1 *Sustainable development and creeping environmental problems in the Aral Sea region*

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The Aral Sea region (Figure 1.1) has been characterized in the popular press and in the scientific literature as a region deep in crisis: an environmental crisis, a health crisis, a development crisis, and most of all a water crisis. Clearly, the rapid shrinking of the Aral Sea in Central Asia has captured the attention, and to some extent the interest, of governments, environment and development organizations, the public, and the media around the globe. Once considered a quiet catastrophe, one that has evolved slowly, almost imperceptibly, over the past few decades, the demise of the Aral Sea is now acknowledged as one of the major human-induced environmental disasters of the twentieth century. In the late 1980s, the Soviet Union issued a set of disaster stamps, one of which related to the demise of the Aral Sea (Figure 1.2).

The blame for this situation has been put on such factors as the domination of the region by Soviet authorities who ruled from Moscow, over-dependence on the cultivation of cotton, the rapid expansion of irrigated agriculture, totalitarian regimes, a controlled news media, inappropriate use of cost-benefit analyses, and the Cold War.

Figure 1.1 The Aral Sea region.

Figure 1.2 Russian postage stamp depicting the Aral Sea. Note ship trapped by receding sea level.

Those harmed by the crisis include, but are not limited to, the following: human populations (especially women and children) in the regions adjacent to the sea and in the lower reaches of the Aral basin's two major rivers (the Amudarya and the Syrdarya), regional vegetation and animals, fish and other living organisms in the aquatic environment, soil quality, air quality, ground and surface water quality, environmental sustainability and societal resilience, and some Central Asian administrative districts.

We now know about most of the environment-related problems in the Aral Sea region and we are now learning through anecdotes that various people in the former Soviet Union (and likely in other countries as well) have known about them for a very long time, almost from their inception (e.g., Goldman, 1972). In fact, signs of change were appearing everywhere throughout the first twenty years of the Aral Sea problem (1960–80): wind erosion, salt-laden dust storms, destruction of vital fish spawning grounds and the subsequent collapse of fisheries, increased salinity of sea water, waterlogging and secondary salinization of soils, disruption of navigation, the division of the sea into separate parts as a result of sea level decline, the need for extra-basin water resources to stabilize the sea level, the loss of wildlife in the littoral areas, the large reduction of streamflow from the region's two major rivers, a dramatic change in regional climate, the disappearance of pasturelands, and so forth. In fact, there were several scientists in the Soviet Union and outside of it who made projections about the fate of the sea and the territory surrounding it. For example, Davis (1956) noted:

> Some of the inland seas and lakes have recently been the scene of extensive human activity which has had notable effects upon coastlines . . . Among these are the changes in the offshore areas and coasts of the Caspian and Aral seas owing to large-scale development of dams for power and irrigation on the rivers supplying water to these seas. [An] extensive lowering of water level is beginning in the Aral Sea basin with the development of irrigation projects on the Amu Darya and Syr Darya, which supply most of the water to this sea. It is the aim of these projects eventually to divert for irrigation most or all of the waters of the rivers from entering the sea. It has been calculated that within twenty-five years the water area of this sea will shrink to half the size that it was in 1940, when the irrigation projects began. This would bring about an increase of nearly 13 000 square miles of land area. (Davis, 1956, p. 517)

Clearly, a considerable amount of information already exists in disparate sources about the Aral basin and the various physical processes of environmental change and environmental degradation.

But political leaders, among others with decision-making power, have not acted on many of these changes in the past. Why? Is it that there have been no financial resources available to do so? Is it that there has been no desire on the part of national, regional, or local leaders to do so? Has it been because there is no *perceived* reason among policy-makers at any level to take immediate action (e.g., did they happen to believe that the sea was not worth saving because its waters could be used more cost effectively elsewhere? Were they led to believe that water would likely be diverted from Siberian rivers to the arid lands of Central Asia)? In fact, at least as early as 1927, Soviet scientists exposed the ultimate fate of the Aral Sea if water diversions from the Amudarya and Syrdarya were not limited in the future. Tsinzerling (1927) constructed scenarios of impacts based on increased amounts of water diversions from these rivers. His scenarios were mimicked in the region by the decades of events that followed.

I would argue that a major part of the environmental and health problem in the Aral Sea basin relates to the nature of these adverse environmental changes and to the nature of human society, especially in the way people look at slow-onset, low-grade, long-term and cumulative environmental changes (e.g., creeping environmental problems or CEPs).

creeping \krē-piŋ\ *adj* : developing or advancing by slow imperceptible degrees < a period of ~ inflation> –

from Webster's Ninth New Collegiate Dictionary, 1991.

A major feature shared by various CEPs is that a change in this type of environmental problem is not much worse today than it was yesterday; nor is the rate or degree of change tomorrow likely to be much different than it is today.

So, for the most part, societies (individuals as well as government bureaucrats) frequently do not recognize changes that would prompt them to treat their environments any differently than they had on previous days. Yet, incremental changes in environmental conditions often accumulate over time with the eventual result that, after some perceived threshold of change has been crossed, those previously imperceptible increments of change 'suddenly' appear as serious crises. If no action is taken, as is often the case, those incremental changes will likely continue to build until they emerge as full-blown disaster(s). In the Aral Sea region, the traditional indicators of these crises relate primarily to the declining levels of the sea; they include changes in water quantity and quality, water diversions, water use, and water-related diseases.

It is important to recognize many of the environmental changes in the Aral Sea region as CEPs with likely adverse consequences at some time 'down the road'. It is also important to realize that, although technologies might exist somewhere in the world 'to save us' from the worst consequences of local or regional environmental changes, governments affected by the CEPs might not be able to afford them. Therefore, ways must be devised to deal more effectively with CEPs than we apparently do at present. We must learn to deal better either with their underlying causes, their consequences, or their characteristics (such as rates of change).

Introduction to the notion of creeping environmental problems

Just about anywhere one lives, people are constantly bombarded with bad news about the environment. Some of that news is about environmental problems of a global nature (e.g., global warming, ozone depletion) and some of it is about problems at the local level. Some of these problems have long lead times before their adverse consequences become apparent, while for others adverse consequences can develop over relatively shorter time frames (e.g., tropical deforestation). The list of environment-related problems around the globe is quite long and, unfortunately, is still growing: air pollution, acid rain, global warming, ozone depletion, deforestation, desertification, droughts, famines, water quality, and the accumulation of nuclear, toxic, and solid waste. Each is the result of long-term, low-grade, and slow-onset cumulative processes. Each is a creeping environmental problem.[1]

1. In a letter critical of the US National Research Council report *Confronting Natural Disasters* (NRC, 1987), the writer (Smith, 1988) noted that the report chose to focus solely on a particular set of 'natural hazards' that happen to be initiated by events that are 'sudden and of short duration'. To do so excludes other hazards that cause orders of magnitude more human damage. The report identifies one class of these other hazards: long-term problems such as desertification, deforestation, and drought. It goes on, however, to reject them because 'mitigating these hazards requires a greater ecological or social emphasis, and civil engineering approaches are less critical.'

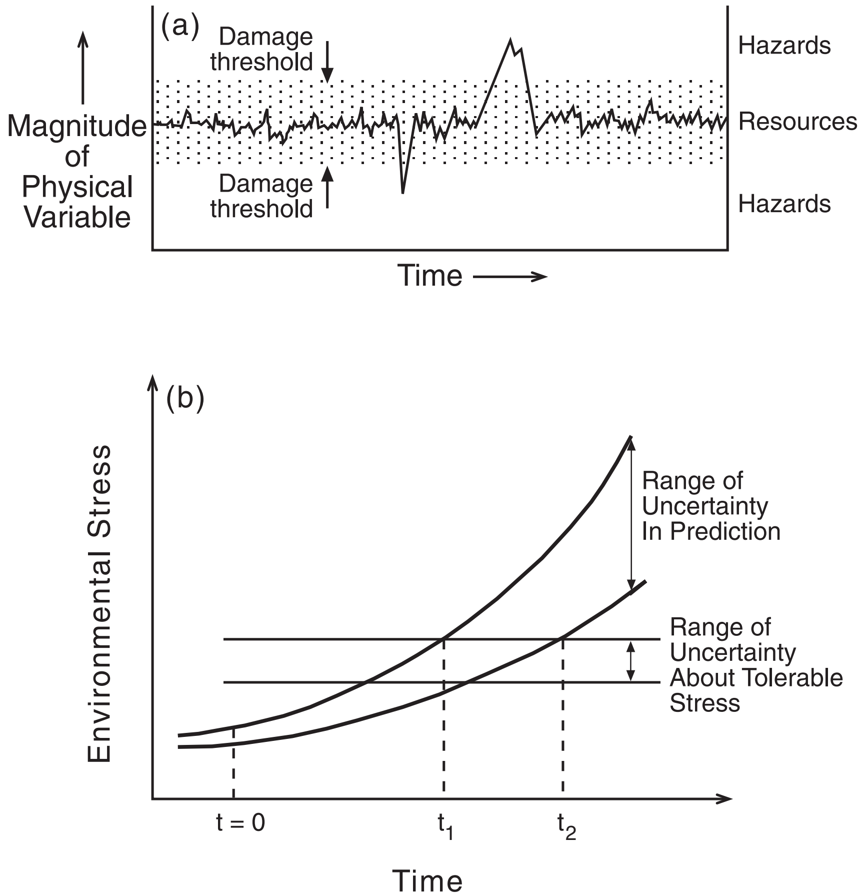

Figure 1.3 (a) Schematic of a rapid-onset natural hazard (Burton and Hewett, 1974). (b) Schematic of slow-onset (creeping) environmental problems (Döös, 1994).

Decision-makers worldwide have had considerable difficulty in addressing ways to slow down, arrest, or reverse these gradually occurring adverse changes. While societies respond relatively quickly to step-like adverse changes in the environment or to problems perceived by experts or the public as crises – for instance 'rapid-onset hazards', such as earthquakes and flash floods (Palm, 1990) – they have much more difficulty in developing an awareness of the risks associated with slow-onset, long-term, low-grade, cumulative change (Figure 1.3).

Thresholds

For each of the creeping environmental changes there may be identifiable thresholds beyond which continued degradation of the environment will increase the likelihood of major, even irreversible, changes in the environment. While our concern should be focused on *thresholds* of environmental change, thresholds are usually easier to talk about than to detect.

For CEPs such as desertification and water quality degradation, at first changes may be noted by individuals at the local level, but may not be considered an immediate or even a potential threat. Such changes in their earliest stages will likely go unreported to local or regional authorities or to national researchers.

Once a creeping environmental change is perceived to have intensified in time, space, or impact, it may be brought to the attention of authorities by local inhabitants, officials, or by environmental researchers who happen to be working in that particular locale. A further deepening or broadening of the adverse consequences associated with environmental change could generate concern at the national policy-making level. At this point the international media can also get involved, generating international awareness of the local or regional problem. Who it is that might be the first to generate awareness of a creeping environmental change and of subsequent thresholds of awareness can vary from one region to the next and from one type of creeping environmental problem to another: it could be a farmer, an hydrologist, a scientist, a policy-maker, or a news reporter.

Because these full-blown problems derive from slow-onset, low-grade, long-term and cumulative environmental changes, it is not easy to identify universally accepted, objective, quantitative indicators for thresholds. Nevertheless, several generic thresholds could be subjectively identified for the evolution of CEPs: a first threshold relates to awareness of a change in the environment that has not yet been perceived as a problem; a second threshold could relate to the awareness that a previously undetected environmental change has become a problem; a third threshold relates to the realization that the problem has reached a crisis stage; a fourth threshold relates to the realization that there is a need to take action to cope with the problem; a fifth threshold is one beyond which direct and specific actions (not just the convening of conferences or workshops) are taken to resolve the CEP.

Why do CEPs continue?

Creeping environmental problems change the environment in a negative, cumulative and, at least for some period of time, an invisible way. As a result of these minor insults to the environment over time, during which no obvious step-like changes occur, both governments and individuals tend to assume 'business as usual' attitudes. People fear change (e.g., Hoffer, 1952) and, unless a crisis situation is perceived, they are not likely to change their behavior in the absence of any incentive to do so.

Most environmental changes are surrounded by scientific uncertainties. For example, are they primarily natural or human-induced changes? Lack of scientific certainty is often cited as another reason for political inaction on

CEPs. Yet, policy-makers are constantly forced to make policy decisions in the midst of uncertainty. For most CEPs, there is often a minority voice, often quite loud, which insists on highlighting the scientific uncertainties, as opposed to emphasizing what is known. Such conflicting interpretations of the science among factions within the scientific community tend to weaken the resolve of those who are expected to act (the public, policy-makers, the media). Thus, the selective use of information on creeping environmental issues drawn from the scientific literature allows policy-makers to pursue any decisions they wish, regardless of the true validity of the scientific information used. Whenever scientific uncertainty is perceived to have been used as an excuse for avoiding political risks associated with decision-making, it should be explicitly challenged as simply an excuse (a tactical measure) to delay meaningful action. Scientific uncertainties will always surround CEPs, and decision-makers must learn to cope with them.

Another reason why CEPs continue is that many changes to the environment are not considered detrimental in their early stages. Such changes would likely be viewed as environmental transformation, not degradation. For example, the cutting down of a small part of a mangrove forest to create a shrimp pond would not necessarily signal a stage in the destruction of a mangrove forest ecosystem (transformation). If, however, numerous ponds were to be constructed in the same location, then the mangrove forest ecosystem and its interactions with other ecosystems would eventually cease.

The willingness of some people to take slightly higher risks also explains inaction on CEPs. Considerable discussion exists in the scientific literature and the popular media about people who are risk-takers and about those who are risk-averse. The former are gamblers, while the latter tend to be more conservative in their approaches (and responses) to environmental change. Yet another risk-related category is that of the risk-maker.

Risk-makers are those decision-makers whose decisions make risks for others, but not necessarily for themselves. For example, reluctance to take action either to slow down or stop desertification processes threatening a village situated far from the capital city where the politicians live will likely have little, if any, direct or immediate adverse political fallout on decision-makers at the national level. Their inaction generates increased risks for the inhabitants of the threatened village, but not necessarily for themselves. With regard to the declining level of the Aral Sea, in reality there were no direct adverse impacts on those policy-makers in the Kremlin, or even in Tashkent, who made decisions about agricultural development in Central Asia, decisions that ultimately led to the degradation of the Aral Sea environment. This can be viewed as a variation of the NIMBY syndrome related to environmental pollution (i.e., 'you can pollute anywhere you want, but not in my back yard'; hence, Not In My Back Yard). Often, environmental change is of little concern unless it directly affects someone's home or workplace.

Yet another constraint on timely action to address a CEP involves the fact that what appears to be an environmental crisis to one person may be considered an opportunity by someone else. While some people may be concerned about environmental degradation, others might believe such degradation is a necessary – and acceptable – tradeoff for improving regional economic development prospects.

Creeping environmental problems in the Aral Sea basin

In the late 1950s, the Aral Sea was the fourth largest inland body of water on the planet, with a surface area of 66 000 km^2. In 1960 the mean level of the Aral Sea was measured at 53.4 m, and it contained about 1090 km^3 of water.

The perennial flows of the basin's two major river systems, the Amudarya and Syrdarya, had until recently sustained a stable Aral Sea level. Over the centuries, about half of the flow of the two rivers reached the Aral. A flourishing fishing industry existed, based on the exploitation of around 20 commercially valuable species. The forests and wetlands surrounding the sea, especially in the Syrdarya and Amudarya deltas, were biologically productive, containing unique species of flora and fauna that had adapted to the natural saline characteristics of the sea. Historically, the levels of the Aral Sea were rather stable, fluctuating less than a meter in the first half of the twentieth century, and by no more than four meters during the preceding 200-year period.

In the span of just four decades, the Aral Sea basin was transformed into a major world-class ecological and socio-economic disaster (Micklin and Williams, 1996). Since the beginning of the 1960s, when the leaders of the Soviet Union embarked on a program to increase river diversions in order to expand irrigated cotton production in this arid region, the Aral Sea level dropped continually and dramatically. In fact, the annual average rates of sea level decline had actually accelerated: from 0.21 meters/year in the 1960s, to 0.6 m/yr in the 1970s, and reaching 0.8 m/yr in the early 1980s (1981–86) (Mnatsakanian, 1992). In all, the sea's level has declined by about 17 meters, and its surface area has been reduced by half. Today it has fallen to sixth place, with respect to its size, as an inland body of water. The initial and primary focus of attention has been on the declining level of the sea, in part because that change has been highly visible (especially from space). However, it is but one of several creeping changes in the Aral basin to have occurred during the past half-century.

Other creeping environmental problems in the basin include reduced inflow to the sea from the Amudarya and Syrdarya, monocropping of cotton and of rice, declining water quality, salt and dust storms, salinization of water and soils, vegetation changes, and escalating health effects. Because of the low-grade nature of these and other problems, high-level policy-makers, as well as decision-makers at other levels, have apparently had difficulties in identifying them as problems and then, once identified as such, in coping with them. As with CEPs elsewhere, it has been difficult to identify in advance thresholds of environmental change in the Aral basin that could serve to catalyze action to arrest environmental degradation. The following list of examples of CEPs in the Aral basin is meant to be suggestive and not exhaustive.

EXPANSION OF COTTON ACREAGE

The desire of Soviet leaders to expand cotton production onto desert lands increased the dependence of Central Asian Republics on irrigation and monocropping. Monocropping has adverse impacts on soil conditions, which prompts increasing dependence on mechanization, pesticides, herbicides, and fertilizers. Socio-economically, these policies are also risky in the sense that a regional economy based on production of a single agricultural crop is highly vulnerable to the variability of climate from year to year and from decade to decade, as well as to the 'whims' of demands, and therefore price, of the marketplace. The chart in Figure 1.4 depicts agricultural water use in the Amudarya and Syrdarya basins as of the late 1980s.

A sizeable portion of Central Asia's agricultural production is dependent on irrigation. Irrigated agriculture in the region predates by millennia the era of Tsarist conquests in the eighteenth and nineteenth centuries. What is 'new' about irrigation, however, is the huge amount of water diverted from the region's two major rivers, the Amudarya and the Syrdarya. Table 1.1 shows the expansion of cotton acreage in Central Asia between 1940 and 1986. The demands of cotton production for irrigation water are high (Table 1.2). Each year increasing amounts of water had been required to irrigate new fields and

Figure 1.4 Agricultural water use in the Amudarya and Syrdarya basins (Tsutsui, 1991).

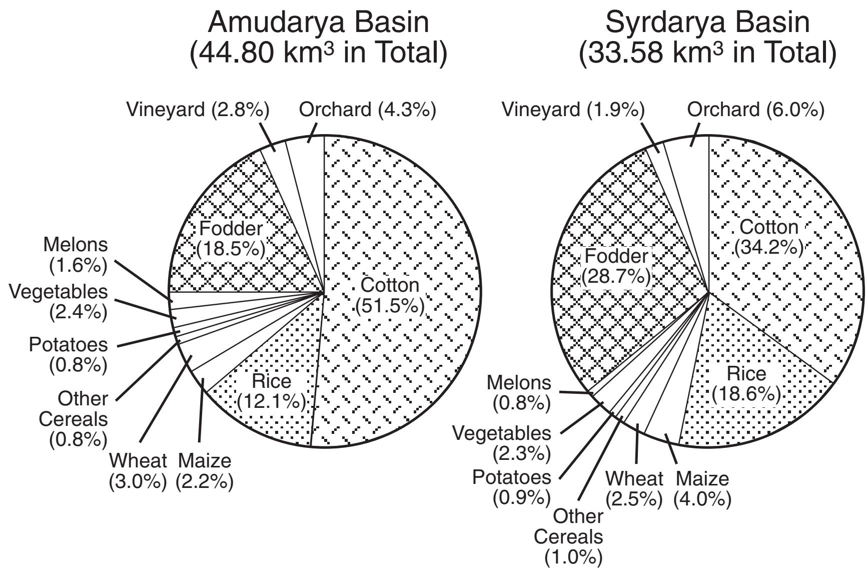

Table 1.1 Cotton sowings (× million hectares)

Unit	*1940*	*1971–75*[a]	*1976–80*[a]	*1981–85*[a]	*1985*	*1986*	*Increase 1940–86 (%)*
Uzbekistan	0.924	1.718	1.823	1.932	1.993	2.053	122
Tajikistan	0.106	0.264	0.295	0.308	0.312	0.314	196
Turkmenistan	0.151	0.438	0.504	0.534	0.560	0.650	330

Note: [a]Average per year for this period.

Source: *Critchlow (1991).*

Table 1.2 Land under irrigation (× 1000 hectares)

Country	*1950*	*1960*	*1965*	*1970*	*1975*	*1980*	*1985*	*1986*
Uzbekistan	2276	2570	2639	2750	2995	3527	3908	4171
Tajikistan	361	427	442	524	566	627	660	703
Turkmenistan	454	496	509	670	855	960	1160	1350

Source: Zonn (this volume).

for the flushing of salts from the old ones. In addition, starting in 1954 with the construction of the Karakum Canal in Turkmenistan, relatively large amounts of water had been diverted each year from the Amudarya to irrigate lands in that republic. The current withdrawals for the Karakum Canal are estimated to be about 15–20 km^3 per year (or 23–30% of the Amudarya's total annual flow).

SEA LEVEL DECLINE

The decline in the level of the Aral Sea has received considerable political attention, both domestically and internationally. It became a highly visible problem in the mid-1980s. Increasing water diversions from the two main regional rivers robbed the sea and deltas of their annual fresh-water replenishment. The rate of decline of the sea can be seen in Figure 1.5. Note also that declining levels were accompanied by an even more rapid reduction in the volume of the sea and by an increase in sea-water salinity.

Another problem related to sea level decline and reduced sea surface area has been the increase in the number, frequency, and impacts of dust storms. In the mid-1970s, dust storms captured the attention of Soviet policy-makers when cosmonauts, during one of their space missions, identified major dust storms raging over the exposed seabed in the receding southeastern part of the Aral Sea. The exposed seabed enabled winds to pick up dust laden with a variety of chemicals and carry it hundreds of kilometers from the original site. Farms downwind of the storms were covered with these dry depositions,