The Aral Sea Basin Crisis: Transition and Environment in Former Soviet Central Asia

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ABSTRACT

The haunting picture of a disappearing Aral Sea is just part of an overall environmental crisis in the Aral Sea Basin, where millions of people are dependent on agricultural production around the flows of two main rivers, the Amu Darya and Syr Darya. Forced cotton cultivation in the former Soviet Union, in the context of inefficient agricultural organization and production, caused water mismanagement, salinization, water and soil contamination, erosion and the desiccation of the Aral Sea. In the post-Soviet era of 'transition', the governments of the Central Asian states and international donors have tried to mitigate the impact of the crisis and contain its scope. Resource-based tensions in the region reflect national (and sometimes ethnic) interests vested in the crucial agricultural sectors that provide foreign exchange and food. Although the Central Asian governments are gradually formulating regional water, land and salt management strategies, the room for manoeuvre that exists to implement policies which would immediately improve the environment, such as efficient water management and sustainable land use, is not being sufficiently utilized.

INTRODUCTION

The Aral Sea Basin crisis has gradually emerged over the past three to four decades; it now represents one of the world's major environmental problem areas. The Basin is largely delineated by the Aral Sea and the area between and around its two tributaries — the main rivers of Former Soviet Central Asia, the Amu Darya and the Syr Darya (Glantz et al., 1993; Martin, 1994; Micklin, 1992; Precoda, 1991). The dimensions of this environmental crisis are as follows. First, the Aral Sea, one of the largest inland water reservoirs of

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the planet, is in danger of disappearing. It has dramatically decreased in size and water volume since the early 1960s, as a result of inadequate water supply from its two arteries, caused by the increasing diversion of water to agricultural irrigation, in combination with high rates of evaporation in the hot desert climate of most of Central Asia (Micklin, 1992; Spoor, 1993). Second, salinization of the Aral Sea and the mid- and downstream reaches of the rivers is an increasing problem. Most of the irrigated lands in the basin are affected by processes of primary and secondary salinization. Furthermore, winds blow enormous quantities of salt and contaminated dust from the exposed sea beds of Aral into the Basin (Precoda, 1991; Smith, 1992), causing soils to deteriorate further. Third, water and soil pollution are having a dramatic and negative impact on the human ecology of the region, in particular in the downstream areas and deltas of the main rivers, such as in the region of Karakalpakstan of western Uzbekistan and Kzyl Orda in south-west Kazakhstan; here, the health of the native population — inhabitants of the region since ancient history — has deteriorated alarmingly (Carley, 1989; Glantz et al., 1993). The water pollution is not only caused by agriculture, the main water user, but increasingly also by industrial and mining sectors which often work with outdated and severely polluting production processes, and by the lack of sewage systems in areas of high population pressure, such as the Fergana Valley, the heart of Central Asia (see map).

While building on some of the publications mentioned above, in which the extent of the environmental crisis in the Aral Sea Basin has been documented, this article will focus on the political economy of this largely anthropogenic disaster. It will analyse the attempts, during the post-1990 transition, of the Central Asian governments of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan, together with international donors and (to a very limited extent) newly emerging environmental NGOs, to contain and mitigate the impacts of the crisis at regional and national level. This analysis, complemented by interviews with key informants and policy makers made during a field trip in September 1997, will link three important elements that determine the causes of the crisis, its current and long-term impact, and the policy options that could influence the outcome of the crisis.

Firstly, the Soviet legacy is taken to be a crucial component of the Aral Sea Basin crisis. The 'forced' cultivation of cotton and the inefficiency in terms of water- (and input-) management of state farms (*sovkhozy*) and collectives (*kolkhozy*) during the socialist era were the main causes of water diversion (for irrigation), contamination, salinization and — given the limited water resources within the Basin (surface and ground water, precipitation) — the squeezing of water supplies for the Aral Sea. The problem is further compounded by the fact that a large share of the water diverted from the rivers for the purpose of irrigation is actually wasted, because of severe problems in water management and irrigation infrastructure. The political economy of the cotton sector was intimately connected with vested interests at national and local levels, which has affected the response to the crisis. Although awareness of the emerging tragedy (Glantz et al., 1993; Rumer, 1989) grew with the introduction of *glasnost* in the Gorbachev era, insufficient measures were taken to improve management practices for water, land, inputs (fertilizer and pesticides) and salt, while the inefficient organization of agriculture — the main consumer of water — remained largely unchanged until the early 1990s.

Secondly, the transition that has been taking place since the collapse of the Soviet Union has altered the scenario of the Aral Sea Basin in terms of actors. The governments of the Central Asian states (CAS) and in some cases, such as in Kazakhstan and Kyrgyzstan, a small but growing number of environmental NGOs, are the new stakeholders at national level. Where previously Moscow made all the decisions relating to water allocation and use, disagreements about water supply and consumption must now be resolved by negotiations. More importantly, the water users are changing, as processes of land reform, the break-up of state and collective farms and the repeasantization of the farm sector take shape in the Central Asian region of the Former Soviet Union (FSU), albeit with substantial differences from country to country (Spoor, 1995). This inevitably makes for complications, as water management and irrigation systems had been developed to serve large-scale farm units; new instruments, such as water pricing, and institutions, such as water users' associations, are only just beginning to emerge.

The industrial sector, now largely privatized, still uses production techniques which are damaging to the environment, but there is neither incentive nor capital to invest in cleaner technology. Population pressure, the absence of sewage systems, and state withdrawal from investments in social infrastructure in much of the Central Asian countryside, contribute further to the continued decline of water quality.

Thirdly, the national governments, in concurrence with international donors, have implicitly agreed that restoring the Aral Sea to its 1960 level in the near future will be impossible, given the dependency of the regional economies on water. It is considered feasible, however, to mitigate the worst effects of the crisis and to develop joint strategies for water, land and salt management that can contain the problem and improve the environment. In the Nukus Declaration of September 1995,[1] the five presidents of the CAS committed themselves to 'sustainable development', based on a fundamental change in economic, land and water management (Talanova, 1997: 37); however, the national governments have not yet (with some exceptions) used the available 'room for manoeuvre' in terms of national policies that would promote a combined economic and environmental recovery.

The article proceeds as follows. After demonstrating the need for a strategy which balances economic growth with environmental recovery in the region, the article then looks briefly at the Soviet legacy (the destruction of traditional water management sytems, the policy of forced cotton expansion) and its contribution to the 'Aral Sea tragedy' (Glantz et al., 1993). In the subsequent section, the environmental crisis is spelled out in terms of desiccation, salinization, wind, soil erosion, eco-systems and climate change. The impact on the overall human ecology of the disaster areas is examined: this is found also to be affected by industrial water and air pollution (particularly in the densely populated areas) and by drinking water that is contaminated by open sewage systems. The following section then analyses water use and water management in the Aral Sea Basin, especially in relation to the main user, irrigated agriculture. The post-1991 CAS agenda in relation to the Aral Sea is discussed; joint consultation is indeed emerging but often conflicts with nationalist interests. For example, regional agreements can be contrasted with the current trends towards national food self-sufficiency, which includes the production of food crops at very high economic and environmental costs. In spite of some encouraging signs of regional consultation and planning mechanisms that point in the direction of regionally-oriented water, land and salt management strategies, the prospect of a disappearing Aral Sea is very real, and the deterioration of the environment in large areas of the Basin continues.

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1. Proclaimed in the city in Karakalpakstan (part of Uzbekistan) which lies in the Amu Darya delta, the Declaration was signed by the five presidents of the CAS on 20 September 1995.

The last section of the article looks at possible solutions. The policy options available to the national governments (separately or together) include making fundamental changes to the structure of incentives, particularly for agricultural production; introducing water pricing (emphasizing the scarcity of this crucial resource in the Central Asian region); investment in irrigation and drainage; the introduction of effluent charges on industrial pollution; and the promotion of water user associations. Finally, in the conclusion, the 'room for manoeuvre' of the CAS national governments is emphasized, as is the need for increased international funding to counter a disaster of vast proportions. In a region which is not stable in political terms, the political will of the governments and the combined strategies of economic and environmental recovery are not enough: large investments are also vital to accompany and support the enormous transformations in water management and production systems that are necessary.

A SUSTAINABLE REFORM STRATEGY

In the transitional economies of Central Asia, and particularly in the main cotton producing (high water-consuming) areas, the environmental crisis will not be easily resolved or reversed. Although the introduction of world market prices for inputs is reducing the use of fertilizers and pesticides, dependency on cotton has actually increased, as it is the main hard currency earner.[2] Furthermore, water remains either free, or only symbolically priced. In most of the CAS, initial reactions have been towards increasing food self-sufficiency, reducing somewhat the cotton area in favour of irrigated wheat and rice (at high economic and environmental costs), while expanding the total cultivated and irrigated acreage.[3]

However, solutions for the survival of the Aral Sea, and for the eco-systems around its tributaries, can only be realistically designed in the context of the continued widespread presence of cotton. Such solutions should therefore focus on improved water and salt management, the introduction of water prices and related fiscal policies, investment in irrigation and drainage infrastructure, reduction of air-, soil- and water-pollution by agriculture and industry, improvement of sewage systems in densely populated areas, and the promotion of cropping patterns based on agro-ecological mapping, territorial policies and market integration. It is up to the national governments to develop and implement economic strategies that are environmentally

2. This might well change in the near future when the large mineral resources of the CAS (oil, natural gas and metals) become sufficiently developed.
3. According to World Bank (1996: 22) this expansion took place within the current water allocation to the CAS, but in a 'technically unsatisfactory way, e.g. without drainage facilities, and the grain yields obtained were considerably lower than expected'.

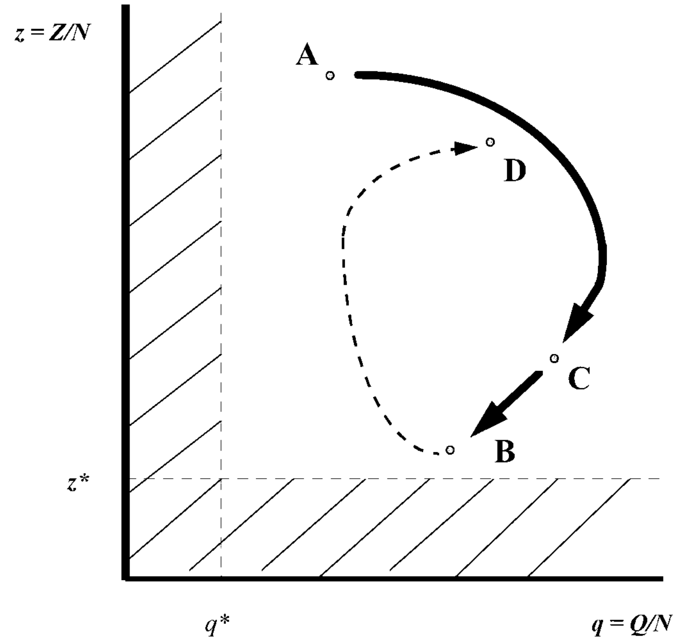
sustainable and socially acceptable. The success of implementing such a reform and rehabilitation agenda will not only depend upon the availability of future investment resources, but also on the political developments in and between the Central Asian states. Furthermore, given that population growth in the region is high and concentrated in relatively small areas, the increasing scarcity of land and water could lead to 'resource-based' inter-ethnic conflicts (Smith, 1995: 365; Spoor, 1997: 586).

A sustainable reform strategy in the CAS will therefore have to balance economic growth and environmental recovery. The interdependency of these variables can be demonstrated by building further on a simple theoretical model that relates environmental stock and potential output per capita (Karshenas, 1994; Taylor, 1996). In Figure 1 an attempt is made to depict the Soviet legacy, the transition period and a possible future scenario of sustainable economic recovery. In this case non-degraded land and water resources in the CAS are taken as the most appropriate measure for the environmental stock Z. The per capita environmental stock z ($=Z/N$) is deteriorating because of high population growth in the CAS, even if Z would remain constant. Per capita output q ($=Q/N$) of cotton is used, as it is intimately linked to the environmental crisis, in particular the deterioration of the environmental stock. In Figure 1 the critical areas are delineated by q^* and z^* as the minimally acceptable and sustainable threshold values (Taylor, 1996: 220).[4] Taking the starting point in 1960 at point A, the relationship between z and q for the period of 1960–90 is then shown by the curve AC, with early rapid output growth ($q\uparrow\uparrow$), followed by stagnation in the mid-1980s and finally per capita decline in the late 1980s ($q\downarrow$), combined with severe deterioration of the per capita environmental stock ($z\downarrow\downarrow$). In the post-1990 transition period the path between C and B (the point that indicates the current state) shows a further decrease in per capita output and decline of the per capita environmental stock ($q\downarrow$ and $z\downarrow$), reflecting the fact that countries such as Turkmenistan and Uzbekistan are actually close to 'mining' their environmental stock of water and land. If no comprehensive measures are taken to contain the deterioration of the per capita environmental stock, the threshold value z^* (of environmental collapse) could be reached rather soon. An alternative strategy is thus absolutely necessary.

Such a future reform path, in which economic growth and environmental recovery must be combined, is shown by the curve between B and D. It is to be expected that per capita output will show an initial further decline ($q\downarrow$) as, for example, severely salinized land is taken out of production, the crop mix is changed (not towards crops that use more water, such as rice, but towards less water-intensive ones) and water pricing is introduced, but it will then be restored by the introduction of improved water management and crop

4. Taylor discussed earlier works of Karshenas, rather than the work that resulted in Karshenas (1994). Therefore, only the latter reference is used in the text.

Figure 1. Environmental Stock (Land/Water Resources) versus Cotton Output per capita



production technology and land productivity ($q\uparrow$).[5] However, there will be rapid short-term gains for the environment ($z\uparrow\uparrow$), which can be further developed in the long run, albeit at a slower rate ($z\uparrow$). The form of the latter curve will be determined by critical socio-economic parameters such as rural employment and income, both heavily dependent on cotton, and adjusting the inclination to the right (as in Figure 1) will depend on the possibilities for using redundant rural labour in other agricultural and non-farm activities, and for producing more and better quality cotton in a sustainable way, with less land and water. Vested interests and social pressures (in particular related to rural employment) will also limit the options for national governments to reduce their dependency on cotton, to diversify the CAS' economies and to recover at least part of the lost environmental stock.

5. In a recent field visit to the Djalal-Abad region of Kyrgyzstan (eastern section of the Fergana Valley), I found that several farmers and peasant associations had introduced a new cotton growing technology of Chinese origin in which each plant was growing on spots 'packed' in plastic, thus saving water, fertilizers and pesticides, and with a doubling of the yield expected (field notes, 20 September 1997).

THE ARAL SEA BASIN CRISIS: A SOVIET LEGACY

Although global warming is expected to lead to rising sea levels, and the volume of the nearby Caspian Sea is indeed increasing,[6] the current volume of the Aral Sea has dropped to just a quarter of its 1960 level. Major changes in inland seas are not unusual in human history, but in this case, the change seems to buck global trends. In 1960 (usually taken as the base-year before the process of rapid desiccation began) the Aral Sea was, with an estimated 66,900 km^2, the world's fourth largest lake, behind the neighbouring Caspian Sea, Lake Superior and Lake Victoria. The Aral Sea has two tributaries, the Syr Darya (1370 miles) which springs from the Tien Shan glaciers of Kyrgyzstan, and the Amu Darya (1578 miles) which originates in the Pamir mountain ranges of southern Tajikistan and northern Afghanistan. The Aral Sea Basin has been host to many civilizations, settling in the oases of a region that is largely covered with inhospitable deserts, such as the Kara Kum and Kzyl Kum (Glantz et al., 1993: 180; Spoor, 1993; Talanova, 1997; UNEP, 1993). The region of the Caspian and the Aral seas, part of one of the world's main historical East–West trading passages, the Silk Road to China, has over the centuries had important traditional (often underground) irrigation and drainage systems that sustained agricultural systems around ancient cities such as Khiva, Samarkand and Bukhara (situated in contemporary Uzbekistan). However, with the inclusion of the area in the Soviet Union (Spoor, 1993), and the introduction of large-scale irrigation systems in the early 1930s, these traditional water management systems were largely destroyed (Micklin, 1992: 270).[7]

By 1960 the Aral Sea had a volume of 1090 km^3, fed by the natural surface flow of the Amu Darya and Syr Darya (respectively 69.5 and 37 km^3 annually); around 45–55 km^3 reached the sea (Martin, 1994: 39; Micklin, 1992: 274; Smith, 1994: 143).[8] Things had already begun to change, however; with the construction of the famous Kara Kum canal in the early 1950s, diverting Amu Darya water at Kerki westwards into the Kara Kum desert of Turkmenistan, discharge from the river into the Aral Sea dropped substantially. During the period 1960–80, the cotton acreage in Central Asia expanded rapidly, for example in Uzbekistan from 1.3 million to 2.1 million hectares, with increasing volumes of Amu and Syr Darya river water being

6. According to the Summary of World Broadcasts (SWB) of the BBC, SUW/0488/WD/2 (30 May 1997), the Caspian Sea has flooded 800 km^2 of land in Azerbaijan, and is expected to flood another 460 km^2 by the year 2010.
7. Precoda (1991: 110) cites a Turkmen Minister of Health as saying, in 1988: 'The water came to us from the mountains via a system of Kyariz [almost horizontal irrigation tunnels linking underground wells] conceived and built by our forefathers, and the water was crystal clear and fresh. The mountains they are bald and there is no water. The Kyariz have crumbled and fallen in'.
8. In World Bank (1996: 17) the 'mean annual surface flows' are estimated to be in total 115.6 km^3.

used for irrigation.[9] Water use for the irrigation of agriculture was such that by the early 1980s on average not more than 7 km^3 reached the Aral Sea annually; in some years no water at all passed through the Amu and Syr Darya deltas. Another supplier of water to the Aral Sea Basin, the Zarevshan river — partly flowing through Tajikistan — is 'used up' in the Samarkand and Bukhara regions.[10] The fishing ports of Maynak (in the delta of the Amu Darya in Karakalpakstan) and Aralsk (in the delta of the Syr Darya in Kzyl Orda *oblast* of Kazakhstan) have literally perished, the former lying around 60 km from the Aral Sea's current shores. By the late 1980s the Aral Sea had split into two, a large (*bolshoye*) — southern — and a small (*maloye*) — northern — sea, with the large sea starting to sub-divide into a western and eastern section (see Table 1 and Figures 2 and 3). Finally, while part of the water that was used for irrigation feeds terminal drainage lakes and desert depressions (or sinks) like Sarykamysh (Turkmenistan) and Arnasay

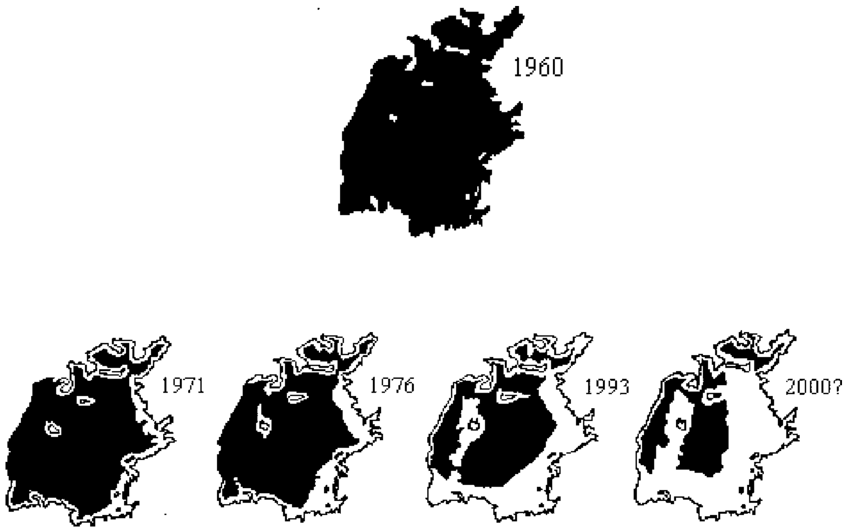
Table 1. The Chronology of a Disappearing Lake

Year	Average level (m)	Average area (km^2)	Average volume (km^3)	Average salinity (g/l)
1960	53.4	66,900	1,090	10
1971	51.1	60,200	925	11
1976	48.3	55,700	763	14
1980	45.4	—	602	—
1985	41.4	—	418	—
1988	40.1	—	358	—
1990 (early)		36,500	330	
large sea	38.6	33,500	310	~30
small sea	39.5	3,000	20	~30
1993 (1 January)	37.1	33,642	300	
large sea	36.9	30,953	279	~37
small sea	39.9	2,689	21	~30
2000 (1 January)*		24,155	183	
large sea	32.4	21,003	159	65–70
small sea	41.0	3,152	24	~25

Note:* Original estimates of 1991 were more pessimistic, with the total surface by the year 2000 reduced to 21,421 km^2, a volume of 140 km^3, and 36 g/l salinity for the small sea (see Micklin, 1992: 275).
Sources: Author's calculations from Bortnik et al. (1992: 316); Glantz et al. (1993:183); Micklin (1992: 275).

9. In the whole Aral Sea basin the irrigated area increased from 1 m ha in 1900 to 4.5 m ha in 1960, rising to 7.5 m ha in 1992 (Smith, 1994: 144). Craumer (1992: 136) comes to estimates of 5.6 m ha in 1960, and 8.7 m ha in 1988, including southern Kazakhstan (Kzyl Orda and Shymkent) and southern Kyrgyzstan (Osh) in his estimates.
10. Smith (1995: 358) sketches the serious inter-state problems that might occur between Uzbekistan and Tajikistan if the latter diverts much more water from the river for cotton production, before it can enter into Uzbekistan (interestingly enough, in a region populated with many ethnic Tajiks).

Figure 2. Shrinking of the Aral Sea (1960–2000)



Source: Micklin (1992: 275).

(Uzbekistan) with large quantities of salt and residues of fertilizers and pesticides, most is discharged into the rivers.

The consequences of overuse and mismanagement of the crucial (for Central Asian deserts) water resources are far-reaching. In Table 1 an inverse relationship is seen between the drying up of the Aral Sea and the increase in salinity, which by now has reached levels close to ocean water. The reduction of the water volume and average water depth has been increasing in pace, from around 1 km^3 per annum before 1960, to 14.1 km^3 in the 1960s, 32.2 km^3 in the 1970s, reaching a peak in the first half of the 1980s at 36.8 km^3 per annum. The slowing down in the rate of volume reduction since then can be attributed partly to an increased environmental consciousness within the leadership, and partly to pressure from below to improve water management systems.

With the greater openness in the Soviet Union, brought about by the introduction of *glasnost* by Gorbachev in 1985, several hidden environmental disasters surfaced, including the full extent of the Aral Sea tragedy. This contributed to improved pest control, with the introduction of Integrated Pest Management (IPM), and the gradual reduction in the use of chemical pesticides. Since the mid-1980s the volume reduction of the Aral Sea has slowed to 20–30 km^3 per annum between 1986 and 1988, and down to an estimated 14–15 km^3 per annum in the early 1990s (Bortnik et al., 1992; Glantz et al., 1993; Micklin, 1992). Depth reduction, which peaked at 0.8 meters per annum during 1981–85, has been at an average 0.6–0.7 metres per annum since then, and is continuing at that rate for the large sea.

Figure 3. Aerial Photo of the Aral Sea

Source: Talanova (1997).
Note: The precise date of this satellite photograph is not given, but the year is almost certainly 1995.

In short, during the Soviet period in Central Asia, the destruction of the traditional water management and crop rotation systems in the early stage of the Soviet era, followed by the 'cotton at all price' policy from Moscow from the 1960s onwards, greatly endangered the environmental sustainability of the Aral Sea Basin. The exclusive focus on 'white gold', as cotton is known in Central Asia, under a social organization of production that ignored the environmental impact of inadequate long-term resource management, has indeed turned into a 'tragic experiment' (Rumer, 1989).

THE IMPACT ON ECO-SYSTEMS AND HUMAN LIVELIHOOD

The most obvious impact of the crisis is the dramatic shrinking of the Aral Sea. At current rates of decline, it seems likely that even the larger *bolshoye* sea, after splitting into a western and an eastern section, will further disintegrate into several smaller lakes and ponds, and will virtually disappear between 2015 and 2020. The eastern section of the large sea is shallow; the western part is deeper, but practically dead in terms of microbiology. Current thinking within the Uzbek government is to concentrate all water inflow from the Amu Darya into the western part, which can be revived and saved. This could be done by cutting off the eastern part from the river delta. Glantz et al. (1993) note that the smaller *maloye* sea grew slightly during the early 1990s. This was probably because of an increased inflow in the Syr Darya river basin; in Kyrgyzstan, more water is let through in the winter for hydro-power production at Togtogul, causing water flows north-westwards into southern Kazakhstan.[11] In the summer, less water comes through. (This was confirmed by recent field visits to Djambul and Shymkent *oblasts*, which precede Kzyl Orda, where most of the farmers visited complained about having much less water than the previous summer.[12]) The danger that insufficient water from the Syr Darya would feed into the *maloye* sea was recognized some time ago. The Karatyup peninsula has almost joined the eastern shores of Aral, close to the Syr Darya river delta: if the small sea were to be cut off from the Syr Darya delta, it would quickly perish. With assistance from the World Bank, therefore, a dike is being built that will secure inflow of the available water into the *maloye* sea, avoiding leakage to the shallow eastern section of the *bolshoye* sea.[13]

11. Personal communication with a World Bank consultant who worked on Kzyl Orda's agricultural sector in 1996.
12. This was partly the result of the above described phenomenon, but was also partly caused by increased water use at the Uzbek side of the border (which the Syr Darya passes through before reaching Kazakhstan), in a year that — like 1995 — was generally seen as dry.
13. Interview with David Pearce, Resident Representative of the World Bank in Kazakhstan (Almaty, 9 September 1997).

A second problem has arisen because the same fields have been irrigated for decades without any form of crop rotation or proper drainage, leading to water logging; this has stimulated processes of primary and secondary salinization, resulting in severe soil degradation in many parts of the Aral Sea Basin, especially in the mid- and downstream areas of the Amu and Syr Darya. By 1985, after the peak period of water diversion from the two rivers for irrigation purposes, 68 and 89 per cent (respectively) of all irrigated land in the Dzhizak and Syr Darya *oblasts* of the Syr Darya basin was salinized. For the Amu Darya basin, the levels were 60 per cent in Karakalpakstan (the delta area), 75 per cent in Khorezm and 90 per cent in Navoi in western Uzbekistan (Smith, 1992: 26). Consequently, more water is used for periodic leaching, in order to (at least temporarily) wash away the salt. Hence, 'water here is both the cause and cure of salinization' (ibid: 3).

It was recently found that in the Amu Darya basin alone, a total of 84 million tons of salt is discharged annually into the river, transported with the water which is used to irrigate the fields, the largest share being found midstream. The ratio between salinity of drainage disposal and water supplied (both measured in g/l) varied between 3.3 and 7.1, which shows the severity of the salt problem. If this trend continues, and no salt management measures are taken, large areas of cultivated land in Central Asia will be unfit for agricultural production within a few decades.[14] Crop yields can be substantially lower when salt content in the upper layers of the soil is too high, with the result that salinized soils are often abandoned in favour of newly reclaimed land.[15]

Thirdly, excessive fertilizer and pesticide use, mostly in relation to cotton and rice cultivation, has contaminated surface and underground water. Not only were inferior quality herbicides, insecticides and defoliants used in the FSU — which were more contaminating than those available on the world market — but highly subsidized prices within the context of a planned farm economy provided no incentive for efficient use, often leading to excessive use and wastage of fertilizers and pesticides. Chemical pollution of drinking water has caused a high incidence of cancerous diseases, and substantial dioxin residues have been found in mothers' milk, in particular in Karakalpakstan (Carley, 1989). The incidence of waterborne diseases such as typhus, paratyphoid and viral hepatitis has increased enormously over the past decades in the midstream and downstream areas of the Amu and Syr Darya.

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14. From an unpublished study on water and salt balances performed by the Central Asian Irrigation Research Institute (SANIIRI), in co-operation with experts of the World Bank.
15. Glantz et al. (1993: 178) cite a Russian author (*Novyi Mir*, 1988): 'If one were to travel by car from Khiva to Tashauz to Nukus [in the Amu Darya delta], then one would see a white, as a snow-covered steppe, lifeless plain from horizon to horizon'.

During a recent visit to Shymkent and Djambul (along the Syr Darya in Kazakhstan) cholera had broken out.[16]

It is not only agriculture, but also industry which is causing water contamination. Concentrated in or around the main cities in the Aral Sea Basin, such as Osh, Namangan, Fergana, Kokand, Andizhan, Samarkand, Tashkent, Bukhara, Chardhou, Mary, Tashauz and Nukus, industrial complexes and mines discharge their poisonous residues into rivers, and into the air. Problems of respiratory disease are widespread, as maximum permissible levels (MPC) of air contaminants are substantially violated (UNEP, 1993: 72–4), in the already dusty environment of Central Asia. Furthermore, water quality also suffers from the existence of mainly rudimentary sewage systems, especially in rural areas. With decreased social funding by national (and regional or local) governments of investments in this field, and with high population pressure, this is a very serious problem.

According to research done by the Institute of Water Management Problems, Uzbek Academy of Sciences, only 8 per cent of the rivers in Uzbekistan are 'clean', applying accepted environmental standards of purity. Around 15 per cent of river water is of 'satisfactory' quality, and 41 per cent is 'bad'. More than 10 million people (50 per cent of the population) reside in the river basins which fall into the latter category. Around 36 per cent of river water is considered 'dangerous' or 'extremely dangerous', particularly in Karakalpakstan and the lower reaches of the Zeravshan river in central Uzbekistan, where 24 per cent of the Uzbek population lives.[17] In many cases, rural dwellers are forced to drink irrigation water, as the only water available, with all the health risks involved — the levels of pathogenic micro-organisms and intestinal bacillus content are substantially higher than the maximum permissible levels (UNEP, 1993: 84). In rural settlements in Kzyl Orda region, water consumption is severely limited during the very hot summers, and there is a structural drinking water deficit.[18]

A fourth problem is that wind erosion and the increased occurrence of salt and sand storms in the Aral Sea Basin, in particular in Karakalpakstan and Kzyl Orda, are causing soil degradation, lower crop yields, and affecting the health of the population living in these areas, as polluted particles are spread on the winds over large distances (Martin, 1994: 37). Air pollution caused by contaminated dust has a major impact on child mortality, which is around

16. Field notes of research visit to Southern Kazakhstan (11–14 September 1997). Other (non-waterborne) diseases have also emerged, such as Siberian haemorrhagic fever (affecting cattle). The local sanitary service of Djambul closed a substantial number of restaurants which were suspected of serving infected meat. I was strongly advised only to eat 'in house', that is, only to consume meat of which the origin and quality had been closely monitored.
17. SWB/SUW/0466/WE/2 (20 December 1996).
18. There are currently several projects underway (executed by international donors and NGOs) to improve the drinking water delivery in Karakalpakstan and Kzyl Orda regions, as this situation has become unsustainable.

three times higher in Karakalpakstan than the average for the FSU. Furthermore, the presence of a much smaller water body in the desert area of Kara Kum and Kzyl Kum is influencing temperatures (making them 1–2°C higher in the summer and lower in the harsh winters). Extreme drought in the southern steppes of western Kazakhstan caused a huge steppe blaze in July 1996, destroying 40,000 hectares in one week.[19] Whether this can be directly related to climate change is unclear, but the areas surrounding the Aral Sea have undoubtedly become more inhospitable than ever. Extreme temperatures also contribute to the shortening of the growing season, as there are fewer frost-free days (Smith, 1994: 157). This has resulted in an observable shift from cotton to short-growing rice varieties in the delta areas, which — ironically enough — increases water consumption. Cotton in Uzbekistan was using around 13,000 m^3 water per hectare in the early 1990s, while in southern Kazakhstan this was 35,000 m^3 per hectare for rice. An additional incentive for such a shift is the high (above world market) price of rice, because of growing demand in Uzbekistan, Kazakhstan and Ukraine for locally produced rice (preferred to imported rice for its taste and quality).

Finally, the drying up, further salinization and contamination of the Aral Sea and the deltas of the Amu and Syr Darya are dramatically affecting their eco-systems. The fishery sector of the Aral Sea has been practically annihilated by the further salinization of the already salty water, the destruction of the spawning areas of the deltas and the contamination with poisonous residues of pesticides and fertilizers used in cotton and rice cultivation, flushed back into the rivers in the absence of proper drainage systems. Traditional vegetation, such as the *tugay* forests in the Amu and Syr Darya deltas, and vast areas of reed, are rapidly disappearing and desertification advances (Smith, 1994: 157). The negative impact on existing eco-systems can be also seen by the extinction of hundreds of species of flora and fauna that were unique to the river deltas (and the Aral Sea itself). Not only have existing eco-systems been affected or destroyed, however; new eco-systems have been artificially created. As Smith (1992: 31) notes in connection with the Kara Kum Canal: 'Infiltration (seepage) along the path of the unlined Kara Kum Canal through the sands of the Kara Kum Desert in the Turkmen SSR [currently Turkmenistan] has resulted in extensive areas of waterlogged soils close to the canal'. The appearance of 'marshlands in the desert' is quite extraordinary, but it is understandable, given estimates that 60 per cent of water withdrawn from the Amu Darya is actually lost.

In summary, the Aral Sea Basin environmental crisis has severely affected the human ecology of the area: millions of people are dependent on soils, water and air which are often highly contaminated, while agricultural employment opportunities are under pressure in a context of rural population growth, in regions with relatively small areas of cultivated land.

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19. SWB/SUW/0445/WE/3 (26 July 1996).

POST-INDEPENDENCE RIVER BASIN WATER MANAGEMENT

In the Soviet era, all major decisions on the supply and distribution of water resources — the scarcest commodity of the region, although at the time not recognized as such — were made in Moscow and not in the region itself. They were thus decoupled, at least at the official level of policy making, from national or ethnic interests. Degrees of water dependency vary markedly among the five countries in the region (Smith, 1995: 357), with Uzbekistan and Turkmenistan the main users of externally provided water, and Kyrgyzstan and Tajikistan the main supplier countries. This unequal division of availability and use, within the general context of a regional water deficit (World Bank, 1996), is one of the main sources of tension for current and future river basin water management, to be carried out jointly by the newly independent river basin states.[20]

For a long time, the problem of water in Central Asia was seen simply as a problem of insufficient supply, and by the late 1970s plans had been made to divert Siberian rivers, and to transport water through a huge canal that would cross the endless steppes of Kazakhstan, in order to bring water to the plains of Central Asia. Low water efficiency ratios, caused by massive water losses through seepage (in unlined channels) and evaporation (in the desert climate of Turkmenistan, Uzbekistan and southern Kazakhstan), were not taken seriously as major factors in explaining the 'Aral Crisis'.

However, in the years following Gorbachev's *glasnost*, and before independence of the CAS in 1991, interest in the environmental problems of the Aral Sea Basin grew. An official FSU Supreme Soviet and Council of Ministers Commission made an inventory of the causes of the crisis and possible scenarios for mitigating its impact (Kotlyakov et al., 1992). The report was rather sceptical of the possibility of restoring the Aral Sea through the transfer of water from neighbouring regions, such as the Caspian Sea or the Siberian rivers, although this option is still present in the minds of Central Asian policy makers and researchers (Micklin, 1992).[21] Now, given the complex political realities of the region, with new players such as Iran and Afghanistan, and a completely different relationship with Russia, such a plan seems unrealistic. With the sudden disintegration of the Soviet Union, the policy agenda has shifted; from an environmental point of view this is a

20. As part of the Soviet legacy of national borders, the rivers also pass through several countries. For example, the Syr Darya starts as Naryn river in Kyrgyzstan, with the large dam and hydroelectric plant of Togtogul. It then flows through the Fergana valley in Uzbekistan (where there are also major dams and artificial lakes for irrigation purposes), before finally coming into Kazak territory.
21. The World Bank (1996: 25) notes: 'The countries of the region seem to recognize the problem of water shortages by frequently raising the issue of importing at least 20 km^3 from outside the Aral Sea Basin. The difficulties of importing this vast amount of water are well known. The basic alternatives appear to be either conserving water in a variety of ways or revising national social and economic goals and policies (or both)'.

positive change, avoiding a 'solution' which would have created potentially even bigger environmental problems. Any real solution to the crisis must be found not by supplying more water, but by using less water, or by using the available water more efficiently.

With the formation of independent states in the Aral Sea Basin, inter-nation and ethnic 'resource-based' conflicts are emerging — or are being more openly expressed. The bloody clashes in June 1990 between Kyrgyz and Uzbeks in the Osh region, which were at least partly caused by problems over access to land and water, are an example of the possible threats to regional stability (Martin, 1994: 36; Smith, 1995; Spoor, 1993). Although the five CAS set up an Interstate Council for the Aral Sea (ICAS)[22] and two river basin authorities, in Tashkent for the Syr Darya, and in Urgench for the Amu Darya (Smith, 1995: 366; UNDP, 1996), and although they have pledged to negotiate water allocations, there is potential for future conflict:

> In Central Asia, regional tensions may be enhanced by current water allocation practices. In recent years, Central Asia has experienced an increase in irredentist activity and inter-ethnic conflicts. Competition over natural resources may intensify such irredentist sentiments, with some viewing escalating future inter-ethnic confrontation in Central Asia as being driven in part by water allocation problems. (Smith, 1995: 353)

Conflicts may arise between Turkmenistan and Uzbekistan, reviving earlier controversies around the diversion of Amu Darya water into the Kara Kum desert, and around the handling of (often polluted) drainage waters in the downstream Amu Darya basin. There is also fierce competition for water between Kazakhstan and Uzbekistan in the regions north-west of the Fergana Valley (Djambul and Shymkent). These tensions reflect the dominance of national interests in regional water allocation. According to the World Bank (1996), there has been a slight improvement in total water use during the period 1990–4 (dropping by a total of 6.4 km^3), much of it attributed to Uzbekistan (see Table 2 below). It was estimated that the inflow into the Aral Sea increased substantially, from 12.3 km^3 in 1990 to 31.5 km^3 in 1994 (ibid: 16).

Taking into account that 1994 was a particularly wet year, however, this seems to misrepresent the overall picture. Recent data on surface inflow of water in the Aral Sea scaled down this estimate to 25.5 km^3; in the two very dry years which followed, this has dropped to 7.1 km^3 and 9.0 km^3, even lower than the 1990 level.[23] The 'Regional Water Management Strategy' study of the World Bank for the period towards 2010, recognizing the growing water demand of the CAS, shows that with a warranted average

22. The ICAS agreement set up an Executive Committee that would have sufficient powers to deal with water management issues. This was confirmed by the Aral Sea Summit held in the town of Kzyl Orda (26 March 1993).
23. Data provided to the author by the World Bank Regional Office in Tashkent (September 1997).

Table 2. Water Use and Irrigated Areas of Aral Sea Basin States

	Actual water use (km^3)		Irrigated areas in basin ($\times$1000 ha)	
Country	**1990**	**1994**	**1990**	**1994**
Kazakstan	11.9	10.9	781.8	786.2
Kyrgyzstan	5.2	5.1	423.7	429.9
Tajikistan	13.3	13.3	609.1	719.2
Turkmenistan	24.4	23.8	1,329.3	1,744.1
Uzbekistan	63.3	58.6	4,222.0	4,286.0
Total	118.1	111.7	7,465.9	7,965.4

Source: World Bank (1996: 22).

water inflow in the Aral Sea of 19.0 km^3 the overall water (*resources-use*) balance per annum would be strongly negative.[24] While the study points out that even this level of discharge 'cannot sustain the Sea at the present level' (World Bank, 1996: 23), it is more than likely that the Aral Sea would be the first 'player' in the field to be cut in its ration of distributed water.

Nevertheless, in the post-independence years more regionally-based water management agreements have gradually been made, and with the support of UNDP, the World Bank, UNEP and the EU, serious efforts have been undertaken to improve co-ordination. The Interstate Council for the Aral Sea (ICAS) was founded in 1993, and in early 1997 a decision-making body became operative in which all governments are represented at the highest level. At the same time, an international fund for the rehabilitation of the Aral Sea (IFAS) was established that focuses on the development of land, water and salt management strategies, wetland restoration and improvement of the livelihood of people residing in the disaster zones. Nationally-based activities, such as improvement of irrigation and drainage systems, will be further implemented within this overall framework. In 1997 the two institutions of ICAS and IFAS were joined. In a recent interview, the Chairman of the combined ICAS/IFAS office in Almaty (the former Executive Director of IFAS), was asked how much water really reached the Aral Sea in 1996. He responded:

> Not even a cup of water. There is a real crisis of the Aral Sea. It will disappear, or at least split into a number of smaller lakes and ponds, in between 10 and 15 years. It would currently need around 30 km^3 to remain at the same level, but if it would become deeper it would need more because of increased evaporation. The solution lies in a rational use of water by each

24. Based on calculated demand of the CAS (and Afghanistan), there would be a deficit of between 23.7 and 47.0 km^3. However, the calculated demand of 1994 is also substantially higher than the actual use.

> river basin state. There is an agreement between states, so if they want to save the Aral Sea, they can do it.[25]

The rational use of water should indeed focus on irrigated agriculture, as most river water is diverted for this purpose. Of total water use in 1994, it was estimated by the World Bank (1996: 20) that 91.6 per cent was for irrigated agriculture, 3.6 per cent for (mostly urban) domestic and household consumption, 1.9 per cent for industry, 1.6 per cent for rural water supply, 0.8 per cent for fisheries and 1 per cent for other uses.

The economies of the Aral Sea Basin are highly dependent on agricultural output for their food security and foreign exchange earnings. Because of the crucial role agriculture plays in the economic development of the CAS it is likely that vested national (and sometimes ethnic) interests that relate to resource use (such as water and energy) will remain dominant and a possible source of tension and conflict. Although land use since the early 1990s has shifted somewhat towards food crops (except in Kazakhstan where the grain sector contracted substantially), cotton is still the predominant — and high water consuming — crop. In Turkmenistan, Uzbekistan, Tajikistan and Southern Kazakhstan this shift in crop mix is not so much 'market induced', but reflects the strategy of food self-sufficiency that has become commonplace at national and even *oblast* level. It was recently reported in Turkmenistan that President Nyasov 'ordered' a bigger harvest of grain for 1996–7, and sacked regional governors when they failed to produce their targets.[26] Overall, the transition towards a market economy in the agricultural sector, except in Kyrgyzstan and some areas of Kazakhstan, is proceeding rather slowly (Delehanty and Rasmussen, 1995; Lerman et al., 1996; Spoor, 1995). The degree of dependency of the CAS on 'white gold', food crops, and the rural employment they provide, makes it difficult to realize fundamental changes in crop mix and land utilization. In the words of the ICAS/IFAS Chairman:

> Who will have the braveness to tell the farmers: 'reduce production and perish'? It will take quite some time to have rational production systems, where instead of cotton and rice, in some places the farms will produce wine and other products. Nevertheless, currently all states want to be independent in the production of grains, although nature defines the production of which commodities can be grown in each place. In fact, it is too hot during the summer in Turkmenistan and Uzbekistan to produce grains. At the same time, cotton is the foreign exchange earner. This question is a very important one, and has to be faced in the very near future.[27]

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25. Interview (by the author) with Mr Almabek Nurushev (Almaty, 8 September 1997). It was interesting to note that the World Bank Resident Representative in Kazakhstan told me in an interview the following day that 'the level of Aral had stabilized'.
26. SWB/SUW/0445/WC/3 (23 August 1996).
27. Interview with Mr Almabek Nurushev (Almaty, 8 September 1997).

Nevertheless, expansion of irrigated areas seems to have largely taken place without increasing the water volumes used, as can be seen from a comparison of the estimates on the Aral Sea Basin states actual water use in 1990 and 1994 (see Table 2). There have certainly been improvements in water management practices and the use of integrated pest management techniques during the late 1980s and early 1990s, particularly in Uzbekistan, partly reflecting a greater environmental concern within policy-making circles. However, the total amount of cultivated (and irrigated) land has increased between 1990 and 1995 (see Table 3), if one excludes the mostly rainfed grain areas of Kazakhstan which have decreased in size, and focuses on the down-stream countries of Turkmenistan and Uzbekistan where the bulk of water is used and practically no agricultural production is possible without irrigation.[28] In Turkmenistan, as an extension of the Kara Kum channel, a new 100 km irrigation channel is currently planned in the southern region that borders Iran, with the capacity to irrigate 20,000 hectares of the Tedzhen oasis.[29]

In Table 3 the cultivated areas for wheat, rice and cotton are given for the five CAS. In terms of water consumption the data suggest that the current crop mix is less water intensive than the former.[30] However, water leaching on severely salinized land and deteriorating irrigation systems which lack replacement investments, are countering this improvement. It is also questionable whether wheat should be cultivated in irrigated desert areas, using substantial water resources and offering only limited yields. Both Uzbekistan and Turkmenistan have failed to reach grain self-sufficiency in the past years, partly because of the extreme drought they had to cope with, but also because grain was cultivated in soil and climatological conditions not really suitable for the crop.

Irrigated agriculture is thus by far the largest water user in the Aral Sea Basin; at the same time, inefficient incentive systems (in water supply and distribution, as well as agricultural production decisions), low quality infrastructure and the extreme desert conditions, cause a large share of the water that is diverted from the Amu Darya and Syr Darya to be wasted

28. GosKomStat (1991: 255) notes that the irrigated acreage of Uzbekistan increased in the 1980s from 3,517,700 ha in 1980 to 3,976,600 ha in 1985, corresponding with the rapid depletion of the Aral Sea that was shown in Table 1; in the second half of the 1980s this figure finally stabilized at a level of 4,221,800 ha. Nevertheless, heavily salinized soils are being taken out of production, and newly reclaimed lands are being included. On the history of cotton production in Uzbekistan, GosKomStat (1987) is a useful source.
29. SWB/SUW/042/WC/1 (5 July 1996).
30. It is estimated that water consumption for cotton is around 13,000 m^3/ha, for wheat 8500 m^3/ha and for rice 35,000 m^3/ha. According to World Bank (1996: 20) average water use per hectare in Central Asia has dropped from 18,200 m^3/ha/year in 1980, through 14,600 m^3/ha/year in 1990, to reach 12,200 m^3/ha/year currently. The study reported that: 'This decrease in irrigation water use was achieved by water use limiting only; because of the shortage of funds, it was not accompanied by necessary technological improvements'.

Table 3. Acreage of Main Agricultural Crops in Aral Sea Basin (×1000 ha)

	1990	1991	1992	1993	1994	1995
Kazakhstan						
Grain	23,356	22,753	22,596	22,250	20,706	18,816
Rice	124	118	121	112	102	95
Cotton	120	117	112	110	111	110
Kyrgyzstan						
Grain	538	557	576	624	586	607
Cotton	30	26	22	20	26	33
Tajikistan						
Grain	230	232	264	279	260	261
Cotton	304	299	285	275	283	270
Turkmenistan						
Grain	190	240	341	434	436	660
Cotton	623	602	570	581	578	555
Uzbekistan						
Grain	1,008	1,080	1,212	1,280	1,522	1,664
Rice	147	160	182	181	167	168
Cotton	1,830	1,720	1,667	1,695	1,538	1,491

Note: In World Bank (1996: 22) it is concluded that between 1990 and 1994 the total irrigated area of the five CAS had increased from 7,465,000 to 7,965,400 hectares, mainly due to large expansion of irrigated grain areas in Turkmenistan, relative to other CAS.
Source: StatKom SNG (1996).

because of seepage, evaporation and leaching. Solutions to the Aral Sea Basin crisis have therefore to focus on improved water (and salt) management systems that form part and parcel of the above suggested reform path in which economic growth — with the cotton sector retaining an important role — and environmental recovery need to be combined (see Figure 1 above).

POLICY OPTIONS AND THEIR IMPACT ON THE CRISIS

In spite of its vital importance to agriculture, water in the Central Asian region has largely remained unpriced, or has been priced at a purely symbolic level. In the Soviet command economy it was not seen as representing a cost, nor did any cost-benefit ratio determine the centrally planned allocation of resources. Currently, estimated costs of delivering water, still according to a planned water management system (Lerman et al., 1996), vary from US$ 1.5 per 1000 m^3 to US$ 8.4 per 1000 m^3. SANIIRI, the Central Asian Irrigation Research Institute in Tashkent, therefore recommended an average water charge at US$ 6.33 per 1000 m^3 (ibid: 168). Water charges were introduced in 1993 in Kazakhstan; in the southern Kzyl Orda *oblast*, these were reported to be just US$ 0.85 per 1000 m^3, as no capital depreciation at border price level was taken into account.[31] In some of my own field visits to farms in Uzbekistan, water pricing was seen by farm managers as something unacceptable, since water is considered as 'God given'. However, continued population and land pressure increase the need to price this most precious resource. Water pricing should go hand in hand with a fundamental change in the incentive structure of agricultural production. As changes are taking place only gradually in most of the CAS (Kyrgyzstan is the exception; here land, price and marketing reforms have progressed much further in the past few years), this is a crucial issue. In the current situation of a still largely unchanged production structure of cotton in Uzbekistan and Turkmenistan, pricing of water could simply have the effect of further taxing the farm enterprises, while the latter have virtually no chance of improving the allocation of factors of production, or influencing water supply and distribution, which is still organized centrally.

One proposal is to introduce tradable water rights ('water markets') and to organize water users' associations (WUA), as *intermediate institutions* for water management. However, given the very gradual, even reluctant, process of farm restructuring in Uzbekistan and Turkmenistan this will still take a long time (if indeed it can ever be implemented). A further complication is that while de-collectivization is on the agenda, the break-up of the large-scale irrigation systems that served the collective and state farms could contribute to their further deterioration, in the absence of newly constructed systems that are more suitable for small and medium-sized private farms. This prevents the restructuring of water management systems, hence prolonging the dominance of the centrally planned water management and distribution system.

The advantages of the existing system are its infrastructure and capacity of distribution, and measures of efficiency improvement could well be implemented here. The great disadvantage is that working with planned norms of water use is leading (as in the FSU with the use of inputs) to the 'use it or lose it' principle (Lerman et al., 1996: 170). The fear is that water-saving measures by a farm will not reduce its costs or improve benefits, but will convince the water authorities that less water is needed (ibid: 168). Nevertheless, water pricing is the key to a more efficient and sustainable way of using water and will not necessarily reduce yields. The water volumes used in cotton in Central Asia, for example, are amongst the highest in the world (ibid: 153), showing clear room for improvement. Sustainable land management, as part and parcel of the process of establishing a new agrarian structure in which private farm enterprises are to become the main force, will also be crucial to

31. Data obtained from World Bank consultant working on Kzyl Orda agricultural sector study, 1996.

induce an improved efficiency of water use in the Aral Sea Basin. Substantial areas that are severely salinized and contaminated must be taken out of agricultural production, and cotton production should be concentrated on high productivity land. Obviously such drastic steps cannot be undertaken without creating alternative job opportunities in rural areas or possibly initiating resettling programmes.[32]

Another important issue for improving water quality and reducing nutrient contamination of the rivers and the Aral Sea is the influence of market oriented reforms on the use of pesticides and fertilizers. During the last five to ten years chemical input use in agriculture (in particular in cotton) has been cut back under the influence of Integrated Pest Management (IPM) methods. The introduction of border prices (or prices at least near to their level) for inputs, has further reduced the use of chemical inputs. According to FAO data for Uzbekistan, nitrogen consumption went down from 410,000 tons in 1992 to 300,000 tons in 1994, and phosphate from 260,000 tons to 123,000 tons.[33] Whether this reduction reflects the former inefficiency of fertilizer use (when much of the applied fertilizer was actually flushed away in leaching and no economic sanctions existed on overuse) is difficult to estimate. It does, in any case, contribute to the reduction of nutrient pollution of rivers.[34]

Investment in new, smaller-scale and more efficient irrigation systems, and the maintenance of the existing ones, is also called for. Estimates have been made of the costs of lining main canals and field channels; calculations of envisaged capital-intensive investments generally indicate that they will be out of reach for most farm enterprises. Nevertheless, the abundant availability of rural labour, some still within the existing enterprises, some already 'shed' in the process of farm restructuring, suggests that labour-intensive (or labour-absorbing) investment projects, which could provide low cost solutions to some of the major infrastructural problems (such as the building of new drainage channels), might be more feasible. In countries like Uzbekistan and Turkmenistan, rural transformation is proceeding only slowly, but the rapidly changing macro-economic situation has imposed certain constraints on the farm enterprises with the introduction of (near) border prices of inputs (fertilizers, pesticides, machines and spare parts). The result of this is that

32. Resettling from the disaster zones (such as Karakalpakstan and Kzyl Orda) is easier said than done, however. There have been resettlement programmes but, in spite of the difficult conditions, most people prefer to stay on the soil which, in many cases, they and their families have inhabited for centuries.

33. Data acquired from the FAOSTAT database on the Internet Site of the FAO, Rome.

34. Foreign exchange constraints have also had a negative impact on the use of IPM. It was recently reported in the Andizhan region (Fergana Valley) that 'farmers may be forced to abandon the use of biological pest controls' because of serious underfunding (and non-functioning) of plants that supply predatory insects. However, 'lack of interest' in IPM methods was also mentioned in the report as one of the reasons to return to chemical inputs (SWB/SUW/0472/WC/1, 7 February 1997).

much of the cotton harvest is once again being brought in by manual labour (in part using the tradition Soviet-style urban brigades); in the lean season, this manual labour could also be used for important infrastructural projects. The national governments have sufficient options ('food for work', for example) to stimulate the use of available surplus labour for realizing infrastructural investments, which would also lessen the pressure of rural–urban migration.

CONCLUSION

The daunting prospect of the disappearance of the Aral Sea is just as realistic now as it was in the early 1990s, when the first major studies of this environmental tragedy were made public. The available data on the depletion of its water volume and depth show that during the late 1980s and early 1990s, rates of decline were less sharp than in the peak years of the early 1980s; they are, however, still alarming, with volume decreasing by around 14–15 km^3 per annum and depth by about 0.6–0.7 meters per annum. If these rates persist, little will remain of the Aral Sea by 2015–20, except for a set of shallow lakes, ponds in the midst of a 'salt desert'. In an epoch in which public knowledge about the severe environmental disaster that is taking place has spread rapidly, and in which the CAS governments have become independent players on the Central Asian (and geo-political) chess board, there are two, rather contradictory phenomena visible in Central Asia. On the one hand, there have been the regional initiatives of establishing the Interstate Council for the Aral Sea and the River Basin Authorities, to manage and allocate limited water resources (UNDP, 1996), recognizing that the Aral Sea 'will be regarded as an independent water consumer' (World Bank, 1996: 26). Furthermore, in several countries policy reforms are being initiated, aimed at the introduction of water pricing, the reduction of chemical contamination, and improved water efficiency.

On the other hand, at farm level — especially in Uzbekistan and Turkmenistan — the centrally planned water allocation and distribution system does not provide incentives to improve water efficiency, nor does it reduce costs for those who do save water. At national and regional levels, the system of water allocation is therefore still leading to the 'use it or lose it' philosophy amongst consumers. The down-stream countries ('the water users') of Uzbekistan and Turkmenistan (as well as some regions in Tajikistan, and southern Kyrgyzstan and Kazakhstan) have expanded their acreage of irrigated crops, although remaining within the existing water quota. At the same time, they have shifted the crop mix somewhat towards wheat and rice in order to promote self-sufficiency of food at *oblast* or national level, without taking into account the real production and environmental costs involved, including the (largely subsidized) energy costs. Water is often transported over large distances or pumped to overcome extreme altitude differences (World Bank, 1994). In terms of industrial water pollution, the CAS have the possibility to tax the polluters, through environmental taxes and effluent charges. In Uzbekistan and Kazakhstan, national environmental action plans (NEAP) are being formulated; Kyrgzystan already has a NEAP, which focuses on environmental monitoring, water pricing and pollution charges. Nevertheless, there is a severe lack of institutional capacity to implement these policies at national and local levels.

On several occasions, such as at the Aral Sea Summit in Kzyl Orda (March 1993), the Nukus Aral Sea Conference (September 1995) and most recently in Almaty (February 1997), the five presidents of the CAS have agreed to a more efficient and sustainable use of the water that is available from the Amu Darya, Syr Darya and Zarevshan rivers. In spite of this, however, national interests prevail, sometimes even expressing themselves under an 'ethnic banner'. Tension over access to land and — especially — water has already provoked some inter-ethnic resource-based conflicts, such as in Osh and in the Fergana Valley (1989–90). Such tensions might well ignite larger conflicts, particularly in areas such as the densely populated Fergana Valley and other traditional oasis economies in Central Asia (Glantz et al., 1993; Smith, 1995; Spoor, 1997).

Many conferences have been organized and hundreds of studies have been produced to make the world aware of the problems that the Soviet legacy of forced cotton cultivation has left in Central Asia, expressed in desiccation, salinization, desertification, the deterioration of health conditions, and the rapid shrinking of the Aral Sea. The problem is that many of the proposed solutions, that include measures for improved water efficiency and sustainable water use, need a combination of national policies and a major international effort in terms of infrastructural investments (in irrigation systems, drainage, sustainable agricultural development and reforestation), well above the current level of pledged aid provided by the World Bank, UNEP, UNDP, the EU and USAID.[35] In the most recent Central Asian Summit in Almaty in February 1997, the Kazakh President Nursultan Nazarbayev was optimistic. The region's leaders had, he claimed, 'finally managed to obtain the recognition of a global ecological catastrophe in the region by the world community and to draw the attention of international financial structures to the liquidation of the consequences'.[36] Whether the pledged and disbursed aid and loans will be of the scale needed to solve the crisis is in serious question; a further problem is that the room for manoeuvre which is available for policy implementation and water management reforms in the CAS themselves is not being sufficiently utilized. There is a need for clear

35. For an analysis of the Aral Sea WB/UNEP/UNDP programmes, see Beentjes and Stemerding (1994); for a new project on institutional support to ICAS, see UNDP (1996).
36. SWB/SUW/0476/WE/5 (7 March 1997). In the same report it was mentioned that the World Bank had agreed to provide US$ 380m in loans up to the year 2000.

intersectoral co-ordination in relation to the Aral Sea Basin crisis, at national levels and within the existing ICAS institutional structure, where water, environment and agriculture are often dealt with by entirely different government agencies, with little institutional communication between them. Finally, a clear change in the political will of the Central Asian leadership is warranted; in spite of the official discourse, they seem to underestimate the danger for their economies and for human ecology that the drying-up of the Aral Sea would imply. Civil society environmental organizations could play an important part here, but at the moment, the role of such organizations is minimal; in Uzbekistan and Turkmenistan, particularly, they are struggling to emerge, and have little influence on the still powerful state structures.[37] Whether short-term solutions to the Aral Sea Basin crisis are feasible within the current political economy framework of the CAS will only become clear in time — but for the Aral Sea and for the millions of people living in the disaster areas, time is running out.[38]

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37. Examples of active NGOs in Uzbekistan are, amongst others, The Association for an Environmentally Clean Fergana and Women of Aral.
38. As the World Bank (1996) study of a regional water strategy concludes: 'The interstate coordination of water and land use and the related policies cannot be any longer contradictory to long-term natural resources management and environmental objectives'.

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