurs as long as abnormal profits exist. At equilibrium, all rents are exhausted at the cost of high levels of harvest of the CPR. Under common property ownership, not all the rents are dissipated and the tragedy can be avoided. This result is obtained when there are few appropriators with heterogeneous costs (Cheung, 1970) and access rules can be enforced (Ostrom, 1990).

Managing the commons

The tragedy of the commons, while not inevitable, is more likely to occur in the presence of **subtractability** and unrestrained open access. Subtractability describes the nature of

the resource and cannot be changed. The key to preserving the commons therefore implies restraining access and consumption. Over time researchers have debated the effectiveness of various management solutions to this class of problem. Hardin (1968) advocates policy measures that would directly impact human behaviour or values of morality. According to him, no technical solution to this tragedy exists where

> 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 (Hardin, 1968).

Three possible ways suggested by Hardin (1968) and others to avert the tragedy are: 'coercion', 'privatisation' and 'polluters pay'.

- **Coercion**

Coercion is generally administered by external agents. In an extreme formulation, this prescription involves total centralised authoritarian control of the resource, for instance, direct management by a government body or state ownership. However, the implementation of this approach has been largely unsuccessful. Centralised solutions involving coercion fail to recognize the general human tendency to resist compulsion (De Young and Kaplan, 1988). Resource users, for instance, can pressure the government so as to undermine the enactment or enforcement of laws if they do not believe in the severity of environmental costs (Ostrom, 1992). Failures of nationalised CPRs have been documented in several developing countries in the case of forests, inshore fisheries and large-scale irrigation systems (see Ostrom, 1999 and Grafton, 2000 for an excellent review of the literature).

- **Privatisation**

Privatisation is a strategy whereby both benefits and costs of resource use accrue to individuals owning the resource. This contrasts with common pool arrangements where external costs due to resource degradation are shared by all the users. Privatisation would result in a socially optimal outcome by internalising that externality. This prescription to the commons problem requires government intervention to define and safeguard property rights. Privatisation, however, does not necessarily ensure sustainability. Private profit maximising CPR owners would be tempted to overexploit their resources if growth of proceeds from using the CPR exceeds resource growth. Moreover, this measure may not be feasible. The fluidity of some resources such as large bodies of water and air makes it difficult to divide them into parcels with distinct bundles of property rights (McCay, 1995).

- **Polluters pay principle**

The polluters pay principle can be applied to curtail incentives to overuse CPRs. An external regulatory agency can manage the commons by fees, taxes or penalties at the request of the majority of the people affected. The implementation of this class of instruments would depend crucially upon factors such as the financial and administrative capabilities of the country or state as well as political will. Scarcity of funds and the lack of necessary administrative skills can emerge as real constraints especially in the case of developing countries. Political economy factors encompass actions by conflicting interest groups having effects on the enforcement of rules (Oates and Portney, 2001).

Self-organised management institutions

A large, growing body of literature shows that, contrary to Hardin's predictions, with proper institutional design and social norms, a socially self-managed commons can be sustainable over long periods of time without the need for external agents or centralised management. Ostrom (1990, 1992) compiled a set of institutional rules and conditions that would effectively result in lower levels of environmental degradation (Box 12.3). These include the ability to have clear enforceable rules that will restrict access to the CPR and conditions for resource governance and use.

Box 12.3. Conditions exhibited by durable CPR institutions

1. **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.
2. **Congruence between rules and local conditions:** Rules restricting time, place, technology, and/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.
3. **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.
4. **Monitoring:** Monitors, who actively audit CPR conditions and appropriator behaviours, 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.
5. **Graduated sanctions:** Appropriators who violate operational rules are likely to be assessed graduated sanctions (depending on the seriousness and context of the offence) by other appropriators, by officials accountable to these appropriators, or by both.
6. **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.
7. **Minimal recognition of rights to organise:** 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 organisation must be perceived as legitimate by the larger set of organisations in which it is nested.
8. **Nested enterprises:** For CPRs that are part of a larger system, the appropriation, provision, monitoring, enforcement, conflict resolution, and governance activities are organised in multiple layers of nested enterprises.

Source: Based on Ostrom (1990, 1992)

As noted by Grafton (2000), the potential weakness of any property regime – by state, private or community – is the inability to adapt to changes in the resource or institutional environment. For collective rights to be successful, they have to adapt quickly enough to

shocks to the resource, technology and encroachment by outsiders. In the case of the latter, the state may play an important role in maintaining exclusivity by restricting access to the CPR from people outside the community. Social norms of the community can be more effective at controlling opportunistic behaviour of individuals within the community.

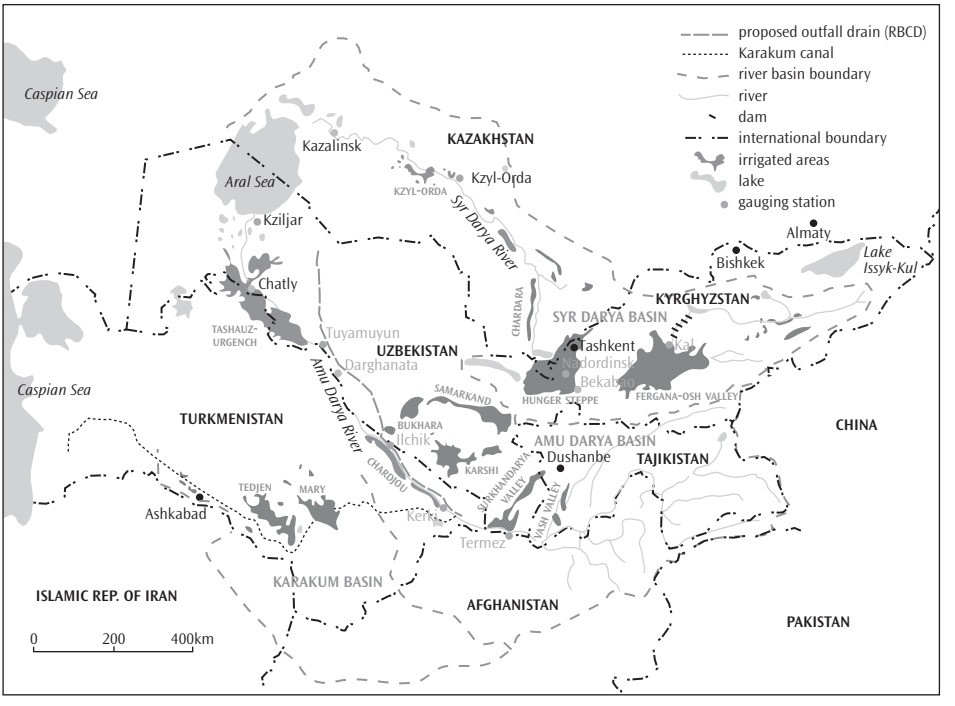
The demise of the Aral Sea: A case study

The demise of the Aral Sea is cited as a modern example of the tragedy of the commons. The sea, which was once the fourth largest inland sea on the globe, is today on its way to extinction as a mighty sea. Described as the 'most staggering human disaster in the twentieth century' by the United Nations Development Programme (UNDP), the Aral Sea basin intersects five Central Asian Republics – Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan – which lie in a 690,000 km^2 landlocked zone (Figure 12.1).

Situation before the 1960s

Before the 1960s, the Aral Sea had a surface area of 64,000 km^2, a water volume of 1,020 km^3 and an average depth of 20–25 km. The mineralisation of the sea, which was freshwater, did not exceed nine grams per litre. The sea supported a thriving fishery with 160 tons of fish being pulled daily from its waters.

Figure 12.1. Map of the region: Aral Sea



Key events leading to human-induced catastrophe

In 1918, the Soviet Union decided that the two rivers that fed the Aral Sea, namely the Amu Darya in the south and the Syr Darya in the northeast, would be diverted to try to irrigate the desert, in order to grow rice, melons, cereal, and cotton. This was part of the Soviet plan for cotton, or 'white gold' to become a major export. Irrigation canals were built on a large scale in the 1940s. These canals were dug speedily without any type of clay or concrete lining leading to massive water loss due to evaporation and filtration. It is estimated that the canals lost up to 40 per cent of the water before it reached its destination (Glantz and Zonn, 2005). However, at the time the influx of money from cotton blinded the Soviet officials to the inevitable results of their actions.

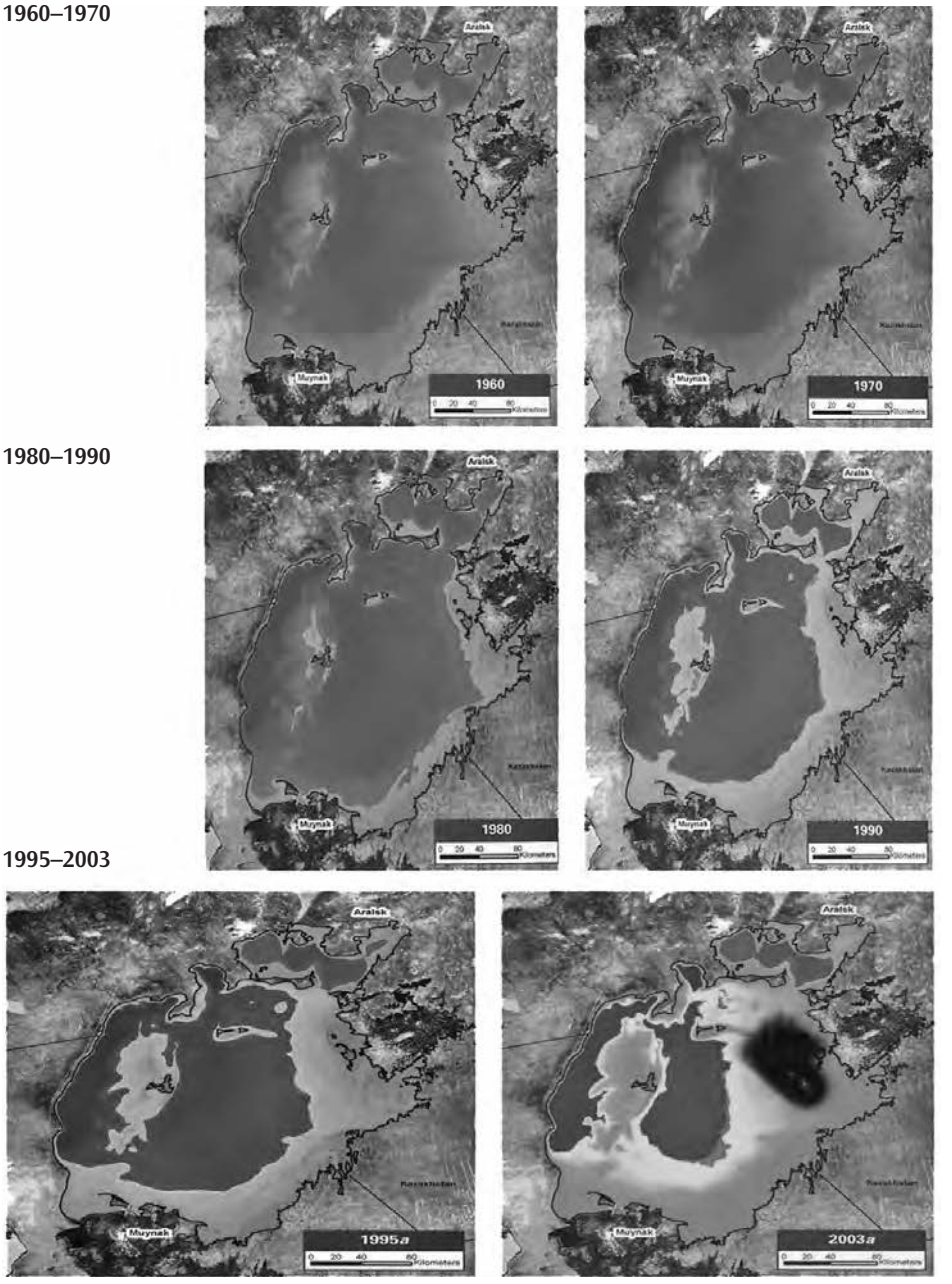
Situation post 1960s: An environmental crisis

- **The sea on its way to extinction:** Excessive water diversion for irrigation has caused a loss of more than 75 per cent of the lake's water. The lake shrunk from over 65,000 km^2 to less than half that size, exposing large areas of the lake bed covered with salt deposits and contaminated with toxic residues made of agricultural chemicals.
- **Economic impacts**
  Fisheries: The lake's salt concentration increased from 10 per cent to more than 23 per cent, contributing to the devastation of a once-thriving fishery.
  Agriculture: Crop yields have diminished due to added salinity – even in some of the same fields irrigated with the diverted water.
  Employment: About 3.5 million people who depend upon fisheries and agriculture in the area have seen their livelihoods severely affected.
- **Pollution:** Dust storms and toxic dust have blown away up to 75,000 tons of exposed soil annually, dispersing its salt particles and pesticide residues even up to the Himalayas.
- **Health:** Widespread air pollution has led to serious nutritional and respiratory ailments in countries bordering the Aral Sea. High infant and maternal mortality rates have been recorded (Grabish, 1999).
- **Climate change:** Due to the shrinking of the sea, the local climate in the region has reportedly shifted, with hotter, drier summers and colder, longer winters.

The time frame of this environmental catastrophe is depicted starkly in Figure 12.2.

Within a short span of about 30 years (1960 to 1990), continued shrinking reduced the sea into two basins: the Small Aral Sea in the north and the Large Aral Sea in the south. In 2003, the Large Aral shrunk further and got subdivided into eastern and western basins (Glantz and Zonn, 2005). In 2007, the salinity of the South Aral is recorded to have increased to 100 g/l (grams per litre) while salinity of normal seawater is typically around 35 g/l (Micklin and Aladin, 2008). The fast disappearance of this sea with associated environmental and socio-economic impacts is an issue of tremendous concern at the international level.

Figure 12.2. Evolution of the Aral Sea



Source: Glantz and Zonn (2005)

International agreements to save the Aral Sea and their effectiveness

- The intensive internal problems of the Aral Sea became internationalised with the break-up of the Soviet Union in 1991.
- In 1992, the five newly independent Central Asian republics – Kazakhstan,

Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan – negotiated an agreement to coordinate policies on their transboundary waters and solve the Aral Sea crisis.

- An Interstate Coordination Water Commission (ICWC) was formed to prepare annual plans for water allocation and use, and define water use limits for each riparian state.
- This agreement also established a coordinating body, the Interstate Council for the Aral Sea (ICAS), primarily responsible for 'formulating policies and preparing and implementing programmes for addressing the crisis'. To mobilise and co-ordinate funding for the Council's activities, the International Fund for the Aral Sea was created in 1993.
- Subsequent agreements in the 1990s and in 2002 have updated policies and reorganised transboundary water management institutions.
- The years 1994 and 1995 saw some major developments. Allocation of water for preservation of the Aral Sea became recognised as a legitimate water use for the first time. In January 1994, the five nations signed a deal to pledge 1 per cent of their budgets to help the sea recover (Micklin and Aladin, 2008).
- The Nukus Declaration was ratified by head of states of the basin nations in 1995 and indicated the need for a 'unified multi-sectoral approach and the development of co-operation amongst the states and with the international community' (McKinney, 1996).
- Despite these forward moves, concerns were raised about the effectiveness of these plans and institutions. Critical issues include funding problems and some legal complications inherent in such agreements.
- In 1998, the Interstate Council for the Aral Sea (ICAS) and the International Fund for the Aral Sea were merged into the International Fund for the Aral Sea (IFAS).
- Since its formation, the IFAS has been under severe constraints and has had difficulties with its credibility and dealing with multi-sectoral issues. The organisation was not very successful with its mandate at developing regional water management strategies (McKinney, 2004). Because of this, the Board of IFAS did not meet until 2002.
- In 2002, the Central Asian Cooperation Organization (CACO) was established with a broad mandate to promote co-operation among member states on water, energy, and the environment. As of early 2004, a secretariat still had not been established, but one is being planned.
- Short-term programmes to stabilise the environment of the Aral Sea are supported and supplemented by a variety of governmental and non-governmental agencies, including the European Union, the World Bank, UNEP, and UNDP.

Strategies at the local/country level

The economies of Central Asia are trying to diversify agriculture. This move is, however, mostly motivated by factors such as the high cost of fertilisers and pesticides, lower yields of cotton fields due to salinised soils and the difficulty in competing price-wise and quality-wise in international markets. It does not seem that there is an urge to save the Aral Sea (Glantz and Zonn, 2005).

Is there hope?

Despite commitments to save the Aral Sea, few attempts have been made to restore it to its previous levels or even much of what remains. One major constraint relates to the importance of the Aral waters to countries benefiting from them. To restore the Aral Sea, large volumes of water would have to reach the sea, crippling local and national economies. Political leaders with short-term agendas dictated by electoral rules may favour policies that do not effectively ensure the sustainable use of this common pool resource despite pressure at the international level. The fate of the South Aral, in particular, spells concern. The larger part of this sea lies in poorer Uzbekistan, which has the highest water withdrawal rate recorded as compared to the other four Central Asian Republics (UNEP/GRID-Adrenal Maps and Graphics Library, 2005).

Figure 12.3. Optimistic outlook v. pessimistic outlook

Source: Glantz and Zonn (2005)

The key to managing this trans-boundary water resource lies in some common arrangement such as international co-operation among all the users of the rivers.

- **A strong regional economic entity can provide support when issues arise between basin states.** The Central Asian Economic Community, now Central Asian Cooperation Organization, played a key role in mediating between the Aral Sea Basin states when difficulties within the IFAS arose. Even though regional economic entities have their own limitations, they can provide a stability that basin states may otherwise not have.
- **Lack of trust and credibility can hinder the process of co-operation.** This became apparent during the years of 'dormancy' of the IFAS when issues of trust and credibility were found to hamper the functioning of the organisation.

To promote co-operation, we need a game-like policy move by which credible threats and repeated games can generate incentives not to cheat upon agreements. Non-co-operative behaviour is more likely in the case of poorer economies highly dependent on agriculture. A reduction in water withdrawal for irrigation may imply sacrificing short-term economic growth to earn benefits in the long-run. Because of the trans-boundary nature of this

resource, a potentially hard-hit country may choose to free-ride if others are abiding by the agreements to avert this tragedy of the commons. While the costs of extraction would be shared by all bordering countries, the benefits of any binding agreement would go to the defaulter as well. To be successful, any commitment to save the Aral Sea must be backed by some adequate compensatory mechanisms from the international community. Good governance both at local and regional levels, and institutional frameworks quickly adapting to changing political, technological and social parameters, would contribute to the success of these measures. To conclude, Figure 12.3 provides both a hopeful and a pessimistic picture of the future of the Aral Sea contingent upon the success of international efforts. This also shows the irreversibility of certain environmental changes beyond a particular threshold.

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