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Environmentally and Socially Sustainable Development Department

DROUGHT

Management and Mitigation Assessment
FOR CENTRAL ASIA AND THE CAUCASUS

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LIST OF ACRONYMS

ADB	Asian Development Bank
BVO	Basin Water Management Association
CGIAR	Consultative Group on International Agricultural Research
CIMMYT	International Maize and Wheat Improvement Center
GIEWS	FAO Global Information and Early Warning System
ICARDA	International Center for Agricultural Research in the Dry Areas
ICAS	Interstate Council for Addressing the Aral Sea Crisis
ICWC	Interstate Commission for Water Coordination
IFAS	International Fund for the Aral Sea
FV IWRM	Ferghana Valley Integrated Water Resources Management Project
MES	Ministry of Emergency Situations
NDVI	Normalized Difference Vegetation Index
NGO	Non-governmental Organization
NOAA	United States National Oceanic and Atmospheric Administration
NRMP	USAID Natural Resources Management Project
RESP	Rural Enterprise Support Project
TACIS	Technical Assistance for CIS Countries
UNDP	United Nations Development Program
USAID	United States Agency for International Development
WB	The World Bank Group
WFP	World Food Program
WUASP	Central Asia Water User Association Support Project

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Since the late 1990s there has been growing recognition in the region that improved natural resource management policies in the region have an important role to play in longer term growth and mitigation of natural disasters. Hence this paper is part of a series of strategic assessments including water resources, biodiversity, disaster management mitigation, and weather forecasting funded by the Region over the 2002 – 2005 period.

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EXECUTIVE SUMMARY

A. Introduction and Objectives

Drought is a recurrent feature of countries of Central Asia and the Caucasus, which requires careful management and mitigation in order to forestall costly damage to the economy and population. If governments and communities do not take steps to prepare for and mitigate the effects of drought, the resulting damage will be greater than necessary, and responses to food insecurity will be delayed, with the poorest segment of the population experiencing further adverse effects. Such was the situation during a severe, prolonged drought that took hold in Central Asia and the Caucasus in 2000-01. The direct economic cost of the drought in terms of lost agricultural production for that period is estimated at US$ 800 million; economic costs were high in all countries; in Georgia they were estimated at nearly 6% of GDP and in Tajikistan 5%. In the aftermath of that drought, governments and international organizations, seeking to mitigate the cost to the economy and to society of future droughts, have expressed a desire to improve drought management and mitigation. **The objective of this paper, taking the 2000-2001 drought as a case study, is to summarize the events leading up to the drought and contributing to its severity, as well as outline a strategy for preparing for and mitigating the effects of future droughts in these regions.**

Historically, severe precipitation deficits, combined with receding surface and ground water levels, occur at least once, sometimes twice per decade in the region**.** Variability between years and among subregions can reach 200-300%. Furthermore if climate change projections are only partially true, the frequency and intensity of weather changes will make drought an even more frequent and intense occurrence. The paper also aims to outline the longer term measures that will need to be taken to mitigate these impacts.

B. Vulnerability to Drought of the Caucasus and Central Asian Countries

While all countries of the region are susceptible to drought through a combination of geographical and structural factors, some characteristics vary between countries.

Geographical vulnerability of the Caucasus countries

The Caucasus sub-region's geography and climate are dominated by the Caucasus mountain range on the one hand, and on the other hand by the Black Sea and wind-flow patterns from west to east. These result in a humid, sub-tropical climate in Western Georgia, high precipitation, much of it from snow in the Western Caucasus, and a dependency on snow melt and winter and spring rains for water in the semi-arid Eastern Caucasus region. These geographical characteristics also make the region vulnerable to flooding, but also mean that much crop-land (44% in Georgia, 75% in Azerbaijan) is dependent on irrigation for reliable production. They also mean that the pasture land, which is the predominant land use in all three countries (about 30% of land area) and dependent on rainfall, together with the rain-fed crop land, need to be managed taking into account these likely rainfall variations. Hydro-electric power accounts for 80% of electricity generation in Georgia and 20% in Armenia, drought periods also result in conflicts between use of water for electricity or agriculture especially in Armenia.

Structural vulnerability of the Caucasus countries

Structural factors increased the vulnerability of the Caucasus countries to the 2000-2001 drought. Agriculture accounts for 30% of GDP in Armenia, 20% in Azerbaijan and 26% in Georgia; the economies are thus highly susceptible to changes in agricultural productivity. Although land and farm privatization during the 1990s has contributed to a more diversified cropping pattern in some countries, including a move away from water-intensive cotton, the break-down of the vertically integrated system of input supply, production, processing and marketing, left rural populations vulnerable.

Many of the "public good" functions which can forecast, plan for and mitigate drought were in disarray in these countries. In Georgia where the majority of the precipitation of the three countries originates, there were 182 hydrological monitoring stations in 1985 but only 72 in 1998; the means to monitor and forecast major declines in water availability had deteriorated. The cooperation between the three countries in disaster planning and mitigation, and in river basin management, had also deteriorated and lacked funding. The slow development of agricultural advisory systems adapted to small farmers also meant that they lacked advice on crop/pasture/livestock management strategies adapted to changes in water availability. And the irrigated areas suffered from deterioration of the maintenance of structures, which had led in turn to water losses and unreliable delivery of irrigation water.

While poor policies may have had a role, it was a broader institutional disorganization that left small farmers with few means to adapt and insufficient organizational support to recover when the drought set in.

Geographic vulnerability of the Central Asian countries

The region is characterized by an extreme continental climate and, except in Northern Kazakhstan and parts of Kyrgyzstan where there is year-round precipitation, there is a strong dependency on winter and spring rains and snowmelt from the Tien Shen and Pamir mountain ranges. These mountains are major contributors to the watersheds of South Asian as well as Central Asian countries. Many smaller rivers from these mountains drain into desert sinks or inland lakes, but the great majority of surface water flows into the Amu Darya and Syr Darya rivers, which flow through these countries into the Aral Sea. Except in the south, Turkmenistan and Uzbekistan are desert or semi-desert countries, largely dependent on irrigated agriculture, as is south-western Kazakhstan; indeed the society and culture of Uzbekistan and Turkmenistan are dependent on irrigation from these rivers. Rain-fed agriculture and livestock dependent on pastures are more important in Tajikistan and Kyrgyzstan. As in the Caucasus, the highly seasonal pattern of precipitation and high mountains make the countries vulnerable to floods and landslides as well as droughts.

Structural vulnerability of the Central Asian countries

As in the Caucasus, the countries of Central Asia are highly dependent on agriculture, which accounts for over 25% of GDP in all of the countries except Kazakhstan. Irrigated agriculture accounts for almost all crop-land in Uzbekistan and Turkmenistan and the majority in Kyrgyzstan and Tajikistan. In all of these countries, however, the predominant form of land use is rain-fed pasture, whose productivity is especially vulnerable to drought. Hydro-power accounts for the great majority of electricity generation in Kyrgyzstan and Tajikistan, which also have water storage structures which provide the downstream countries with some of their summer irrigation. Water management within the countries is poor; in Uzbekistan, which accounts for over half of the irrigated land in the Central Asian countries, it is estimated that 70% of water is lost between the river and the crop, and poor drainage further exacerbates water management. Deterioration in piped drinking water systems has led to increasing dependency on local groundwater sources and water from irrigation systems, increasing the risk of drinking water shortages from drought.

As in the Caucasus, hydro-meteorological monitoring stations fell into disrepair during the 1990s, though cooperation among countries continued, with heavy dependence on Uzbekistan, the country in the region with by far the strongest weather forecasting service. Given the dependence of so much of the region on snow-melt for irrigation, accurate monitoring of winter precipitation can help farmers develop timely drought mitigation strategies, but public funding and mechanisms of cooperation on emergencies and weather forecasting between the countries has deteriorated. In Tajikistan, while there were 265 snow-pack surveys in 1985, there were none in 1998. Incomplete and often unfair farm privatization, and difficulties with developing advisory services adapted to private farmers' needs, also played a role. But in Central Asia, there also has been a long-term neglect of sustainable land use strategies for rain-fed farming and pasture. The loss of vegetative cover on these lands has contributed to the severity of runoff, floods, landslides and drought when weather events did occur.

There was a broad lack of leadership as the importance of adequate emergency management and response systems, was neglected and in addition was slow to adapt to emerging social and political realities. Many countries did have a Ministry of Emergency Situations, but appreciation of the role that local communities and NGOs can play in disaster management was slow to develop, and coordination with other ministries was not adequate in most countries.

Summary of Disaster Preparedness and Vulnerability in the 1990s

In both regions the economic crisis following the transition, and breakdown of the older institutional structures, contributed inevitably to governments' focusing on short term economic stabilization and social services. Public services such as weather forecasting, emergency management, farmers advisory services and maintenance of major infrastructure, and development of policies to mitigate the impacts of major weather events, received less attention.

Disaster management in the 1990s remained focused upon relief (rather than mitigation), while slow-onset disasters such as drought received insufficient attention. Institutional structures developed to plan for and respond to drought during the Soviet period had deteriorated but alternative structures better adapted to transition economies had not yet emerged. Institutions lacked capacity at local levels, and there was little NGO and community participation in disaster management. The early warning observation networks had fallen into decay, largely due to inadequate funding and a focus of public expenditure on short term priorities. Information exchange and data management systems did not function well. Information flowed vertically within ministries rather than horizontally to all the necessary ministries and agencies involved in disaster management; a coordinated, multi-sector response to the drought was therefore lacking.

Structural vulnerabilities and inattention to drought management and mitigation, combined with high levels of exposure, placed significant segments of the rural population at risk. The total population of the region in 2000 was over 72 million of which about 40 million was rural. It is projected to increase in all countries except Armenia, Georgia, and Kazakhstan over the next 20 years. Among the farming population, the most vulnerable were subsistence farmers, those relying upon rain-fed farming, herders with excessive numbers of animals and/or unable to access non-degraded pastures, and farmers in downstream areas of river basins relying upon deteriorated irrigation and drainage systems.

Most policy and investment attention has been on irrigated area where cotton is grown; rain-fed areas have received relatively little attention from government or international organizations. The rural households with greatest vulnerability to drought had one or more of the following characteristics: limited access to irrigated land or livestock, lack of cash income earning opportunities, poor drinking water supplies. In addition they had the typical features of poor households in that they were very large or female-headed, had chronically ill or invalid members, and/or were headed by a civil servant with low state salary and no other income earning opportunities.

Long-term Climate Changes

Overall, the **Caucasus** has observed declines in precipitation of 5 to 15 % over the last 70 years, and temperature rises of 0.5 to 1 degree Centigrade. Temperatures are expected to increase by 2-5% and precipitation to decrease except in Western Georgia, with more frequent extreme weather events. These changes will lead to accelerated glacier melt, to further reductions in the level of Lake Sevan in Armenia, to water deficits in Azerbaijan and increased river runoff in Western Georgia. This is likely to result in decreased pasture and agricultural land productivity, in increased flooding and erosion along both, the Black and Caspian Seas, and to increased desertification and erosion processes. For **Central Asia** the recent history has been more varied. There have been precipitation decreases in Tajikistan and Kazakhstan but increases In Kyrgyzstan, and temperature increases in all countries. Significant temperature increases, of 2 to 6 degrees Centigrade, are predicted, but the estimates regarding precipitation vary very widely. Crop and livestock productivity is likely to increase in Kyrgyzstan and northern Kazakhstan but water deficits and desertification processes to accelerate elsewhere. The biggest impact is to be expected for the wide grassy planes of Kazakhstan, and the marginal lands of Uzbekistan and Turkmenistan where evapotranspiration will increase and desertification might spread further.

C. The Drought of 2000–01

Impact of Drought

When drought took over Central Asia in 2000 –2001, impacts were severe upon agricultural and non-agricultural sectors of the economy, the environment, and the rural population.

- During 2000-01, precipitation levels reached only 40% to 60% of normal.
- River flows dropped to between 35% and 40% below average levels. Irrigation water scarcity became progressively worse during 2000-01, particularly in downstream areas; almost no irrigation water was available for Karalpakstan, in the north of Uzbekistan and the poorest part of that country, and because of failing groundwater sources widespread trucking of drinking water was necessary.
- Drought damaged agricultural output the most in rain-fed areas but also tail end in irrigated areas were affected. Damages to crops and livestock amounted to around $800 million in Armenia, Georgia, Tajikistan, and Uzbekistan. Other water-using sectors, such as hydropower and fisheries, incurred damages, including in the delta lakes of the Amu Darya and the Kura river in the Caucasus.
- Desertification and deforestation processes intensified, which make these countries more vulnerable to floods and landslides when there are rainstorms. Examples observed include deforestation in Nakhchivan in Azerbaijan due to erratic availability of hydro-electric energy and deterioration of high Alpine meadows, desertification in the Kyzyl Kum steppes between the Amu Darya and Syr Darya, and in Ust-Yurt between the Caspian and Aral Seas; and erosion in Eastern Georgia.
- Residents of drought-stricken rural areas lost as much as 80% of income, while poverty rates rose significantly, and malnutrition and water-related diseases became more widespread. In 2000 the share of the rural population in need of food aid was 30% in Armenia and Georgia and 50% in Tajikistan. Due to the socioeconomic effects of the drought, relief and recovery operations costing at least $187 million were put together by the international community.
- Because of the underlying conditions summarized in section B, mitigation measures were slow to be adopted and the rural economy took longer to recover than necessary; in Armenia, for example, available wheat, barley and potato seed for the 2001 planting season was only 10% of requirements, since there had been no surplus above subsistence needs in 2000.

The hydrological and socioeconomic effects of the drought persisted as late as 2003, while precipitation and agricultural production returned to normal in most areas during 2002.

Table 1: Population affected by the drought and share of GDP loss

Countries	Pop in 2000 in millions	Rural % of Pop	% of Rural Pop in Poverty	Ag Share of GDP in 2000	2001 losses due to drought as % of		Hydrological Posts	
					GDP	Agriculture GDP	1985	1998
Armenia	3.1	35	41	26	2.7	10.1	na	na
Azerbaijan	8.0	49	43	17	1.0	6.0	na	na
Georgia	5.3	47	50	22	6.0	25.5	182	76
Kazakhstan	14.9	44	49	9	na	na	147*	111*
Kyrgyzstan	4.9	66	70	37	na	na	139	85
Tajikistan	6.2	74	85	29	4.8	16.8	38	23
Turkmenistan	4.6	55	81	25	na	na	155	119
Uzbekistan	24.6	63	31	34	0.8	2.4	80	58

Mitigation Measures by Government and the International Community

Governments were initially not prepared for the drought. In Georgia, for example, lack of information led the government and the WFP (World Food Program) to believe that drought was severe only in the east, and to neglect relief measures elsewhere. And despite the Department of Emergency Situations and Civil Defense having quite a solid administrative structure, there were no mechanisms for working with, for example, the Medical Centre for Disasters within the Ministry of Health. The countries with the best coordinated responses were Armenia, where the Red Cross and Ministry of Emergencies coordinated effectively, and Uzbekistan, where the First Deputy Prime Minister led a committee to address the low water level in the Amu Darya, and a coordination unit was led by the Ministry of Emergencies. Provincial and district governors coordinated the response at local level. Uzbekistan quite quickly established emergency measures to conserve water; cultivation of rice (the most water consuming crop) was forbidden, water was rationed, drainage water was to be used for irrigation as an emergency measure and pumps were distributed, drinking water was trucked in to the worst hit areas and desalination plants for drinking water were repaired. Despite inequities in the distribution of water, Uzbekistan's overall economic losses from the drought were modest compared with Tajikistan's (see table above).

Governments did organize their response better over time, and assistance from the international community was substantial. Measures focused on emergency food aid, health monitoring, installation of emergency pumps and debt relief. There was less focus on longer term recovery, and some groups, in particular pastoralists and households headed by women, were not adequately considered in relief operations. Efforts to target the most vulnerable also improved over time, with community bodies increasingly involved in the selection of beneficiaries. The Bank supported short term recovery programs in Tajikistan (eg. through provision of seed and input packages to facilitate planting in the season following the drought) but most of its support has focused on development of longer term measures (see below).

D. Developing strategies to mitigate future droughts

Strategic pillars

Despite the focus on the drought in 2000-2001, development and implementation of longer term programs to plan for and mitigate the effects of future droughts is still in an early stage in most countries. Kazakhstan has prepared a comprehensive Natural Disaster Preparedness Plan, which devotes much attention to preparedness procedures for the government, the public, NGOs and the private sector. Preparation of such plans is under way in some of the other countries, disaster management training and the development of natural disaster management plans have progressed, and early warning systems in Central Asia

function better than before. However, systematic drought management plans using a ten-step process[1] adopted for developing national or by agro-climatic region still need developing. Projects that address structural vulnerabilities only do so over the long term. Few initiatives are directed specifically at managing and mitigating drought, and gaps remain[2] .

An emerging drought management and mitigation strategy would have the following pillars:

- Strengthened hydro-meteorological monitoring and forecasting systems
- Incorporation of drought management into national development strategies
- Development of coordinated emergency response and recovery systems
- Development of longer term forecasts and strategies to address climate change

1. **Strengthening weather forecasting and hydrological monitoring**, through both national programs, and through improved coordination of information at both local and regional level. A number of programs are contributing to this effort in Central Asia, where the Swiss government and other organizations are providing long term assistance. **The highest priority for improvement is in the Caucasus region, especially regarding information exchange between and for system improvement within Georgia.** Elements include rehabilitation of hydro-meteorological networks and information exchange, and development of services better adapted to the needs of specific users. Limited support is being provided by other agencies in the Caucasus (especially USAID and German assistance), and somewhat more extensive support in Central Asia (especially by USAID, the Swiss government).
2. **Incorporation of drought management into agricultural, rural and food security strategies**, through dissemination of technologies to combat drought, and support to policy and incentive measures to use land and water resources rationally. Since public resources are still very limited, the focus needs to be on adapting existing technologies, and to support community based initiatives for developing sustainable land and water management practices. Activities in these areas have begun in most countries**.** Examples of programs supported by the Bank include the Natural resources and poverty alleviation project in Armenia, the Community Agriculture and Watershed Project in Tajikistan and the Dry Lands project in Kazakhstan. Water management projects include, the drainage and wetland rehabilitation project in Uzbekistan, which supports improved use of drainage water and restoration of wetlands for fisheries and pasture recovery, and the irrigation rehabilitation programs. These all support improved water management and conservation. Results need to be carefully monitored and programs adapted and mainstreamed as appropriate into public expenditure programs. Policy measures include removal of subsidies and reduced support for programs favoring water-intensive crops and farming practices as opposed to water conserving and rain-fed practices.
3. **Development of coordinated emergency preparedness, response and recovery systems**: most countries have these institutions, but they need to be reinforced, with real information exchange and cooperation between agencies at central level, between local level, and with much greater community participation and support. Vulnerability assessments can also help to target relief/recovery expenditures most effectively when disasters do occur. The most important, however, is that knowledge from the first two "pillars" flows into the third. Hydro-meteorological monitoring, for example, can provide

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[1] A ten-step process[1] (originally created by Dr. Donald Wilhite in 1991 and subsequently revised and updated) adopted for developing national or agro-climatic region based drought preparedness plans emphasizing strengthening existing institutions rather than developing new ones, and establishing a process for the development of drought management strategies (annex 5).

[2] A recent report produced by The Future Harvest Foundation and CARE named "Weathering Natural Disasters- Refocusing Relief and Development through Agricultural & Environmental Practices" makes the point that relief projects and development projects insufficiently reflect respective lessons learned. The report advocates better integration of relief and development efforts to maximize benefits from aid.

the information needed to trigger responses. Precipitation 15% below normal would lead to more intensive monitoring of water resources, crops and pastures; reductions of 15-25% would activate impact task forces, media campaigns, a revision of reservoir operations and ground-water extraction regimes and water and crop restrictions, and more extreme droughts to inter-agency and relief responses and financial analyses of impact on output and government revenues.

4. **Strategies to address longer term climate change:** The economies of the Caucasus and Central Asia must become more robust to climate change. At the moment, Central Asian agriculture is heavily dependent on snow and glacier melt. At present, very imperfect forecasts indicate that in the medium term, as glacier melt accelerates, there may be increased water available, but in the longer term greater dependence on precipitation will increase seasonal and annual variability. Forecasting models need to incorporate aridity anomaly indexes using evapotranspiration (Thornthwaite's formula)[3] to monitor incidence, spread, and intensification of drought This will allow more effective adaptation of agriculture to climate changes. In some cases, agriculture will have to be cut back to the level of water resources supplied by regional precipitation. Steppe grasslands need to be managed with care so as not to break the fragile, moisture retaining topsoils, and maintain the vegetative cover.

Second, hydrological forecasting must be set on a firmer base. According to the IPCC (International Panel on Climate Change) report, *Regional Impacts of Climate Change,* climate change scenarios as yet do not provide a basis for prediction of how regional hydrology will change. Given the complex feedbacks in the system, observation will provide an answer before modeling does. It is therefore of great importance that hydrological networks be restored, the countries of the region improve data sharing and cooperation, and hydrological models be updated, to give direction to further adaptation measures.

Sub-regional and Country Strategies: the Caucasus

A priority for the **Caucasus** region is to support regional information exchanges and strengthening of regional capacity in hydro-meteorological monitoring and forecasting. A second priority is to support regional workshops to determine the possibility of coordinating National Water Shortage Response plans and relief measures.

For **Armenia**, which has a functioning Department of Emergency Situations, the priorities are: (a) to rehabilitate the agro-meteorological network and create monitoring bulletins and outreach information for end-users, including establishment of early warning systems in drought prone areas; (b) to develop regional and national water shortage response plans based on improved monitoring of water reservoirs, and a multi-layered map defining water availability and water demand; (c) to continue and expand support for integrating drought management into land and water management programs, through water conserving irrigation, tree-crop, forestry, pasture and rain-fed agricultural technologies with emphasis on conservation of the upper ends of watershed and with extension programs that emphasize productivity and conservation depending on regions; and, (d) to support capacity building in mitigation and emergency response measures among local communities and improve local food monitoring measures. One of the most difficult issues in the long term, which will require a multi-stakeholder approach, will the balancing the use of Lake Sevan water between the requirements of agriculture, energy, recreation and ecosystems conservation.

For **Georgia** which also has a department of emergencies, the priorities are (a) to integrate drought management into broader disaster management planning and response systems with emphasis of risk man-

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[3] C.W. Thornthwaite produced studies on climate classification and evapotranspiration that were among the most important of the twentieth century. His early publications on climate classification were empiricism-based and featured a systems approach dwelling on the synergistic effects of rainfall and evapotranspiration in microclimatologically constraining soil and vegetation development. In his famous 1948 and 1955 publications he provided a theoretical framework for these relations which, despite objections from some quarters, has proved highly influential.

agement at the local level including improved food reserves monitoring in the areas most at risk for drought; (b) to upgrade substantially hydro-meteorological monitoring systems to improve monitoring of river flows from East to West and the respective reservoirs; (c) to rehabilitate irrigation systems especially in Eastern Georgia where these have the potential to be economically viable, and to support establishment of effective water user associations and more efficient use of irrigation water; and (d) to integrate drought management into broader agricultural and rural development strategies. Georgia is especially vulnerable to floods as well as droughts, so flood and drought mitigation strategies will need to go hand in hand.

Azerbaijan needs to introduce permanent institutional arrangements for risk mitigation and disaster planning. As the lower riparian country in the Caucasus it is almost fully dependent on irrigation for its intensive agriculture. For agricultural production, it will be very important to (a) develop a river flow measurement system in the Kura and Araz Rivers, (b) rehabilitate and modernize irrigation systems, not only of higher order level, but especially lower order level in order to use water efficiently so that tail ender schemes and farmers will not end up without water during periods of low water flow; (c) develop sustainable water user associations that build incentives for more effective irrigation water use; and (d) develop extension services with a focus on advice for appropriate cropping pattern and water management and maximize the advantages that can be drawn from the highly varied agronomic-climatic conditions of the country. More attention will need to be given to non irrigated lands particularly in terms of improved water and land management practices, not overlooking fisheries.

Sub-regional and Country Strategies: Central Asia

For Central Asia improved information sharing and upgrading of hydro-meteorological monitoring systems is a priority throughout the region. Improvements in legislation regulating water extraction levels, uses, and release, including contamination levels will be necessary. Investments planned and ongoing to increase the efficiency of water management at the sub-basin level (the Syr Darya/Northern Aral Sea control project, the planned investments in the Ferghana valley and other programs to improve river regulation) should also be supported. The countries already have in place a system for managing water in the basins under drought conditions, but earlier and systematic information- sharing would permit more effective planning and drought mitigation measures.

Tajikistan remains highly vulnerable to drought although overall irrigation water supply is not a constraint. In addition to improved early warning systems, priorities include a rebalancing of public expenditure support and policy away from large-scale irrigation and cotton and towards measures which conserve water in both irrigated and rain-fed land, and community-based watershed management measures which support these programs. Regarding institutional planning and response systems, the Ministry of Emergency Situations needs to develop the capacity to work more closely with other agencies and with local governments, NGOs and communities. Tajikistan needs to urgently reinvest in its meteorological forecasting capacities, in order better to inform the population of weather changes but also, as an upstream country to help improve information flows to downstream nations so that they can more effectively plan for drought occurrences.

Uzbekistan has largely maintained the central structure and institutional arrangements inherited from the Soviet period. Its hydrological and meteorological systems as well coordination logistics remain largely intact. Investment programs are on-going to restore delta ecosystems in the drought-prone north and to improve drinking water supply systems there. However a mix of policy reform and rehabilitation of drainage and irrigation systems to improve irrigation water management and conservation will have the highest impact, together with greater community outreach and involvement in drought planning and mitigation measures. An added focus on conservation especially in the steppe areas and marginal lands would also contain desertification and improve the sustainability of steppe herdsmen livelihood.

Kazakhstan has prepared a national drought planning and mitigation strategy with the participation of a range of stakeholders. It also has an effective emergency intervention system, but to mitigate risks, more

effective monitoring of food reserves including warehouses, especially in the risk exposed Western areas would need to be considered. Improved natural resource management, including measures to address desertification and restore degraded pasture and forest, together with improved water management, are planned for and substantial investments have already begun. The challenge will be to involve local communities as the main stakeholders in planning and implementation of such programs. Strategies need to include increase in yields and productivity in the irrigated areas of the Center and East and conservation methods for the great Western plains. Capacity building at line ministry level and local government level to support large scale implementation will be crucial.

Although **Kyrgyzstan,** is not water scarce, it has to conserve water in order to serve lower riparian countries in an equitable way. Therefore modernization of irrigation systems is important, as well as the development of sustainable water user associations that can manage water in an efficient way. Main priority tough is strengthening the Ministry of Ecology and Emergencies to work with other agencies, local government and communities in developing planning and mitigation measures, and improved pasture management strategies. This includes rebuilding of it meteorological capacity in order to be able to better forecast available water levels to riparians, but also improve its capacity to prevent human losses, and regulate electricity generation.

For **Turkmenistan** little updated information is available. However, with over 97% of crop-land dependent on irrigation, the priority is improved management of irrigation and drainage water through policy, rehabilitation and infrastructure improvement measures. Turkmenistan also needs to concentrate some of its efforts in maintaining its marginal grasslands and prevent further erosion and desertification. More adapted crops and cropping pattern should be introduced to improve productivity of irrigated areas.

Bank Strategy for Support to Drought Management in the Caucasus and Central Asia

1. In general, Bank support for drought management should be integrated into broader rural and natural resource management programs and policies, rather than regarded as “stand-alone” projects. Community watershed, irrigation and drainage, water management and forestry and agricultural services projects can all include measures that support drought mitigation. It will be important to ensure that this aspect of project design is not neglected.
2. Given the close links between vulnerability to poverty and vulnerability to drought poverty assessments, poverty reduction strategy papers and broader country economic studies need also to incorporate natural resource and disaster management issues into their analysis and policy recommendations.
3. Given IDA limitations and the new GEF operational programs which support measures to address land degradation, there is also scope for seeking grant funding from this source and others to support these programs. There is scope for more extensive support to upgrading hydro-meteorological monitoring systems and to capacity building for Ministries of Emergencies. As part of climate mitigation strategies the GEF may also be a source of funding for meteorological upgrading, especially where the benefits are sub-regional. The Bank should work closely with other international financing agencies to synergize approaches.
4. A major gap remains in “mainstreaming” community outreach into drought planning and mitigation programs.

1 INTRODUCTION

Drought is a recurrent feature of countries of Central Asia and the Caucasus, which requires careful management and mitigation in order to forestall costly damage to the economy and population. It is a complex phenomenon with greatly varying impacts depending not only on the magnitude, timing, duration, and frequency of precipitation deficits but also on the differing responses of various soils, plants, and animals to water stress. If governments and communities do not take steps to prepare for and mitigate the effects of drought, damage will be far greater than necessary, and responses to food insecurity and other adverse effects upon the poorest segment of the population will be delayed and possibly inappropriate. Such was the situation during a severe, prolonged drought that took hold in Central Asia and the Caucasus in 2000-01. In the aftermath of the drought, governments and aid organizations, seeking to avoid the significant costs incurred during 2000-01, have expressed a desire to improve drought management and mitigation. There is an opportunity and a need for international organizations including the World Bank to assist them in this endeavor.

1.1 Objective and Structure

The objective of this study is to raise awareness and understanding of exposure and vulnerability to drought in Central Asian countries and Caucasus and to introduce a strategic, pro-active framework of mitigation and prevention. The audiences of the report are the governments of Armenia, Azerbaijan and Georgia in the Caucasus and Kazakhstan, Uzbekistan, Turkmenistan, Tajikistan and the Kyrgyz Republic in Central Asia. The report will further be of interest to NGOs and civil society, as well as donors and IFIs. More specifically, the report should help the ministries of, agriculture, irrigation and water resource management, environment, meteorological services, emergency services, and regional and local government (including municipalities) to improve their preparedness for future droughts.

The report explores the ways that effective management and mitigation can soften the impact of drought in Central Asia and the Caucasus and reduce damage and relief and recovery costs. The inquiry begins with an examination of types of drought and exposure to them. Chapter 2 contains an analysis of vulnerabilities to drought, as well as the capacity of the disaster management structure to mitigate and respond to slow-onset natural disasters of this nature. The ensuing chapter covers different types of drought in 2000-01(meteorological, hydrological, agricultural, and socioeconomic drought) and analyzes the measures taken to manage and mitigate them. The conclusion of the report provides recommendations concerning how international agencies including the World Bank can coordinate and synergistically assist the countries of Central Asia and the Caucasus in successfully creating and implementing a drought management and mitigation strategy.

1.2 A Typology of Drought Conditions and Impacts

A range of definitions is employed to describe various drought conditions and impacts. The most commonly employed definitions are meteorological, hydrological, agricultural, and socioeconomic drought.

- *"Meteorological drought"* refers to a deficit of precipitation compared to long-term averages. Definitions of meteorological drought must be considered as region specific since the atmospheric conditions that result in deficiencies of precipitation are highly variable from region to region. It is stated to be occurring when the Annual/seasonal precipitation received over an area is less than 75% of its long-term (50 Years norm) average value. It is further classified as moderate drought if the rainfall deficit is 26-50% and severe drought when the deficit exceeds 50 Years norm.
- *"Hydrological drought"* is a deficit of surface or subsurface water supply resulting from precipitation shortfalls. The frequency and severity of hydrological drought is often defined on a watershed or river basin scale. Hydrological droughts usually lag the occurrence of meteorological and agricultural droughts because precipitation deficiencies take time to show up in components of the hydrological system such as streamflow, and ground water and reservoir levels. Hydrologic storage systems are often used for multiple and competing purposes (e.g., flood control, irrigation, recreation, navigation, hydropower, wildlife habitat), further complicating the sequence and quantification of impacts.
- *"Agricultural drought"* is the susceptibility of agricultural activities to the effects of meteorological or hydrological drought. Agricultural drought links various characteristics of drought to agricultural impacts, focusing on precipitation shortages, differences between actual and potential evapotranspiration, soil water deficits, reduced ground water or reservoir levels, and so forth. Water demand in agriculture depends on prevailing weather conditions, biological characteristics of the specific plant, its stage of growth, and the biophysical properties of the soil. A good definition of agricultural drought should therefore be able to account for the variable susceptibility of crops, and animals, at different stages of their development, from emergence to maturity. Agricultural drought can take place in; early season, when it affects seeding and planting; mid season, during the vegetative period of crops thus stunting plants; and, late season when in the formative stage of the fruit, seed or grain is forced to mature before having reached full development.
- *"Socioeconomic drought"* is when the impacts of the drought extend beyond the agricultural sector to disrupt the rest of the economy and significantly detract from the livelihood of the population. Socioeconomic drought differs from the aforementioned types of drought because its occurrence depends on the time and space processes of supply and demand for basic goods such water, food and power etc, that are influenced by weather. If water supply in the area is in shortfall and unable to meet human and environmental needs socioeconomic drought occurs. The demand for economic goods may be increasing as a result of increasing population and per capita consumption but supply may also increase because of improved production efficiency, technology. If both supply and demand are increasing, the critical factor is the relative rate of change, vulnerability and the incidence of drought may increase in the future as supply and demand trends converge.

In addition to these most significant conditions and impacts of drought, this study also covers the affect of drought upon the environment and non-agricultural sectors such as hydropower and fisheries.

1.3 Exposure to Meteorological and Hydrological Drought

Meteorological and hydrological droughts are regular features of the climate of Central Asia and the Caucasus. Meteorological drought occurs once or twice every decade. Dry years are characterized by as much as a three- to four-fold precipitation anomaly, while wet years provide 1.5-2 times more moisture than the long-term annual average.[4] (Figures A1-A4 in Annex 1 present long tern precipitation trends in various countries.) As pointed out in Table 2 below, meteorological drought is specific to locale and season.

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[4] Glavnaia redaktsiia Uzbekskoi sovetskoi entsiklopedii, *Entsiklopediia khlopkovodstva v dvukh tomakh*, Vol. 1, pp. 414-17; Regional'nyi ekologicheskii tsentr, 2002, *Mezhdunarodnoi konferentsii po problemam zasukhi i opustynivaniia: doklady uchastnikov konferentsii, predvaritel'naia publikatsiia*; A Karimov, 1997, "Quruqlik wa qisjlaq khojaligi," *Ozbekistan qishlaq khojaligi*, No.3, p. 48

Table 2: Exposure to Meteorological Drought in Central Asia and the Caucasus

	Average Annual Precipitation 1961-90 (mm)	% Cropland Irrigated	Precipitation and Drought Peculiarities
Armenia	526	51	Meteorological drought in Armenia most common in winter in the Debed, Sevan, Araks, and Agstef River basins and in summer in the Hrazdan, Azat/Vedi, and Arpa basins. 250 mm precipitation in lowlands, 400-600 in foothills and low mountains, 800-1800 mm in high mountains. During 1935-90 precipitation fell 5.8%
Azerbaijan	541	74	Arid zone in lowlands (up to 200-900 m altitude) contains 70% of population, drought once every decade. Precipitation declined 10% during 1961-90.
Georgia	1,065	44	Droughts especially frequent in east (Kakheti). Precipitation fell 5-20% in northeast and northwest, rose 5-15% on southeast during 1961-90.
Kazakhstan*	300	8	Drought occurs every five years. Reduction in grain yields due to drought on rainfed cropland in the north 2 of every 5 years. No tendency observable in precipitation during 1961-90, but slight increase in rainfalls over the last 5 years.
Kyrgyz Republic	553	75	Precipitation 300-500 mm in Chu, 100-500 mm in Ferghana, 250-300 mm in Issik Kul and Talas. In the Chu Valley, drought struck 18% of the time during 1975-92, compared with 7% of the time during 1960-74. Significant increase in precipitation in 20th century except in inner Tien Shan.
Tajikistan	691	83	In lowlands, as little as 70-100 mm precipitation, in mountains up to 1800 mm. In the southwest and north, precipitation down as much as 20% and drought more frequent during 1961-90; precipitation rose 18-20% in the northeast (over 1500 m altitude).
Turkmenistan	191	100	Only mountain areas receive over 250 mm precipitation. During 1961-90 decline in spring and autumn precipitation; increase in winter in north, east, and Kopet Dagh foothills.
Uzbekistan	264	89	80-200 mm precipitation in lowlands, 300-400 mm in foothills, and 600-800 mm in mountains. In the foothills, very strong drought (over 50% precipitation deficit) 3 times per century; drought with a 20-25% deficit in seasonal precipitation amounts occurs 3-4 years. In the desert and semi-desert areas very strong drought every 10 years; precipitation deficit of 20% every 5 years.

* 64 % of cropland in the Aral Sea basin (southern) portion of Kazakhstan is irrigated

Sources: FAO Aquastat;; T. Grizishvili and G. Lazriev, "Investigation of Extreme Temperature Frequency and Intensity Dynamics Under Climate Change in Eastern Georgia," *National Bulletin of the National Agency on Climate Change*, No. 6, p. 57; Mott MacDonald and Arcadis Euroconsult, January 2003, *Joint Rivers Management Program: Kura Basin Interim Report*, p. 102; Tatyana Spektorman, "Assessment of the Aridity Indicators for Uzbekistan Related to Climate Change," http://www.siwi.org/waterweek2003/Workshop%204%20Poster(20).htm; UNCCD National Reports; UNEP, 2001,*Kyrgyz Republic State of the Environment 2000*.

In many lowland areas of Central Asia and the Caucasus, meteorological drought is a permanent condition or is extremely frequent (as often as six out of every ten years). Average precipitation is minimal in many countries, while the percentage of area occupied by desert is high (especially in Turkmenistan, Uzbekistan, and South Kazakhstan).

Precipitation has declined and drought has become more frequent in many parts of Central Asia and the Caucasus. Moreover, it is likely to become more widespread and intense in several countries as global warm-

ing continues. Although projections vary, in general the lengths of dry spells within years are projected to increase, precipitation to become more intense during wet periods, and the number of extremely moist and extremely dry years to rise. However, it must be noted that uncertainties concerning precipitation estimates are more significant than for temperature. Existing projections are occasionally at variance with one another and should be revised using complete, consistent sets of data.

Hydrological drought is also common. Emergency water supply measures were required six times in Uzbekistan during 1970-99 due to hydrological drought. As shown in Table 3 (and Figure A5), among the countries of the two regions only Georgia, the Kyrgyz Republic, and Tajikistan possess an ample supply of water resources. Per capita water resources are lowest in Armenia, Azerbaijan, and Uzbekistan. Downstream countries such as Azerbaijan, Uzbekistan, Turkmenistan, and the southern portion of Kazakhstan depend heavily upon water resources originating from those located upstream (Georgia, Armenia, Tajikistan, and the Kyrgyz Republic). If climate change scenarios are correct, water supply will become even more precarious. In all countries except Georgia, the availability of water is expected to remain the same or decline by as much as 40% in some areas (see Annex 2 for details).

Table 3: Water Resources in Central Asia and the Caucasus

	Surface Water Resources (km3)	Ground Water Resources (km3)	Per Capita Water Resources (m3/year)	Dependency Ratio
Armenia	7.7	4.2	2,780	13.9
Azerbaijan	28.1	2.2	3,765	73.2
Georgia	62.1	17.2	12,035	8.2
Kazakhstan	103.5	35.9	6,778	31.2
Kyrgyz Republic*	18.2	13.6	4,182	0.0
Tajikistan**	40.0	6.0	6,489	16.7
Turkmenistan	24.4	3.4	6,739	97.1
Uzbekistan	10.9	18.0	2,026	77.4

*Kyrgyzstan has a –25.9 km3 outflow of surface water resources.
**Tajikistan has a –22 km3 outflow.
Sources: FAO Aquastat, World bank, 2003, *ECA Water Resource Strategy*.

Regional discrepancies in available water resources are significant in all countries. For example, in Georgia, 78% of water resources are concentrated in the West, while 60% of industrial facilities, 85% of irrigated land and 62% of population is concentrated in the East of the country. In the otherwise water-rich Kyrgyz Republic, the Talas, Osh, Jalalabad, and Batken Provinces are vulnerable to significant fluctuations in river flow.

The flow of rivers such as the Syr Darya and Amu Darya in Central Asia, and the Kura and Araks in the Caucasus, is highly variable (as indicated Figures A6-A7 and Tables A1-A6 in Annex 1). The volume of flow in dry years is between 25-45% below average. Flow to downstream areas of river basins has declined dramatically. In the Syr Darya and especially Amu Darya basins, this is due to excessive withdrawals for irrigation, while in the Kura-Araks basin reduced flows are also attributable to natural conditions.

1.4 Implications

The availability of rainfall and water in Central Asia and the Caucasus is highly uncertain, and there are substantial discrepancies in local conditions. Although climate is a primary contributor to drought, other factors such as changes in land use (e.g., deforestation), land degradation, and the construction of dams all affect the hydrological characteristics of a watershed. Because regions are interconnected by hydrologic systems, especially in the CAC countries, the impact of drought may extend well beyond the borders of the

precipitation-deficient area. For example, meteorological drought may severely affect Uzbekistan and Kazakhstan in Syr Darya valley, Turkmenistan and Karkalpaakstan and the eastern part of Uzbekistan, and Southern part of Azerbaijan below the Mingechur reservoir in Arakh river valley, there may be significant hydrologic impacts downstream. Similarly, changes in land use upstream may alter hydrologic characteristics such as infiltration and runoff rates, resulting in more variable stream flows and a higher incidence of hydrologic drought downstream.

Azerbaijan and Kazakhstan, for example, have shown an increased frequency of water shortages in recent years because land use changes have occurred within, and in neighboring countries. Land use change is one of the ways human actions alter the frequency of water shortage even when no change in the frequency of meteorological drought has been observed. With increasingly less predictable rainfalls as a consequence of global warming these effects will only worsen. Thus meteorological forecasting must improve its identification of trends so as to be better able to identify the beginning of a meteorological drought so that preventive measures can be taken in the hydrological systems dependent upon precipitations for recharge. Careful management is required to forestall hydrological, agricultural, and socioeconomic drought.

2 VULNERABILITY AND CAPACITY

The countries of Central Asia and the Caucasus were highly vulnerable to the drought that slowly took hold in 2000-01. Structural factors were the underlying causes of vulnerability. These included inefficient water management, a crisis situation in agriculture, widespread rural poverty, general economic downturn, and environmental degradation. Moreover, the countries of the two regions possessed little capacity to manage and mitigate drought. Given that exposure to drought is high in Central Asia and the Caucasus, these circumstances placed the population, especially water users, farmers and herders, and other villagers, at significant risk.

2.1 Structural Factors

2.1.1 Economy

The economies of Central Asia and the Caucasus were vulnerable to drought in the late 1990s, due to several factors. The size of the economies is important, as small economies are typically more vulnerable to natural disasters. Table 4 below indicates that half of the countries in the region had a GDP of $3 billion or less. In part, this is due to economic downturn following the economic transition in the early 1990s.

The economic structures of most countries are very simple, relying on one or two main sectors of activity, which renders them vulnerable to shocks from drought. The most drought-susceptible sector, agriculture, contributes 10-38% of GDP and 18-65% of employment. Productivity is often lower than in other sectors, such as industry. Moreover, there is significant integration between agriculture and industry (cotton growing and viniculture), which implies a significant multiplier effect from agricultural drought.

Table 4: Economic Structure in Central Asia and the Caucasus

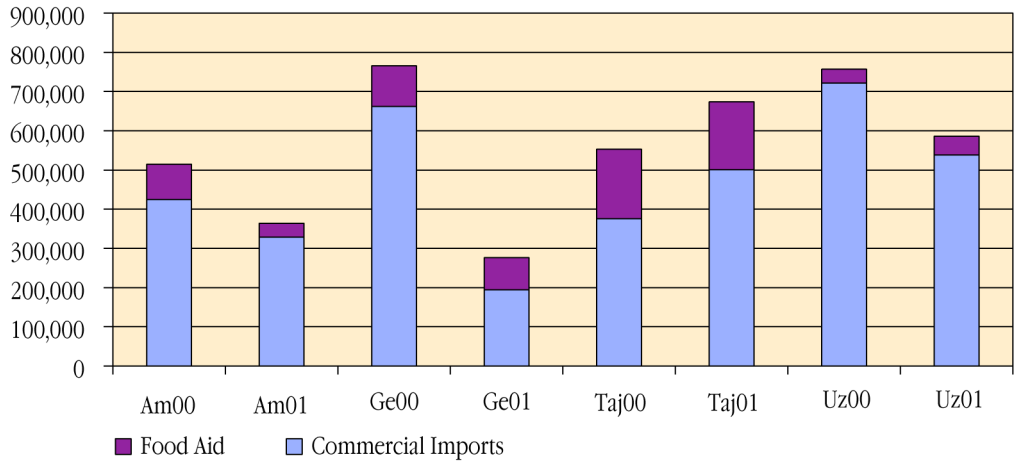
	GDP in 2000 (million USD)	2000 GDP as % of 1990	Agriculture (% of GDP)	Agriculture % of Employment	Industry (% of GDP)	Industry % of Employment
Armenia	1,912	67	29	43	32	14
Azerbaijan	5,273	55	19	34	41	7
Georgia	3,042	29	26	50	23	9
Kazakhstan	18,292	90	10	18	35	22
Kyrgyz Republic	1,370	66	38	52	27	9
Tajikistan	991	48	27	65	29	8
Turkmenistan	4,404	76	28	48	47	12
Uzbekistan	7,813	95	34	35	24	13

Sources: *World Development Indicators* database; IMF Staff Country Reports, 2000-01.

Trade barriers made it more difficult for countries to respond to drought. Despite the existence of various bilateral and multilateral trade agreements, most were implemented only partially, owing to impediments such as export taxes, import quotas, transport restrictions, currency non-convertibilty and/or conversion restrictions, incongruous and archaic pricing policies and regulations and procedures, as well as

corrupt and arbitrary implementation.[5] These factors became critical when it became necessary to import significant amounts of food, as occurred in 2000-01 (see Figure 1 below).

Figure 1: Imports Of Wheat And Food Aid (In Cereals) In Selected Countries, 2000-01 (Metric Tons)



Source: FAOSTAT.

2.1.2 Finance

The severe economic downturn of the 1990s created a gap in the ability of countries of Central Asia and the Caucasus to finance catastrophes. Therefore, they could not allocate adequate funds for drought management and mitigation, much less afford the cost of large-scale relief operations in the event of major natural disasters. Because of the underdevelopment of the financial system, especially in rural areas, risk transfer mechanisms such as rainfall insurance and spreading risk directly to capital markets were infeasible.

2.1.3 Water Management

Inefficient water use rendered large sections of the population vulnerable to interruptions of supply. Coordination was lacking at the regional level, while integration among sectors was needed at regional and national levels. Despite the significance of these problems, the main cause of vulnerability to drought was high water consumption, created by deteriorating infrastructure and poor management, combined with poor discipline by users who treat water as a "free good", as during the Soviet period.

Following the breakup of the USSR, transboundary cooperation in water management has been a challenge. The transboundary water management institution that appeared in Central Asia, the Interstate Water Coordination Commission, has operated under tough constraints. These constraints are more fully discussed in other documents[6] .

The water management problem that contributes most to vulnerability is the very high and inefficient water consumption by agriculture which remains a major employer in all of these countries. Agriculture relies heavily upon irrigation in most countries, which accounts for the lion's share of water use (see Table 5 below). For example, due to poor condition of infrastructure and ineffective operations and maintenance in Central Asia, water losses on the main channels were between 25% and 48% in the on-farm canal network, with 27% of the

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[5] See: Suresh Babu and Valerie Rhoe, "Food Security in Central Asia: Economic Opportunities, Policy Constraints, and Future Challenges."

[6] "Regional Water Strategy for the Aral Sea Basin Countries" Water and Environment Management Project, 2003; "Aral Sea Basin Program: Strategic Directions" ECSSD Policy Note, August 2003.

water actually making it to the field. Although around one-half of this "loss" returns as groundwater flow, this is a highly inefficient way to irrigate and contributes to the raising of the water table and can lead to salinization in highly mineralized soils. Salinization had rendered large areas dependent upon obtaining extra water (2,000-3,000 m^3/ha) for leaching. The average amount of water withdrawn per hectare is 12,900 cubic meters.[7]

The water supply of households was unreliable, particularly in rural areas, which rendered them highly vulnerable to drought. In most countries, less than half of the rural population had access to improved sources of drinking water (as shown in Table 5), and in many cities the quality of services had deteriorated substantially. Where piped delivery systems existed (mostly in the cities and towns), losses reached up to 50% of extraction, and the water quality was often poor. Some areas with severe drinking water problems, such as the Karakalpakistan region of Uzbekistan, and Dashhawuz province of Turkmenistan and the lower reaches of the Kura-Araks and Samur River basins in Azerbaijan, were also the most drought-prone.

Table 5: Water Use Indicators in Central Asia and the Caucasus

	Reservoir Capacity	% Hydro Power	% Cropland Irrigated	Ag Share of Use	% Improved Drinking Access (Urban/Rural)
Armenia	1.2	25	51	75	87 / 45
Azerbaijan	21.6	10	74	81	84 / 28
Georgia	2.7	80	44	60	95 / 35
Kazakhstan*	88.8	13	8	82	93 / 26
Kyrgyz Republic	23.5	81	75	93	51 / 40
Tajikistan	29.0	98	83	89	87 / 35
Turkmenistan	2.9	0	100	91	86 / 14
Uzbekistan	19.8	13	89	95	74 / 65

*64 % of cropland in South Kazakhstan is irrigated, while 17 % of electricity is generated by hydropower.
Sources: Armenia, Azerbaijan, Georgia, and Uzbekistan Goskomstat;; FAO Aquastat, World Bank, 2003, *ECA Water Resource Strategy*; World Bank, 2003, *Rural Development Indicators 2002*; Various World Bank ECSSD agriculture studies.

2.1.4 Agriculture

Agriculture is a highly significant sector in Central Asia and the Caucasus, which at the end of the 1990s comprised a major portion of GDP and an even larger share of employment (as noted above). Crop and livestock production accounted for 50-60% and 40-50% of agricultural GDP, respectively. The rural population, which depends upon this sector for most of its livelihood, accounts for 33-73% of the total population.

Agro-ecological conditions do not favor agriculture without irrigation in Central Asia and in much of the Caucasus, which is why under the Soviet regime huge investments were made in building massive irrigation systems to improve agricultural productivity in these temperate, semi-arid climatic zones. In spite of these huge systems, a majority of the grazing/pasture, wheat and arboriculture is practiced in semi-arid land with less than 600mm of yearly precipitation because of the prevalence of commercial mono-cropping in the prime irrigated lands. This presents an extra risk in terms of food supply since these areas are much more to drought susceptible because of the higher variability of rainfalls and inaccessibility to irrigated water. These areas where only extensive farming is possible cover the largest land mass in central Asia including; Zhezqazghan, Quangurat, Quaragandhy, Termitau in Kazakhstan, Myunbulak, Dhizak, Khamza, of Uzbekistan, Batken, Syulukta, Ravat areas of Kyrgyzstan, Taboshar, Istarafshan, Gonchi areas of Tajikistan, and entire the Turkmenistan. Similarly in Caucasus, North of Saradarapat steppe and Southern parts of Talin, and Eastern Noyemberian areas in Armenia, Northern parts of Agsabedi, Fizuli, Southern Ujhar, Neftelan, Goranboy of Azerbaijan and north of Senaki, and Zugdadi areas of Georgia.

[7] Royal Haskoning, 2001, *Water and Environment Management Project, Regional Report No. 2*, pp. 114-17.

A large part of the soils in Central Asia and the Caucasus are high water retaining vertisols (of various depth and horizons), interspersed with associated sub classes of that soil. Aridisols are found in the arid areas of Southwestern Kazakhstan, much of Turkmenistan, and Central Uzbekistan. The Caucasus and Central Asia also contain alfisols at various horizons (< 0.1 to > 1 meter) with a medium to medium-high water retention capacity (the length of the growing season in these areas is between 110 and 210 days). This last category is typically the most productive land. However, without adequate vegetative cover, these soils are highly prone to erosion, which results in an average annual loss of 100-250 t /ha of soil. In any of these soils, sustainable agricultural production can only be maintained through a combination of efficient crop, water, and soil management practices that are adjusted in line with long-term weather forecasts.

Although agro-ecological conditions made the sector prone to vulnerability, several changes in agriculture in the 1990s heightened this susceptibility. First, crop diversity diminished during the 1990s (as shown in Tables A8-A11). In Tajikistan, Turkmenistan, and Uzbekistan wheat displaced nitrogen fixing fodder crops. In the Caucasus, subsistence crops became prevalent. In all countries crop rotations became unsustainable (or were entirely abandoned) and fodder became scarce. Thus, farmers were less able to spread the risk among different crops, or even livestock and thus became more vulnerable.

Farmers were unable to guarantee that crops received adequate moisture. As noted above, irrigation and drainage infrastructure had become decrepit, owing to a decade of neglect, and institutions could not ensure reliable operations and maintenance. Rainfed areas have always been especially vulnerable to agricultural drought, especially in arid lowlands. However, this sub-sector received little attention, and hence agricultural technique was poorly developed for rainfed crops.

Farmers possessed neither the resources nor skills to manage drought and mitigate its effects. Access to critical inputs such as fertilizer, seed, fuel, machinery, and transport was low. Moreover, farmers did not possess the agro-technical know-how required to mitigate the effects of drought. Poverty had driven many "farmers" from other occupations into subsistence agriculture, which they were still learning by the late 1990s. Agricultural extension had not reached them.[8]

Due to the range of factors noted above, crop production became vulnerable. A recent global food security assessment by USDA concludes that production volatility in Central Asia and the Caucasus ranks second among regions of the world (North Africa is first). The highest coefficients of variation are in Kazakhstan (42%), Tajikistan (36%), Georgia (27%), and Turkmenistan (27%). However, these coefficients are improving by reducing grain crops in marginal lands where crops are highly uncertain from year to year. An analysis of various scenarios based upon historical production shortfalls indicates a substantial vulnerability to production shocks in most countries. [9]

Livestock production also became more vulnerable. Fodder became scarce and patterns of rangeland use changed. In many countries, fodder production for livestock declined, as did the irrigation of pasture areas. Due to lower access to transport and winter shelters and mobile services, only the wealthy could afford to graze and water their stock in remote areas, which resulted in the depletion of local resources and a decline in seasonal migration. Meanwhile, due to their inaccessibility and the decline of the total number of livestock, distant pastures mostly recovered from overgrazing in the Soviet period. The lack of fodder was exacerbated by the excessive size of many individual flocks and herds, which also made animals less productive. [10]

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[8] WFP, November 2000, *Georgia Emergency Household Economy Assessment*, p. 11

[9] USDA ERS, February 2003, *Food Security Assessment, Agriculture and Trade Report GFA-14*, pp. 23-24.

[10] Carol Kerven, Ilya Ilych Alimaev, Roy Behnke, Grant Davidson, Leen Franchois,Nurlan Malmakov, Erik Mathijs, Aidos Smailov, Sayat Temirbekov, and Iain Wright, 2003, "Retraction and Expansion of Flock Mobility in Central Asia: Costs and Consequences," unpublished report for the *VII International Rangelands Congress, Durban, South Africa, 26 July-1 August 2003*.

Not all developments in agriculture increased vulnerability. Efforts to restructure the agricultural sector and increase off-farm employment contributed to agricultural diversification, giving farmers and herders a greater range of choices for mitigating and coping with drought. However, most lacked the means and skills to benefit from a range of options, and the development of off-farm employment lagged far behind other rural development initiatives.

2.1.5 Poverty

Central Asia and the Caucasus became more prone to socioeconomic drought in the 1990s, owing to growing poverty. Except in some areas of the Caucasus, poverty was concentrated in rural areas, where it reached 40-80% of the population (as presented in Table 6 below, rural population comprised between one-third and three-quarters of the total). Moreover, many areas in which drought struck the hardest also contained more poor people than elsewhere in the country. For example, Khatlon and Sughd provinces in Tajikistan contained 65% of the poor population of Tajikistan.[11]

Food security was already precarious. Due the critical food security situation in Tajikistan, Armenia, and Georgia, the World Food Program had targeted around 800,000 people in these countries for assistance by 1999.

Table 6: Rural Population and Poverty in Central Asia and the Caucasus

	Total Population (× 1,000)	Percent Rural Population	Percent of Rural Population in Poverty
Armenia	3,112	33	41
Azerbaijan	8,157	48	43
Georgia	5,262	44	50
Kazakhstan	15,639	44	49
Kyrgyzstan	4,921	66	70
Tajikistan	6,089	72	85
Turkmenistan	4,644	55	81
Uzbekistan	24,912	63	na

Sources: FAOSTAT; various World Bank agriculture and poverty studies

2.1.6 Environment

Degradation made both the environment and its inhabitants more vulnerable. This occurred in several ways, although many linkages are only generally known. Most significantly, desertification was intense in many countries. The percentage of land area undergoing desertification processes ranges from 30% in Azerbaijan to 80% in Armenia. The situation near the Aral Sea has reached catastrophic proportions. There can be little doubt that desertification made the population of severely affected areas such as Karakalpakistan more susceptible to drought impacts.[12] Moreover, land degradation was significant. The erosion of soils by wind and water intensified in the 1990s, reducing the fertility and water retention of soils. Salinization increased water withdrawals significantly and lowered crop yields. Finally, as noted above, climate change during the twentieth century made meteorological drought more likely than before in many areas.

[11] World Bank, 2000, *Republic of Tajikistan Poverty Assessment, Report No. 202085-TJ*., pp. 20-22.

[12] Desertification may also contribute to climate change in which drought becomes more frequent. See: FAO, 2000, *Desertification and Drought – Extent and Consequences.*

2.2 Disaster Management in the 1990s

The poor condition of disaster management contributed to vulnerability as much as structural factors. Natural disaster management plans were lacking or improperly focused. Moreover, institutions were overly centralized, poorly funded, and under coordinated. Early warning systems of all types had fallen into decay. Therefore, disaster management institutions were not ready for the onset of drought nor had any mitigating measures been taken.

2.2.1 Plans

During the 1990s disaster management was in the process of transition from a reactive and narrowly focused mode of operation to one that relies upon proactive planning, mitigation, capacity building, and community and NGO participation. This new emphasis upon planning and preparedness began in the latter part of the decade and stemmed from donor and government fatigue from managing frequent, and sometimes preventable, humanitarian crises. By the end of the 1990s initiatives to improve planning for natural disaster management were underway in many countries.[13]

Despite these efforts, existing plans did not provide specific guidance for disaster management in general, much less in the event of drought. (Annex 3 contains a highly simplified version of such a plan.) In Georgia, poor planning led to confusion concerning roles and responsibilities in the event of disaster:

Up to now responsibilities for disaster management have not been properly distributed and coordinated. Roles and functions between the main political and administrative institutions for action in disaster situations are not clarified and a state strategy for disaster management to meet newly recognized requirements, as well as contingency plans for local authorities and entities are not developed.[14]

Criteria for declaring drought emergencies and mechanisms to trigger contingency plans were either absent, uncoordinated, or outdated. Lack of information, poor information management, and non-standard procedures and methodologies hampered planning and risk and impact assessment.

Moreover, national plans for water scarcity were lacking, which gave little hope for adequate management. National water management agencies had at their disposal only *variants* of water distribution plans to be triggered by various supply levels. They could also correct plans *in situ* based upon measurements taken at ten-day intervals. Variants and plan corrections did not include a full range of measures for various sectors, were not flexible enough, and often did not include an adequate buffer of water reserves for periods of scarcity.

2.2.2 Institutions

Disaster management during the drought involves many institutions. In the late 1990s national level institutions included the following, listed from top to bottom:

- An Emergency Situations Commission or Security Council typically oversaw the Ministry of Emergency Situations (MES, sometimes a committee or agency). The Commission and MES, was responsible for overall supervision of preparedness measures, impact assessment, and relief and recovery operations following natural disasters (as shown for Tajikistan in Figure 1 below).

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[13] UNDP Armenia, 2000, *Consolidated Support to National Disaster Preparedness System*; UNDP Azerbaijan, 1999, *National Program of the Republic of Azerbaijan to Reorganize and Develop the Disaster Management Training System*; UNDP Georgia, 1999, *Disaster Management Capacity Building*; UNDP Kyrgyz Republic, 2002, *Strengthening the Capacity of the Government for Disaster Mitigation and Preparedness: Final Report*; UNDP Uzbekistan, 1999, *Project Formulation Services for Disaster Preparedness in Uzbekistan*.

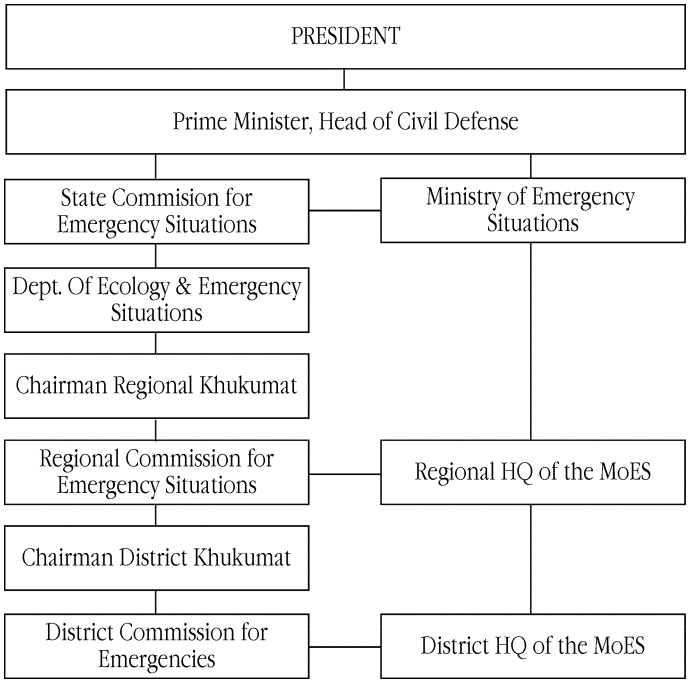
[14] UNDP, September 1999, *Project of the Government of Georgia: Disaster Management Capacity Building.*

- The Hydrometeorology Service and other institutions were responsible for early warning for weather, water, and agriculture (discussed below).
- Province and district governments were fundamentally involved in the coordination and direction of disaster management at the local level.
- National Red Cross/Red Crescent Societies were significantly involved in disaster management throughout the 1990s, as were the World Food Program, FAO, UNDP, ECHO, and DIPECHO in countries that had experienced major crises (Armenia, Azerbaijan, Georgia, and Tajikistan).
- Communities were not seen by line ministries and agencies as key players in disaster management and for the most part depended upon the district governments. Despite the presence of many NGOs, in countries such as Georgia they were "not reckoned as a considerable national resource at all."[15]

Regional disaster management institutions were lacking. There was limited communication and bilateral cooperation among national MESs, such as those of Tajikistan and the Kyrgyz Republic.

The institutional and organizational structure of the various agencies reflected the layout that was left over after the collapse of the centralized Soviet system, vertical in nature and with little cross communication with the other ministries or agencies that played a role in managing disasters. Due to this factor and poor planning, systematic organization and coordination of efforts among institutions was lacking. For example, in Georgia the MES (Department of Emergency Situations and Civil Defense), despite possessing a "quite solid administrative structure," was unable to work with the Medical Center for Disasters at the Ministry of Health Care, which should have been its chief counterpart. Coordination was perhaps better developed in Uzbekistan, where the Government had established a coordination unit led by the MES, and in Armenia, where the Red Cross and MES had forged close linkages.[16] The lack of coordination for interven-

Figure 2: Government Disaster Management System in Tajikistan



Source: Asian Disaster Reduction Center.

[15] Ibid.

[16] TACIS, 2002, *Evaluation of ECHO Disaster Preparedness Actions in Central Asia: Synthesis Report*. UNDP, December 1999, *Project of the Government of Uzbekistan: Project Formulation Services for Disaster Preparedness in Uzbekistan*; UNDP, September 1999, *Project of the Government of Georgia: Disaster Management Capacity Building*. The latter document notes "weak overall coordination and consequently missing vision of how to involve the Centre together with other actors."

tion by government resulted in costly mistakes in drought management in 2000-01. It also reduced the effectiveness of outside organizations which had their own resources, but were not informed on where need for intervention was most imminent.

MESs and other institutions lacked adequate capacity to manage a large-scale drought disaster. Most MESs lost significant budgetary resources after 1991 and became largely dependent upon external technical and financial support. While the upper level staff of most MESs was well qualified, training had not yet reached many in the provinces and districts. District governments also possessed little capacity for disaster management. For instance, a "Doctors Without Borders" report on Karakalpakistan noted with regard to analyzing the impact of the drought on food security, "there is very inadequate expertise locally." Communications systems in all countries were outdated, while early warning systems had fallen into decay (see below).[17]

Most relief agencies and NGOs had less capacity than was required for an effective response to the drought. The report of the Tajikistan Red Crescent Society in 2000 adequately characterizes the situation: "Despite the [Society's] considerable experience in the implementation of relief programs, the...branches had to start from the very beginning in developing their knowledge and operations, not having had this type of experience from previous operations."[18] World Food Program (WFP) and other donor agencies lacked both the physical and institutional capacity to handle the logistics entailed in the food aid operations that eventually became necessary.[19]

2.2.3 Meteorological and Hydrological Early Warning Systems

Because drought is a "creeping" weather phenomenon with a slow onset, careful forecasting, monitoring, and early warning concerning drought and its potential impacts are critical to avoid being caught unaware. However, these aspects of drought management were in disarray in Central Asia and the Caucasus by the late 1990s, due to incomplete restructuring and inadequate funding.

In countries of Central Asia and the Caucasus the Hydrometeorology Service (Gidromet) is responsible for meteorological, hydrological, and agrometeorological services. In addition to Gidromets, there are other institutions for hydrological monitoring: the operative monitoring service of the irrigation agency, a Committee for Geology (responsible for groundwater), and the Sanitary and Epidemiological Service (usually responsible for monitoring and maintaining a database concerning water quality, health, and environment indicators).

These services by design had to be vertically integrated: information collected in the regions was brought up to the center where it was compared and analyzed. Each service was typically composed of several departments with very specific functions, including data collection and maintenance, data processing and analysis, and communications and dissemination. While the structure served its pur-

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[17] Doctors Without Borders/Medicines Sans Frontieres, August 2000, *Drought-Related Health Assessment in Karakalpakstan and Dashoguz Veleyat, Turkmenistan*; TACIS, 2002, *Evaluation of ECHO Disaster Preparedness Actions in Central Asia: Synthesis Report*; UNDP, September 1999, *Project of the Government of Georgia: Disaster Management Capacity Building.*

[18] IFRC, 2001, *Tajikistan Drought Appeal No. 26/00, Final Report*; —, 20 June 2002, *Food Deficit Appeal No. 26/01, Operations Update No. 3.*

[19] The capacity of infrastructure and transport was inadequate. The distribution of food aid in the amounts required entailed a considerable expansion of storage and transport capacity, as well as the logistical capabilities of the staff. In 2000 the World Food Program proposed to deliver 66,000 tons of food aid to Georgia, over four times greater than the volume delivered annually in the years before. Operations in Armenia required a 25% expansion of storage capability. WFP Tajikistan's storage facilities were three times smaller in capacity than those required by its 2000 food aid program, while the local WFP fleet, as well as that of the private trucking countries, could not meet transport needs. See WFP, 2000, *Tajikistan: Emergency Food Assistance to Victims of Crop Failure and Drought*; WFP, 2000, *Emergency Operation Armenia*, p. 12; WFP, 2000, *Emergency Operation for Georgia*, p. 11.

pose well in a centralized system run from Moscow, it was inappropriate for the current environment in which analysis is preformed and decisions are made locally within each country, often even at the regional level.

Another major flaw in these services was that they were not conceived as a public service provider. They were linked in such a manner that information reached the respective echelons in the institutions responsible with determining water demand and distribution and other production activities, and these then adjusted their production decisions correspondingly. However, today where farmers themselves are expected to make decisions about their crops and assume the risks, a modern system should be concerned with dissemination to the public first and foremost. While these services benefited from extremely knowledgeable and high caliber staff and equipment, their services were only accessible by a few end users.

Following the breakup of the USSR, state funding of the hydrometeorological services declined to a fraction of its previous level. Presently Armenia and Azerbaijan allocate 0.08% of the state budget for Gidromet services, while the figure for Georgia is even lower (0.06%). Tajikistan's Gidromet receives only 5-10% of the required amount.[20] Support for Gidromets has been close to normal only in Turkmenistan and Uzbekistan (the latter of which maintains by far the strongest weather service in Central Asia). Because budgets are low, many staff have departed for the private sector or retired.[21]

Table 7: Number of Meteorological Observation Posts in the Aral Sea Basin and the Caucasus, 1975-95

	1975	1980	1985	1990	1995
Southern Kazakhstan	61	64	63	54	40
Kyrgyz Republic	95	95	95	87	63
Tajikistan	64	64	64	58	51
Turkmenistan	51	51	50	47	53
Uzbekistan	84	91	89	85	75
Aral Sea Basin	355	365	361	331	282
Armenia*				80	45
Azerbaijan*					77
Georgia*	240				60
Caucasus*					182

*"1995" Figures are for various years in the late 1990s.
Sources: V.E. Chub, 2000, *Climate Change and Its Impact on the Natural Resources Potential of the Republic of Uzbekistan*; *Initial National Communication under the United Nations Framework Convention on Climate Change*, 1998-2003.

Inadequate funding also postponed maintenance of the observation network, which fell into decay after 1991. Tables 7 and 8 indicate that during the 1990s the number of observation posts fell by 33% in Southern Kazakhstan and the Kyrgyz Republic, by almost half in Armenia, and by several times in Georgia. Snowpack surveys disappeared altogether, except in Uzbekistan. Many remaining stations contained only obsolete, outdated equipment, often in abysmal condition. Many sites were "totally demolished," to quote a field researcher in Georgia. During the 1990s, around 20% of the meteorological posts left in Tajikistan and one-third of the hydrological posts remaining in Georgia were inoperable.

[20] DAI, February 2002, *Analytical Report: water Quality and Quantity in Armenia, Azerbaijan, and Georgia*, pp. 20-21; Ministry of Nature Protection of the Republic of Tajikistan, 2003, *The First National Communication of the Republic of Tajikistan under the United Nations Framework Convention on Climate Change, Phase 2: Capacity Building in Priority Areas*, p. 82.

[21] A drought appraisal mission in Kakheti District of Georgia described the operation and staffing of the local meteorological stations as follows: "We visited every meteorological station we could find. None had complete meteorological records for the last three years, due to extended periods of salary arrears. At one station the data collection staff had left; data were being recorded on a volunteer basis by a veterinarian." See: Save The Children, Georgia Field Office, 2000, *Rapid Appraisal*, p. 4

Table 8: Number of Hydrological Observation Posts and Snowpack Surveys in the Aral Sea Basin and the Caucasus, 1985 and 1998

	Hydrological Posts		Snowpack Surveys	
	1985	1998	1985	1998
Southern Kazakhstan	147	111	0	0
Kyrgyz Republic	139	85	191	0
Tajikistan	38	23	265	0
Turkmenistan	155	119	0	0
Uzbekistan	80	58	198	164
Aral Sea Basin	559	396	754	164
Armenia*		97		
Azerbaijan*		77		
Georgia*	182	76		
Caucasus*		306		

Sources: V.E. Chub, 2000, *Climate Change and Its Impact on the Natural Resources Potential of the Republic of Uzbekistan*; DAI, February 2002, *Analytical Report*, pp. 7, 12, 15.

Despite all difficulties, many Gidromets managed to retain a highly qualified staff to interpret the data generated by the observation network and produce forecasts for weather and river flow (for growing and non-growing seasons). But the observation network did not generate enough accurate data to reliably assess weather extremes and their impact. Therefore, the quality of forecasting declined.

The transmission and handling of data was in need of improvement. Data was often not transferred or in irregular intervals from observation posts and between institutions often due to financial constraints. Manual, radio, or telephone transmission often distorted data. Although there are databases concerning meteorology, hydrology, aerology, glaciers, snow cover, air pollution, and hydrochemistry, and health, they were usually kept by separate institutions or departments and have poorly integrated methodology and technology. Access to information sometimes required time-consuming clearances.[22]

Cooperation among Gidromets had to start from scratch after the fall of the Soviet Union. Until 1991 they were vertically integrated into a USSR-wide reporting system located in Russia, in which data collection and management were often designed to address regional rather than national issues. After the demise of the Soviet Union Gidromets and other agencies had to learn to set strategies and address issues at the national level, as well as develop cooperation with other national ministries and international agencies. In Central Asia pre-existing horizontal cooperative arrangements continued, such as the heavy reliance of Central Asia countries upon the Uzbekistan Gidromet for river flow forecasts for the Amu Darya and Syr Darya Rivers. Regional data sharing and other arrangement were in their infancy.[23]

The virtual collapse of the system due to the lack of finance, combined with the very rigid vertical communication structure, had a paralyzing effect upon early warning. While scientists and specialists in the

[22] DAI, *Analytical Report*, pp. 7, 12, 15, 19; Regional Environmental Centre for Central Asia, 2002, "Environmental Monitoring in Central Asia," *UNECE Ad Hoc Working Group on Environmental Monitoring, Second Session, 28 February – 1 March 2002*; UNCCC, 1999, *Initial Communication of the Republic of Uzbekistan under the Framework of the United Nations Framework Convention on Climate Change*; UNECE, February 2022, *Diagnosticheskii doklad dlia podgotovki regional'noi strategii patsional'nogo i effektivnogo ispol'zovaniia vodnykh resursov tsentral'noi Azii*, pp. 19-21.

[23] The Central Asia Gidromets also forged new relationships through data sharing agreements. In 1998 the countries of Central Asia signed the "Agreement Concerning the Exchange of Information on Surface Transboundary Waters." Since then the directors of the national Gidromet services have met three times to review ways to improve data collection and information flows concerning water management in the Aral Sea basin under the HYCOS project, and another agreement was signed for data sharing in 2004. It remains to fully implement these commitments.
In the Caucasus, "there is no common mechanism for the exchange of water-related observations." See: DAI, February 2002, *Analytical Report*, p. 4.

field of the individual services were able to see the oncoming problem, the tubular communication structure prevented the knowledge from one service to properly flow to the agencies that were in a position to undertake preventive or mitigating measures.

2.2.4 Agrometeorological Network

In Central Asia and the Caucasus, where agriculture is the employer for a large part of the population and contributes a significant share of the economy, reasonably accurate long-term weather predictions are essential for survival. The agrometeorological network (Agromet) should have an updated strong database for forecasting the crop-weather relationship and for enhancing the sustainability of the agricultural production in the country. Scientific study of the influence of weather on crops is of vital importance. Since any abnormalities in the weather during the season, such as delay/deviations in the precipitation pattern, untimely low or excessive precipitations, or spells of too high or too low temperatures, would very seriously affect the growth and final yield of the crops.

The decline of the agrometeorological network heightened vulnerability to agricultural drought. For example, before 1991 there were around 500 on-farm observation points and 100 agrometeorological stations in Uzbekistan that assessed various crops and pasture, including phenological observations (development state, leaf index, biomass, etc.), and performed yield estimates. All of the agrometeorological tasks in Uzbekistan then fell to the meteorological stations, because only two of the original 100 agrometeorological stations remained operational, and almost all of the on-farm observation points disappeared. In Georgia and Armenia, agrometeorological surveys were conducted relatively infrequently at the few stations that remain from before 1991.[24]

The transmission of the information and analyses generated by the Gidromets, the likely availability of water, and the prospects for various crops was disseminated to the public through bulletins and mass media. For instance, in Uzbekistan weekly or 10-day agrometeorological and hydrological bulletins and river flow forecasts were transmitted to district irrigation departments and production cooperatives ("shirkats"). But in many cases bulletins became irregular or were discontinued. Moreover, the early warning needs of farmers changed (and grew) considerably after 1991, when the primary objective of most farmers was to "fulfill the plan." In many countries direct communication to farms ceased with the restructuring of kolkhozy and sovkhozy. Other means of early warning did not fill this gap during the 1990s.[25]

2.2.5 Food Security Early Warning Systems

When severe agricultural drought takes hold, an early warning system for food security in particularly vulnerable regions is required to soften the impact of socioeconomic drought. But early warning systems of this type had not been established by the late 1990s. In assessing food security, crop yield prediction was often inaccurate, and reliable data unavailable. Nutritional surveillance was often not carried out when required. Data flows were erratic, both among and within ministries and other authorities, and there were frequent disharmonies between datasets.[26] In general, food security information systems were inadequate or completely lacking.

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[24] Vladimir Antsypovich, November 2002, "Assessment of the Problems and Requirements of NMS Uzbekistan Related to the Migration to Table-Driven Code Forms (TDCF)," WMO; DAI, February 2002, *Analytical Report*, pp. 20-21; RESAL, February 2000, *Support to Establish a Food Security Information System in Armenia*, p. 28; TACIS, October 2001, *ISEAM Information System*, p. 18.

[25] WMO, October 2002, *Agricultural Meteorology Working Group on the Communication of Agrometeorological Information: Methods Used by the Countries Belonging to Regional Association II.*

[26] Goskomstat Azerbaijan, 2001, *O prodovol'stvennom obespechenii v Azerbaidzhane*, *Joint ECE/EUROSTAT/FAO/OECD Meeting on Food and Agricultural Statistics in Europe (Geneva 17-19 October 2001)*; RESAL, February 2000, *Kyrgyz Republic National Food Security Information System;* RESAL, February 2000, *Support to the Establishment of a Food Security Information System in Armenia.* During a project to set up a food security communication system in Armenia, field data were actually transmitted only 30% of the requested instances, due to "administrative rather than technical constraints"Ïlocal units were more inclined to report to district executive bodies that their own ministry.

2.3 Population at Risk

The irregular rainfall and highly variable availability of water resources make careful management a precondition for preventing and mitigating drought. However, severe structural problems developed during the 1990s in water management, agriculture, and rural livelihoods that made the population, especially its rural segment, highly vulnerable to meteorological, hydrological, agricultural, and socioeconomic drought. It is impossible to fully quantify the number of the population most at risk from drought by the late 1990s, owing in large part to the lack of consistent datasets that are disaggregated by district. However this portion of the population can be expressed in various ways and probably constitutes the majority.

Table 9: Rural Population in 2000 and Projections for 2020 and 2030 (× 1,000)

	2000	2020	2030
Armenia	1,021	837	695
Azerbaijan	3,924	4,344	4,037
Georgia	2,300	1,655	1,340
Kazakhstan	6,906	6,137	5,302
Kyrgyz Republic	3,229	3,847	3,697
Tajikistan	4,408	5,214	5,183
Turkmenistõn	2,564	2,920	2,815
Uzbekistõn	15,760	19,189	18,496
Total	40,112	44,143	41,565
Total (Urban and Rural)	72,737	85,346	89,903

Source: FAOSTAT.

As shown in Table 1 above, meteorological drought affects the majority of most countries of Central Asia and the Caucasus, often at various times of the year. The areas most frequent visited by meteorological drought are the lowlands, which contain around 90% of the population of Central Asia, 70% of that of Azerbaijan, and less than half of that of Armenia and Georgia. However, precipitation deficits are also frequent in certain mountain locales of Armenia, Georgia, the Kyrgyz Republic, and Tajikistan.

Hydrological, agricultural, and socioeconomic drought mostly affects the rural population, which comprises 55% of the total (and is expected to remain the majority until 2020-30, as shown in Table 8). However, in various ways urban populations were also at risk. The following are rough indicators of the scale of the risk:

- Significant numbers of farmers experience hydrological drought on a regular basis and/or are at substantial risk of it. Water supplies had become irregular during periods of scarcity in irrigated areas in downstream parts of river basins and irrigation systems such as those of Karakalpakistan and Khorezm Province in Uzbekistan (which contained 11.5% of the country's population of 24.9 million).
- Depending upon the country, 35-85% of the rural population (56% of the total on average, or 22.5 million persons) lacked access to improved sources of drinking water. A significant portion of the remaining percent, as well as many city dwellers, obtained water from purification and delivery systems that are on the verge of collapse.
- Both rural and urban populations in Georgia, the Kyrgyz Republic, and Tajikistan relied upon hydropower for 80-98% of electricity supplies. Given the lack of a viable alternative, the population of these countries was at significant risk of power outages in the event of hydrological drought.
- Agricultural drought occurs first on land in which rainfed agriculture was predominant and precipitation deficits frequent. Although the exact number of farmers on these lands is unknown, they occupied

45-50% of the total area of cropland in Armenia and Georgia and 25% or less in remaining countries. Most of these farms were small, largely subsistence operations, rendering their occupants quite vulnerable to drought, as well as the mudslides that commonly follow it in these areas.

- Rural households were greatly at risk of socioeconomic drought. Those with greatest vulnerability to this type of drought had one or more of the following characteristics: limited access to land or (especially) livestock, lack of cash income earning opportunities, were very large or female-headed, had chronically ill or invalid members, and/or headed by a civil servant with low state salary and no other income earning opportunities. This portion of the rural population comprises roughly 15-25% of the total.

Vulnerable groups such as this absorbed the greatest impact of drought that was slowly taking hold in many areas in the late 1990s.

3 THE DROUGHT OF 2000–01

The arrival of drought in 2000-01 seemed sudden, due to the failure of early warning systems. However, it actually developed gradually, as precipitation and water supply deficits slowly accumulated. The impacts upon agriculture and other water using sectors, the environment, and society were severe: Armenia, Georgia, Tajikistan, and Uzbekistan incurred significant damage and were forced to mount costly relief and recovery operations. Although these operations were muddled at the outset, institutions concerned with them gained significant capacity as their operations improved.

3.1 Early Warning Failures

Early warning systems failed to alert governments, farmers, and other water users of the approach of drought, in part due to inaccurate observation, poor data, and consequent incorrect forecasting. For example, the prognoses of the Uzbekistan Gidromet for Amu Darya and Syr Darya River flows in spring of 2000 were inaccurate by 30% and 17% (86% and 93% of the norm was predicted).[27] Because the Georgia Gidromet did not have enough data at its disposal to adequately estimate drought extent and damage, it appealed to the United States National Oceanic and Atmospheric Administration (NOAA).[28]

Moreover, early warning systems were not linked with end users. This disconnect is evident in the statement of a farm worker in Karakalpakistan who asserted that he had resorted to "praying to God" for rain, because Gidromet had failed him:

We have, what's it called, a [local] hydrocenter, yes? It must give a correct forecast of whether or not there will be water...No one can guarantee that there will be water...Last year [2000] we planted wheat on 3,150 ha and couldn't irrigate 604 ha of it even once. They gave an incorrect forecast. Fifty percent of the sown area didn't provide the expected yield. Thus, the private and cooperative farmers didn't get any profit. That's why you need an accurate forecast.[29]

Thus, in 2000-01, the end users paid for the collapse of early warning systems during the previous decade.

3.2 Meteorological Drought

Meteorological drought had developed for some time before it became apparent to the farmer quoted above. The drought was unusual not because of the low precipitation and high heat during the course of a single year, but due to the deficits in precipitation combined with the high levels of evaporation from high heat cumulating over a period of several years, which led to extremely low river flows and dropping water tables that made the situation extremely difficult.

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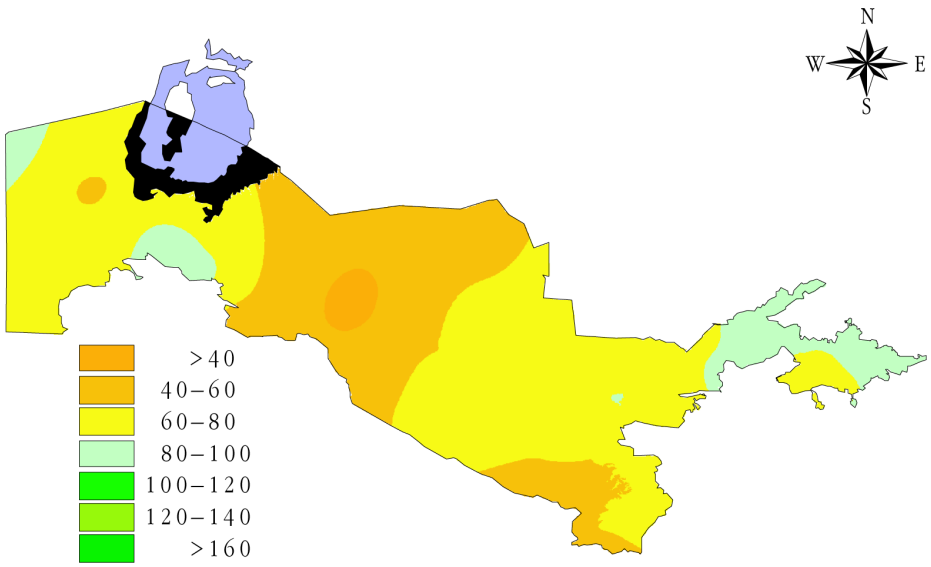
[27] UNECE, February 2002, *Diagnosticheskii doklad dlia podgotovki pegional'noi strategii patsional'nogo i effektivnogo ispol'zovaniia vodnykh resursov tsentral'noi Azii*, pp. 19-21.

[28] Personal communication, Felix Kogan, NOAA National Environmental Satellite, Data, and Information Service, May 1, 2003.

[29] World Bank, 7 July 2001, Focus Group Discussion, *Uzbekistan Rural Enterprise Support Project Survey 2000*.

Figure 3: Precipitation in Uzbekistan in 2000 (Percent of 1961-90 average)



Source: Uzglavgidromet, *Climate Change Problems in Aral Sea Basin (Example of Uzbekistan)*, http://unfccc.int/cop8/se/se_pres/wwf_pres_uzb.pps.

Below-average precipitation and above-average temperatures prevailed as early as 1998 and 1999 in most of the Caucasus and parts of Central Asia. Climatic extremes were not significant enough to cause alarm, except in some areas of the Caucasus where cereal crops were suffering from a moisture deficit. In 2000 precipitation unexpectedly fell off, especially in the summer, while temperatures soared (to over 40 C) in many areas. In Uzbekistan, precipitation was only 69% of the norm, although distribution was uneven (as indicated in Figure 3). The winter of 2000-01 was dry in both Central Asia and the Caucasus and remained so for the rest of the year in much of Central Asia. A brief spell of rain brought temporary relief to the Caucasus in the spring of 2001. It preceded the onset of drought within a slightly reduced area during the summer. However, drought returned in fall and winter. Normal amounts of precipitation did not return until 2002. (See Figures A8-A13 in Annex 1 for detailed information.)

3.3 Hydrological Drought

Hydrological drought became apparent in Central Asia and the Caucasus by the late spring of 2000, when diminished river flows led to (unexpected) water scarcity. As shown in Table 10, the flow of rivers such

Table 10: Water Deficit Along the Amu Darya River During the 2000 Growing Season

	Deficit (km3)	Percent Deviation From Average Flows
Tajikistan	0.7	11
Turkmenistan	4.6	30
Midstream	1.8	17
Downstream	2.8	55
Uzbekistan	5.8	37
Midstream	0.8	15
Khorezm	1.2	36
Karakalpakistan	3.8	59
Total	11.1	30

Source: Dukhovnyi, "Amu Darya River Basin: Ways of Probable Conflicts Prevention," pp. 2-3

as the Amu Darya fell significantly. Releases from the Toktogul Reservoir during winter were higher than in previous years, which, together with low flows of the Syr Darya River, resulted in water scarcity downstream. In Armenia, water supply was 30% below 1999. Downstream in the Azerbaijan section of the Kura-Araks basin some areas received as little as one-third of normal flow. Some small rivers dried up altogether.

Hydrological drought slowly grew until it affected an expanded area in 2001. Table 11 indicates that the amount of water available on the Amu Darya River dropped slightly, but that supply of downstream areas such as Karakalpakistan worsened. In the Caucasus, water supply also deteriorated. Azerbaijan's reservoirs were drawn down from 63% to 51% of full supply level volume between 1999 and 2000, which made it utilize dead storage in them in 2001. By the spring and summer of 2001 flows of the Kura River were at 30% of normal. River levels were so low downstream that pump stations and inlets had to be modified.

Table 11: Water Distribution on the Amu Darya River During Various Seasons of 2000 and 2001

	2000 Vegetative	2001 Vegetative	2002 Non-Vegetative
Limit (km3)	38.1	31.4	12.0
Actual (km3)	26.3	24.3	11.3
Percent of Limit Received			
Total	69.0	77.3	94.1
Upstream	84.2	97.3	90.9
Midstream	82.8	91.8	116.2
Lower Stream	48.4	49.5	53.6
Karakalpakistan	30.7	27.5	16.2

Source: ICWC, cited in *Tsentral'naia Aziia: problemy opustynivaniia*, No. 40, June 2002

Figure 4: Withdrawals for Irrigation in Uzbekistan Provinces on the Amu Darya River 1999-2001 in Million m3

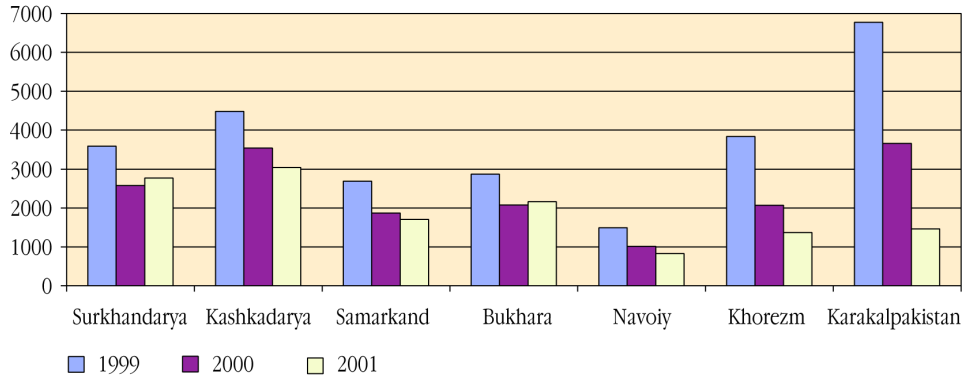
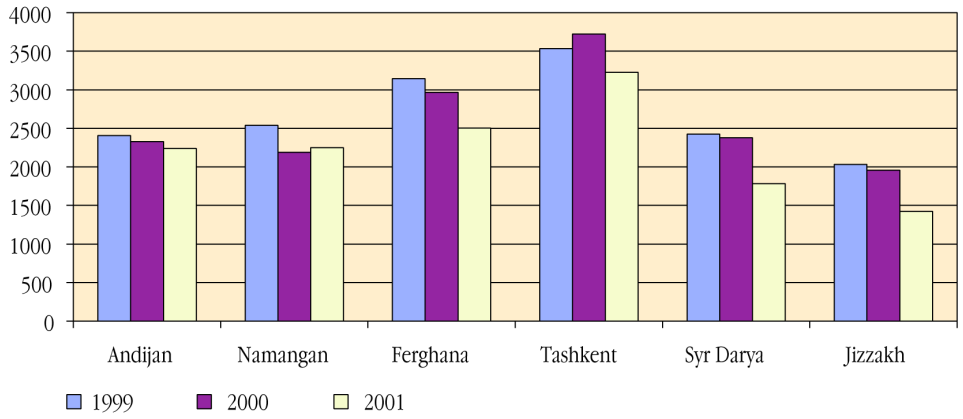


Figure 5: Withdrawals for Irrigation in Uzbekistan Provinces on the Syr Darya River 1999-2001 in Million m3



Note: 1999 is considered to be a normal year in terms of water supply.
Source: Uzbekistan Ministry of Agriculture and Water Resources.

Significant water-using sectors, in particular irrigation, were able to withdraw only part of the water normally available to them, as shown for Uzbekistan in Figures 4 and 5 above. Downstream provinces in the Amu Darya River basin (Khorezm and Karakalpakistan) and the Syr Darya River basin (Syr Darya and Jizzakh) suffered a greater loss in water supply for irrigation than upstream and midstream provinces (located to their left in the figures).[30] Inequities between upstream and downstream water users prevailed at several levels of water delivery systems throughout Central Asia and the Caucasus.

Drinking water supplies declined in both quantity and quality, as wells dried up and aquifers became depleted. Even in countries with normally abundant supplies such as Armenia, drinking water availability dropped by 35-40% in drought-affected locales. Water quality deteriorated: in Karakalpakistan, the mineral content of the water was 0.85-2.1g/l and water hardness reached 17 mg/l. Because local supplies were often nonexistent or undrinkable (in some instances unfit even for laundry), water was delivered from far afield and distributed at a rate of 12-15 liters per person as a daily norm.[31]

Dysfunctional management and decrepit infrastructure made hydrological drought worse than it should have been. In 2000-01 cooperation among the countries of the Caucasus was almost absent.[32] In Central Asia there was palpable uncertainty and acrimony surrounding transboundary water distribution. Allocation of the Syr Darya River, in which energy-water tradeoffs are a major issue, became especially contentious, requiring several rounds of negotiations and agreements (most of which went unfulfilled). Despite the open displays of bitterness and the leverage that was inevitably applied in backroom discussions during the drought, interstate conflict did not break out over water, as many observers had expected. Nevertheless, downstream areas of the Amu Darya and Syr Darya River basins did not receive enough water, and energy-water issues remained largely unresolved. (See Annex 5, for a chronology of transboundary water management in Central Asia, 1992-2002.)

Lacking a comprehensive Water Shortage Response Plan, most governments responded to hydrological drought at the national level in *ad hoc* fashion in 2000-01. The Government of Uzbekistan had perhaps the most comprehensive package of measures, which it tried to implement beginning in the summer of 2000. Measures consisted of the following:

- Reduce water distribution limits: distribution limits for the vegetation period of 2001 by 12% for Kashkadarya Province, eight percent for Bukhara province, and 12% for Khorezm;[33]
- Circulate instructions concerning irrigation methods under water scarcity to line personnel of the Ministry of Agriculture and Water Resources, as well as irrigators of production cooperatives;[34]
- Impose "water discipline;"

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[30] According to an Uzbekistan newspaper, "Measurements indicate that the water level in the Amu Darya River, especially in its lower reaches, is currently the lowest since monitoring began. Supplying water to many areas of Karakalpakstan has become very difficult. Since early April, only 20-30 m3/s has been discharged from the hydraulic section of the Takhiatash hydrosystem, which supplies water to 13 Districts of Karakalpakstan, while during the maximum flood period, quite unusually, it was no more than 200-250 m3/s. And even that low level lasted only 21 days." See: *Narodnoe Slovo*, 5 August 2000.

[31] *Pravda Vostoka,* 14 April 2001; UNDP Armenia, 2000, *Study of the Communities Most Affected by the Drought, August-September 2000*.

[32] A senior official of the State Amelioration and Irrigation Committee of Azerbaijan remarked in August of 2001, "Distribution of water between Azerbaijan and Armenia is currently impossible," due to the ongoing dispute over Karabakh. Cooperation between Azerbaijan and Georgia began to develop only after the drought, when a project was launched under USAID auspices for regional cooperation in water management. See: *News from REC Caucasus: Bi-Monthly Newsletter of the Regional Environmental Centre for the Caucasus*, Issue 3, August 2001, p. 8; *Joint Seminar on Water Management Issues, Tblisi, Georgia, November 6 to 8, 2002*; TACIS, 2001, *Joint River Management Programme on Monitoring and Assessment of Water Quality on Transboundary Rivers: Kura Basin Report,* http://www.jointrivers.org/.

[33] *Khalq sozi*, 30 June 2001; *Narodnoe Slovo,* 30 January 2001.

[34] Uzbekistan Ministry of Agriculture and Water Resources, 2001, *Khojalik irrigatorlari uchun eslatma.*

- Forbid the cultivation of rice, the most water-intensive crop, in some areas in 2001;
- Utilize water from drainage collectors for irrigation;
- Provide emergency hand pumps for drinking water and irrigation;[35]
- Repair and equip wells and restore desalination plants;
- Transport drinking water by truck;

However, these measures were only partially implemented, for several reasons. First, they were adopted last-minute. Furthermore, funding was in short supply. Last but certainly not least, they assumed a top-down, command-and-control system of management, for which the Government did not possess the capacity to implement and which excluded public participation. Thus, as noted above, the supply of water for irrigation and drinking water continued to worsen during 2000-01. Moreover, "water discipline" was violated at all levels. On the Amu Darya River, the upstream provinces of Surkhandarya and Kashkadarya Provinces withdrew 173% and 120% more water than was allocated in plans for fall of 2000 and winter of 2001, while Khorezm and Karakalpakistan received only 77%, and 55% of water allocated, respectively.[36] The lack of water control and failure to deliver supplies brought periodic rebukes of local officials and water users in the media for "negligence" and "lack of initiative."[37] It also led to a rise in conflict over water within and among communities, although these were mostly small in scale and non-violent in nature[38] .

Water users attempted to overcome water scarcity on their own. Villagers made their own attempts to obtain water for home and kitchen garden use, resorting to alternative, yet unsafe sources such as canals and drainage collectors. Those that could afford it bought piped water. But most did not possess the money to purchase hand pumps and otherwise exploit alternative sources and storage for household water supplies.[39]

Farmers employed various strategies to improve water supply and reduce demand for irrigation. In Tajikistan and Uzbekistan, they introduced rotations in the delivery of water on secondary and tertiary canals (know as *nawbat* or *avandaz*), utilized drainage water, irrigation at night to reduce evaporation, reduced furrow length, and applied more extensive winter pre-irrigations to maximize soil moisture.[40] This did not suffice to deliver water to crops, which consequently perished in many areas.

3.4 Agricultural Drought

Agricultural drought was severe in 2000 and 2001. Farmers in Central Asia and the Caucasus attempted to adapt production systems to meteorological and hydrological drought in various ways. But in most instances agricultural producers were unprepared, and, due to the decline of agrometeorology, unaware of the onset of drought. Therefore, it caused substantial damage to crop and livestock production in 2000-01.

When agricultural drought conditions became apparent in 2000, farmers modified their production strategies. In addition to the water strategies described above, these measures included the following:

- Farmers tried to salvage failed crops by cutting maize and other crops for fodder.[41]

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[35] *Narodnoe Slovo*, 5 August 2000.

[36] Mamadaliev, Ghoyipnazarov, and Zununova, 2001, *Assessment of the Drought's Impact*.; UNDP, 2003, *Report #1 on Results of the Participatory Community Appraisal Conducted in Kazaketken Village Community of Citizens, Boztau District.*

[37] *Pravda vostoka*, 2 September 2000; *Pravda vostoka*, 14 April 2001; *Khalq sozi*, 1 August 2001.

[38] International Crisis Group, 30 May 2002, "Central Asia: Water and Conflict," *ICG Asia Report No. 34;*

[39] Mamadaliev, Ghoyipnazarov, and Zununova, 2001, *Assessment of the Drought's Impact.*

[40] Interviews conducted for the Uzbekistan Rural Enterprise Support project in 2000-01. Focus groups and interviews conducted by Mike Thurman in Uzbekistan and Tajikistan, November and December 2003 and January-March 2004.

[41] Save The Children Georgia Field Office, 2000, *Rapid Appraisal*, pp. 4-5.

- Some tried to cultivate and/or mulch to reduce moisture loss in the soil during the growing season.[42]
- Herders attempted to move livestock to pastures with some cover, but most could not afford the cost of transport.
- Farmers sought to diversify their sources of income, often in favor of non-agricultural occupations such as petty trade (jobs in agriculture were even more scarce than before, owing to the drought).[43]
- Late season second crops in 2000 were altered in favor of lower water use and higher drought tolerance. In 2001 many crop rotations emphasized winter wheat, grown during a cool, water-abundant season, over water-intensive summer crops such as cotton and rice.
- Marginal lands, especially those lacking irrigation, were left fallow. For example, in Tajikistan in 2002 a much smaller area was devoted to rainfed wheat crops than during the drought, despite normal rainfall for the first time in years, and a larger area was actually harvested. Yields per hectare rose by almost 130% (to a decidedly unimpressive 0.75 t/ha, indicating the low productivity imposed by the drought and poor agricultural practices).
- Villagers increasingly reverted to subsistence production. "Where land is scarce, such as in the mountainous region of [Tajikistan], dependence on fruit trees and livestock for own consumption and sale/barter is higher."[44]

In most instances the adaptations are simply attempts to reduce losses and enable a minimal level of survival. Agriculturalists lacked both the resources and expertise required for mitigation. In the long run, a more diversified agriculture that will act as a hedge to vagaries of the weather will be crucial to mitigate some of the effects of droughts.

Table 12: Impact of Agricultural Drought Upon Output in Armenia as of August 2000

	1999 Ha Sown	2000 Ha Sown	Expected Harvest (tons)	Actual Harvest (tons)	Percent of Expected Yield	Losses (tons)	Losses ($1000)
Wheat	69,000	72,776	161,219	56,260	34.90	104,959	13,645
Barley	44,658	46,891	75,624	19,626	25.95	55,998	5,880
Potatoes	23,256	25,349	407,899	171,703	42.09	236,196	23,620
Vegetables	8,252	7,712	143,680	71,089	49.48	72,591	10,889
Milk			250,000	152,878	61.15	97,122	12,626
Total	145,166	152,728			42.5		66,659

Source: UNDP, 2000, *Study of Communities Most Affected by Drought.*

Because farmers were not ready for drought, the damage to production was significant in countries where drought was most severe (Armenia, Georgia, Tajikistan, and Uzbekistan). Armenian farmers obtained only 40-65% of expected yields, costing around 67$ million by the fall of 2000 (see Table 12). Based upon the estimates made by governments in Central Asia and the Caucasus, a rough aggregate figure for agricultural damage from the drought during 2000-01 is around $800 million (as presented in Table 13). This figure should be taken as only an approximation of damages to agricultural drought: methodologies for impact assessment remain highly imperfect, and the estimates provided to date are certain to be riddled with inconsistencies. Moreover, the table above is incomplete, due to lack of data. Figures for Uzbekistan include only Karakalpakistan and Khorezm, although farmers also lost crops and livestock to drought. Agricultural drought affected parts of Turkmenistan, Kazakhstan, and the Kyrgyz Republic, but no data is available.

[42] Save The Children Georgia Field Office, 2000, *Rapid Appraisal*, p. 5.

[43] FAO GIEWS, 8 September 2000, *Special Report...Georgia.*

[44] FAO GIEWS, 3 August 2002, *Special Report...Tajikistan.*

Table 13: Losses Due to Agricultural Drought in Central Asia and the Caucasus, 2000-01

	2000-01 Losses (million USD)	% of GDP	% of Ag GDP
Armenia	110	2.7	10.1
Azerbaijan*	110	1.0	6.0
Georgia	350	5.6	25.5
Tajikistan	100	4.8	16.8
Uzbekistan	130	0.8	2.4
Total	800	2.0	7.9

*The Azerbaijan figure includes losses to fisheries.

Sources: Tahir Mamadaliev, Norboy Ghoyipnazarov, and Gulchehra Zununova, *Assessment of the Drought's Impact Upon Agriculture and Drinking water in the Republic of Karakalpakistan and Khorezm Viloyat*; **Ministry of Nature Protection of Tajikistan, October 1998, *First National Communication of the Republic of Tajikistan under the United Nations Framework Convention on Climate Change*,** Regional'nyi ekologicheskii tsentr, 2002, *Mezhdunarodnoi konferentsii po problemam zasukhi i opustynivaniia: doklady uchastnikov konferentsii, predvaritel'naia publikatsiia;* UNDP, 2000, *Study of Communities Most Affected by Drought.*

If the available damage estimates are reasonably accurate, agricultural drought had significant effects upon the economy as a whole. The table above indicates that Tajikistan. Georgia, and Armenia lost between 2.7%, 4.8%, and 5.6% of GDP to agricultural drought. Of course, much higher portions of agricultural GDP were lost. [45] These losses likely resulted in reduced revenues and expenditures, postponed investment, diminished provision of services, and a weakening of external position. For instance, agricultural drought is among a number of factors that caused Tajikistan's external deficit to grow during 2000-01.[46]

In drought-affected areas, a significant portion of the farming population lost crops and livestock. A survey in Armenia found that the share of farms damaged by drought in 2000 was below 60% in only two provinces (see Table 14 below). In the Karakalpakistan and Khorezm areas of Uzbekistan, only 64% and 87% of planned crop area was actually sown in 2001, respectively, and 22% and 12% of the area sown was a complete loss (as

Table 14: Farms Affected by Agricultural Drought in Armenia as of August 2000

Province	Total Number of Farms Surveyed	Total Number of Farms Damaged by Drought	Percent of Farms Damaged by Drought
Aragatsotn	23,681	22,865	96.6%
Ararat	17,512	17,512	100.0%
Armavir	13,667	12,080	88.4%
Gegharkunik	62,833	54,630	86.9%
Lori	43,357	43,357	100.0%
Kotayk	30,749	13,300	43.3%
Shirak	23,504	23,504	100.0%
Syunik	5,750	3,296	57.3%
Vayots Dzor	6,605	6,605	100.0%
Tavush	30,346	30,346	100.0%
Total	258,004	227,495	88.2%

Source: UNDP, 2000, *Study of Communities Most Affected by Drought.*

[45] The World Meteorological Organization has estimated that, due largely to agricultural drought, both Armenia and Georgia lost over five percent of GNP in 2000 and over two percent of GNP in 2001. S.G. Cornford, July 2002, "Human and Economic Impacts of Weather Events in 2001," *World Meteorological Organization Bulletin*, No. 51 (3), pp. 10-11. See also: IMF, November 2001, *Georgia: Recent Economic Developments and Selected Issues, IMF Country Report No. 211*, p. 6.

[46] World Bank, 2004, *Tajikistan Public Expenditure Review*. According to the report, "the external deficit worsened during [2003] because of the declines in international prices of cotton and aluminum, two consecutive droughts (affecting electricity, wheat production and energy imports), and greater import demand encouraged by increased workers' remittances."

presented in Table A9). The situation in Georgia was perhaps worst of all: all households interviewed in an in-depth food security assessment experienced more than 40% losses in all agricultural sectors.[47]

The drought damaged various production systems in different ways. Most notably:

- Farmers in areas where a significant percent of cropland was rainfed lost a greater portion of their harvest than those on irrigated land. This occurred particularly in 2000, when they were caught off guard.
- Subsistence farmers suffered especially. Those holding small plots of land grew less, spent less on inputs, and had marginal yields. Owing to their inherent poverty, these farmers had fewer resources for coping than those with larger farms, and many lacked technical expertise.
- Households with few sources of income were much worse off than those with diverse sources, especially in the case of those able to work outside of the agriculture sector.[48]
- Livestock owners were forced to conduct distress sales. Typically, they were forced to sell cheap during the drought and later purchase the items at higher prices when they attempted to restore production. However, the population of mountain areas suffered less and survived better than farmers in the lowlands, owing to greater reliance upon livestock.[49]
- In countries like Uzbekistan, Turkmenistan, and (to a lesser extent) Tajikistan where farm restructuring is circumscribed and state production orders are still transmitted to farmers, farmers were often not permitted to make changes in cropping patterns or irrigation scheduling. Crops earmarked for state purchase (particularly cotton) received priority in irrigation over the household plots of the rural (and urban) population that rely on this production as a hedge against impoverishment.[50]

Table 15: Availability of Seed for 2001 in Armenia after the 2000 Harvest

Crops	Available Quantity (tons)	Requirements (tons)	Shortage (tons)	Percent Shortage
Wheat	2,117	23,543	21,426	91.01
Barley	1,154	12,542	11,388	90.80
Potatoes	14,698	77,050	62,352	80.92

Source: UNDP, 2000, *Study of Communities Most Affected by Drought*.

The drought also complicated recovery in agricultural production, thereby making it harder for farmers to cope. The failure of crops made it problematic to obtain seeds of adequate quality: the deficit in Armenia was 80-90% for the growing season of 2001 (as shown in Table 15).[51] Job opportunities declined, especially seasonal work in large farms and enterprises.[52] Informal aid from friends and neighbors (borrowing food, inputs etc.) was less available during the drought, because "better off" farmers, themselves hurt by crop and livestock losses, now possessed fewer resources that could be distributed or loaned to other households.[53] Many farmers became risk-averse and "reluctant to invest in purchased inputs such as seeds, fertilizers, and farm power." Some withdrew from production altogether: a farmer in Ellikkala District told an interviewer in early 2001, "Last year everything dried up, because of drought...I am afraid to sign a contract, because I might not be able to fulfill it."[54]

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[47] WFP, November 2000, *Georgia Emergency Household Economy Assessment*, p. 5.

[48] FAO GIEWS, 8 September 2000, *Special Report...Georgia;* —, 27 December 2000, *Special Report: Serious Feed and Seed Shortages Emerge in Armenia.*; —, 7 August 2001, *Special Report...Tajikistan*.

[49] WFP, November 2000, *Georgia Emergency Household Economy Assessment, p. 31*.

[50] FAO GIEWS, 7 August 2001, *Special Report...Tajikistan*; —, 19 December 2000, *Special Report...Uzbekistan.*

[51] Save The Children Georgia Field Office, 2000, *Rapid Appraisal*, p. 10; UNDP Armenia, 2000, *Study of the Communities.*

[52] Save The Children Georgia Field Office, 2000, *Rapid Appraisal*, p. 9.

[53] FAO GIEWS, 5 October 2000, *Special Report...Armenia.*

[54] FAO GIEWS, 3 August 2002, *Special Report: FAO/WFP Crop and Food Supply Mission to Tajikistan*.

3.5 Damage to Other Sectors

Although agriculture bore the main impact of the drought, all water-using sectors of the economy felt its effects. For example, hydroelectric power generation fell to well below capacity, owing to a lack of water to turn the turbines. The depletion of reservoirs was so severe in Georgia that power had to be rationed in the capital city. Fisheries in Azerbaijan incurred a disruption in stocks. Reduced flows of the Kura River disrupted sturgeon and salmon breeding, decimating at least four generations of fish stocks.[55]

3.6 Damage to the Environment

In addition damaging the economy, the drought of 2000-01 contributed to environmental degradation. The most apparent type of damage was desertification, which accelerated in areas such as the Kyzyl Kum and Ust-Yurt. High alpine meadows in Azerbaijan degraded. In Karakalpakistan, a lake occupying 200,000 ha in January of 2000 totally disappeared by the end of 2001. Due to disappearance of wetland habitat, 46 species were entered into the Red Book of Uzbekistan during 2000-01. Dry hot wind, in western Georgia, in fall of 2001 and the winter of 2001-02, intensified erosion.

Deforestation accelerated, mainly because fires became more widespread. Erratic hydropower supply in the Nakhchivan enclave of Azerbaijan led to use of organic fuel for cooking and heating, which also increased deforestation. [56]

3.7 Socioeconomic Drought

The drought significantly damaged livelihoods in Central Asia and the Caucasus. The population, already vulnerable before the start of the drought, experienced significant loss of income and experienced even higher levels of unemployment, food insecurity, and non-income poverty than before 2000-01. Damage to livelihoods was such that expensive relief and recovery operations became necessary.

The drought of 2000-01 produced several deeply felt socioeconomic effects. First of these is loss of income and unemployment in drought-affected locales such as Karakalpakistan. Unemployment became widespread, especially among women.[57] Incomes fell precipitously, sometimes by as much as 80-90%, owing to impacts upon production, primarily in agriculture. Reliance upon loans and remittances heightened. A food assessment in Georgia found that the percent of incomes obtained as loans rose from five percent to 15-20% in many households.[58]

Expenditures rose, in part due to higher food prices. Prices for cereals and milk climbed in areas where local produce had become scarce, severely affecting the food intake of children and pregnant women. Food itself was not hard to find in most markets, since traders imported it from other parts of the country and abroad. Yet fewer could afford to pay the higher prices that resulted from the drought. Meat became cheaper in some areas (briefly), owing to the slaughter of cattle by farmers that could not afford to keep their animals during the drought.[59]

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[55] FAO GIEWS, 2001, *Republic of Azerbaijan*; FAO GIEWS, 19 December 2000, *Special Report...Uzbekistan*; Regional'nyi ekologicheskii tsentr, 2002, *Mezhdunarodnoi konferentsii po problemam zasukhi i opustynivaniia: doklady uchastnikov konferentsii, predvaritel'naia publikatsiia*, p. 84.

[56] *Tsentral'naia Aziia: problemy opustynivaniia*, No. 40, June 2002; Regional'nyi ekologicheskii tsentr, 2002, *Mezhdunarodnoi konferentsii po problemam zasukhi i opustynivaniia: doklady uchastnikov konferentsii, predvaritel'naia publikatsiia*; Save The Children Georgia Field Office, 2000, *Rapid Appraisal*, p. 7.

[57] FAO GIEWS, 7 August 2001, *Special Report...Tajikistan*.

[58] UNDP Armenia, 2000, *Study of the Communities*; WFP, November 2000, *Georgia Emergency Household Economy Assessment*.

[59] FAO GIEWS, 5 October 2000, *Special Report...Armenia*; IFRC, 24 April 2002, *Georgia Drought Appeal No. 31/00, Final Report*; Medicins Sans Frontieres, 2001, *Focus Group Discussions on Food Security, MSF Aral Sea Programme Operational Research*, pp. 8-10.

Rates of poverty rose significantly. Largely due to the drought, the rural poverty rate in Georgia surpassed the urban poverty rate for the first time (moving from under fifty to over sixty percent). In drought-stricken areas surveyed by UNDP in Armenia in 2000, the estimated level of poverty rose from 55% to 77% of all households.[60]

Food security fell precipitously, requiring significant amounts of aid (see Annex 4 concerning food security and other socioeconomic impacts). In 2000 the share of the rural population in need of food aid was over half in Tajikistan, one-third in Armenia, and 30% in Georgia. In Eastern Georgia, calories per person per day fell to dangerous levels between 1999 and October of 2000, as shown in Table 16. The percentage of households in drought-affected districts of Georgia experiencing moderate or severe food insecurity was 60% by December of 2000, 64% by the next April, and 66% by August of 2001. Similarly, a survey in drought-affected areas of Armenia found that in 2000 80% of households had reduced the number of meals or substituted cheaper food.[61]

Table 16: Average calories Per Person Per Day in Eastern Georgia, 1999-2000

	Households With Small Budget			Subsistence Households		
	1999	2000	2000/1999	1999	2000	2000/1999
Dusheti	3,109	2,821	91%	2,450	2,189	89%
Gori	2,725	2,409	88%	1,829	1,800	98%
Akhaltsikhe	3,425	2,333	68%	2,059	1,961	95%
Tetri Tskaro	3,045	2,579	85%	2,400	2,334	97%
Borjomi	3,282	2,769	84%	2,076	2,346	113%
Bolnisi	4,292	3,641	85%	2,103	1861	88%
Lagodekhi	3,505	3,086	88%	2,310	1,945	84%
Dedropolistskaro	3,056	2,773	91%	2,467	1,608	65%
Akhmeta	3,305	2,336	71%	2,554	1,786	70%
Telavi	3,496	2,856	82%	2,707	2,015	74%

Source: WFP, November 2000, *Georgia Emergency Household Economy Assessment, p. 15*.

Non-income poverty rose dramatically. Women and female children had to spend additional time, as much as three hours per day, finding, fetching, and storing water in order to cope with the scarcity of drinking water supplies.[62] The health impacts of the unavailability of clean water became apparent. Diarrhea and water-borne diseases (viral hepatitis, malaria, and brucellosis) become more prevalent. Nevertheless, there was "no particular epidemic as a result of the current drought," even in areas with preexisting vulnerabilities such as Karakalpakistan, Dashhawuz Province of Turkmenistan, and Tajikistan[63].

Malnutrition became widespread. A survey conducted in Tajikistan in late autumn of 2001 found that up to 10% of adults suffered from acute malnutrition and 43% of children from chronic malnutrition. Chronic malnutrition among Armenian children rose from 13% in 1998 to 22% in 2000, with levels especially high in drought-affected districts.[64]

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[60] UNDP Armenia, 2000, *Study of the Communities*; World Bank, 10 January 2002, *Georgia Poverty Update*, *Report No. 22350-GE*, p. 22.

[61] FAO GIEWS, 19 December 2000, *Special Report..Uzbekistan*; Georgia National Center for Disease Control and Save the Children Georgia Field Office, 2002, *Nutritional Status of Children Less than Five Years of Age in Six Drought-Affected Regions of Georgia: 2000-2001, Final Report*; WFP, UNICEF, and UNHCR, September 2000, *Food Security and Nutritional Status Survey.*

[62] UNDP Armenia, 2000, *Study of the Communities*

[63] Medicins Sans Frontieres, 2000, *Drought-Related Health Assessment in Karakalpakstan and Dashoguz Veleyat – August 2000*; UNICEF, 2000, *Mission Report: Drought Assessment on Health, Water, Sanitation and Hygiene in Uzbekistan and Turkmenistan, 25 August – 4 September 2000*.

[64] Georgia National Center for Disease Control and Save the Children Georgia Field Office, 2002, *Nutritional Status*; WFP, UNICEF, and UNHCR, September 2000, *Food Security*.

The drought damaged the health of women more than that of other social groups, largely due to lower access to food. In Georgia and other countries, malnutrition among mothers became widespread, as they denied themselves food in order to give it to children, the elderly, and husbands. Anemia among females, already frequent in many locales before the drought, became prevalent in some areas (in Armenia, from 15% of women aged 15-45 years in 1998 to over half in 2000). Infant and maternal mortality, already high in many areas of Central Asia, abruptly increased in Karakalpakistan and Tajikistan.[65]

Migration from drought-stricken areas accelerated, as residents left to look for work. However, relief efforts were mostly successful in preventing wholesale out-migration, even from areas with a history of outmigration such as Karakalpakistan.[66]

3.8 Providing Relief and Restoring Livelihoods

The drought placed significant demands upon the governments of Central Asia and the Caucasus, which possessed inadequate capacity and insufficient funds to mount successful relief operations. Because plans were not in place, aid was not triggered in time, and targeting was off the mark. For example, confusion concerning the 2000 wheat harvest in Tajikistan delayed appeals for aid and made targeting problematic. The statement of a senior official of Tajikistan's agriculture ministry in September of 2000 is characteristic: "In the first few weeks of the drought, I didn't think there was a famine threat. Now I'm afraid the situation is really critical." A report on the food crisis in Tajikistan the next year noted, "Relief is being planned in an information vacuum."[67]

At least in the initial stages of relief efforts, donor agencies were also in the dark concerning the actual impact of the drought. For example, both WFP and the Government of Georgia incorrectly believed that socioeconomic drought was severe only in the eastern part of the country while planning an Emergency Operation to deliver food and agricultural inputs. This was corrected only after a Vulnerability Analysis and Mapping Unit was sent to conduct an in-depth study, which considered the complaints of local officials from other drought-stricken areas of the country.[68]

Coordination was conducted "on the spot," for lack of prior arrangements. In the countries where the drought necessitated relief operations for the population (Armenia, Georgia, Tajikistan, and Uzbekistan), the Governments created coordinating temporary commissions comprised of various ministries and linked with aid agencies and NGOs..[69] For instance, in Uzbekistan the Government in July of 2000 established a committee headed by the First Deputy Prime Minister in response to the low water level in the downstream areas of the Amu Darya River. The next year the Ministry of Macroeconomy and Statistics played the lead role in coordinating the endeavors of the commission at the central level. Coordination at local levels was assigned to province and district governments. In general, these temporary structures performed adequately, although sector coordination was at times problematic, and donor briefings and meetings were too infrequent. [70]

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[65] UNICEF, September 2000, *Food Security and Nutritional Status* Survey; Georgia National Center for Disease Control and Save the Children Georgia Field Office, 2002 *Nutritional Status of Children...Final Report.*

[66] This was the case even in areas like Karakalpakstan where emigration had begun in the 1980s owing to severe desertification. See: N.F. Glazovskiy, N.V. Kudinova, L. Yu. Odinokova, A.S. Shestakov, and V.N. Streletsky, 2000, *Migrations Induced by Desertification and Drought in C.I.S. Member* States, UNEP; *Institute for War and Peace Reporting*, August 22, 2001.

[67] *Institute for War & Peace Reporting,* 22 September 2000; IFRC, *World Disasters Report 2001*, Chapter 6. When the President of Tajikistan initially issued famine warnings in 2000, the agriculture minister suggested that farmers had underreported harvests to avoid taxation.

[68] WFP, November 2000, *Georgia Emergency Household Economy Assessment*, pp. 4-5.

[69] The Government of Armenia formed a Drought Commission, Georgia a National Drought Coordination Committee, and Tajikistan a Drought Management Team.

[70] See: UN OCHA, *Report on the OCHA-UNDP-WHO Mission to Uzbekistan, 1-7 July 2001*.

Although donor response was delayed and inadequate (in particular for recovery operations and disaster preparedness appeals), major relief operations were undertaken. Significant resources were devoted to these operations: as shown in Table 17 below, they required a total of $187.5 million, of which over half was disbursed in 2001. Tajikistan by far received the largest amount of aid. Relief and recovery operations were extended into 2002, owing to the lasting effects of the drought.

Table 17: Cost of Operations for Relief and Recovery from Drought in Central Asia and the Caucasus, 2000-01 (USD)

	2000	2001	2002	2003	Total
Armenia	4,629,195	13,771,971	882,300		19,283,466
Georgia	11,147,962	28,930,374	834,654		40,912,990
Tajikistan	34,583,923	47,864,858	21,631,220	350,000	104,430,001
Uzbekistan	2,902	22,465,000	442,673		22,910,575
Total	50,363,982	113,032,203	23,790,847	350,000	187,537,032

Note: The table does not include PRRO operations or most government contributions.

The measures adopted to address the drought in Central Asia and the Caucasus were limited mostly to relief. These included the delivery of emergency food aid, provision of potable water to households (through modifying or drilling new wells, installing pumps, or transporting water), monitoring the health of the population and providing technical assistance to local hospitals, and tax and debt relief. Some stakeholders, such as women and pastoralists, were not adequately considered in relief and recovery operations.

Recovery measures were emphasized much less than relief, in part due to lack of experience. The most common recovery measure was the distribution of seed, fertilizer, and other inputs in areas, where these were lacking for the upcoming growing season: the typical "kit" in Georgia consisted of around 100 kg of seed, fertilizer, herbicide, and money to cover land cultivation costs. Sometimes small credits were provided, such as those given to farmers in Tajikistan, which were accompanied by agricultural advisory services.[71] To the limited extent possible, relief agencies linked food aid with recovery measures.[72]

Relief and recovery operations improved during the drought of 2000-01, beginning with targeting. Community participation improved selection, particularly where village or neighborhood community bodies became involved in beneficiary selection and addressing complaints. During the drought this type of targeting became more widespread, which aided greatly in the selection of beneficiaries and monitoring of delivery. [73]

Participatory implementation helped to ensure proper governance in relief efforts. In Georgia, publicity campaigns informed the population in advance of aid through leaflets describing criteria for beneficiary

[71] Euronaid, 22 October 2002, *Food Security Programme: Technical Document for the Republic of Tajikistan.*

[72] Save The Children Georgia Field Office, 2000, *Rapid Appraisal*, p. 12; WFP, 2000, *Tajikistan: Emergency Food Assistance to Victims of Crop Failure and Drought*; —, 2000, *Emergency Operation*, p. 12; —, 2000, *Emergency Operation for Georgia*, p. 11.
World Food Programme aid components included Food For Training, in which aid recipients must undergo training in agricultural techniques and other skills, Food For Work, in which recipients provide labor for community projects, and Food For Asset Rehabilitation, which entails the rehabilitation of community infrastructure, agricultural assets, and irrigation facilities, as well as income generating activities in rural areas.
These programs were nascent, and often behind the pace of events: in March of 2001, NRCS Tajikistan was still attempting to "develop and propose sound and realistic programmes" in irrigation-related food for work activities, while seed distribution was "on hold until further notice" due to lack of donor response.

[73] ECHO, 2000, *Evaluation Food Sector, 1998/1999 and 1999/2000, ECHO Tajikistan: Final Report*; IFRC, Drought Appeal and other reports for Armenia, Georgia, Tajikistan, and Uzbekistan, 2000-03.
During the 1990s the targeting of relief efforts in many areas utilized the same categories as in the Soviet era, which are too broad for effective food relief. Moreover, district governments occasionally manipulated beneficiary lists by padding them with "dead souls."

selection, entitlements, and modalities of food distribution.[74] Although at times local authorities and elites interfered in delivery of aid, agencies attempted to monitor the situation. In Tajikistan beneficiary lists were obtained from local authorities, which were subsequently compared with NGO beneficiary lists. Food distribution and monitoring staff were put in place on the ground (after training) to work with local authorities in supervising distribution of aid.[75]

Considering that governments, donors, and stakeholders were caught off guard by the onset of the drought, it is remarkable that relief operations managed to deliver a substantial amount of food aid. Despite the difficult (and expensive) initial process of trial and error in disaster management, the urgent response required by the drought accelerated an already ongoing process of capacity building and also emphasized the need for mitigation, resulting in significant gains in disaster management during 2000-01. For instance, many countries requested support for the preparation of Natural Disaster Preparedness Plans. The only comprehensive national plan produced to date, for Kazakhstan, devotes a great deal of attention to general preparedness procedures for government, NGOs, the private sector, and the public.[76] As the drought ended, agencies began to focus their strategies more upon mitigation measures and less upon relief.

Central Asian countries began to realize the need for regional cooperation in disaster management, a process that has culminated in a regional Disaster Response Team and joint MES exercises (Armenia also participated in the latter). UNDP began to prepare a Sub-regional Initiative for Disaster Risk Management involving the Central Asian countries and Azerbaijan.[77]

Food security and poverty surveys improved impact assessment and targeting. For this purpose, the WFP sent Vulnerability Analysis and Mapping units to Tajikistan and Georgia.[78] Necessity drove relief agencies to establish food security early warning systems to determine where and when aid would be required the most. Early warning systems began operation in Tajikistan and selected districts of Karakalpakistan in 2001-02.[79]

Institutions such as the Red Cross expanded their network into rural areas and grew stronger. The experience of the Tajikistan Red Crescent Society is typical: the Society gained "organizational capacity at its grass roots level, a strengthened volunteer base, as well as a sense of ownership of the implemented activities within local communities." NGOs contributed considerably in countries that had previously fostered their development.[80] Community-based management and public awareness acquired a more prominent role in disaster strategies.

3.9 Aftermath

The impact of the drought of 2000-01 was felt in the ensuing years. Meteorological drought ended in 2002, during which precipitation returned to or even exceeded normal amounts. However, hydrological drought persisted through 2002 in many areas. For example, the Tuyamuyun Reservoir, which supplies the

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[74] IFRC, 24 April 2002, *Georgia Drought Appeal No. 31/00: Final Report*; WFP, 2001, *Emergency Operation*, p. 9.

[75] WFP, 2000, *Tajikistan: Emergency Food Assistance to Victims of Crop Failure and Drought*.

[76] Agentstvo Respubliki Kazakhstan po chrezvychainym situatsiiam, 2000, *Plan podgotovlennosti Kazakhstana k prirodnym katastrofam*. The creation of similar plans is ongoing in Armenia, Georgia, and Tajikistan.

[77] Ferghana 2003; IFRC Central Asia 2003 and 2004 Annual Reports; UNDP Sub-regional Initiative for Disaster Risk Management.

[78] Doctors Without Borders, German Agro-Action, and other NGOs also conducted or commissioned in-depth studies of various drought impacts, such as food security and health. See: FAO GIEWS, 1 August 2002, *Special Report...Tajikistan*; WFP, November 2000, *Georgia Emergency Household Economy Assessment*.

[79] IFRC Drought Appeals for Tajikistan and Uzbekistan, 2001-03.

[80] For example, Armenian NGOs were sufficiently involved to warrant the creation of a Drought Task Force of NGOs under the auspices of their main partner, the World Food Programme. WFP, 2000, *Emergency Operation Armenia*, p. 10; —, 2000, *Emergency Operation for Georgia*.

lower course of the Amu Darya River, was drawn down to 2 km3 in 2002 from 4.4 km3 in 2001. Local officials asserted that increased flows in the river in 2002 had made "no major positive impact" on irrigation in Karakalpakistan.[81]

Recovery from agricultural drought was more rapid. For instance, aggregate wheat production which is mainly cultivated on rainfed land, rose to levels higher than before the drought in all countries, excluding Tajikistan. Nevertheless, farmers had not recovered coping mechanisms in many drought-stricken areas: seed supply was short, and irrigation water supply remained problematic in downstream areas like Karakalpakistan that relied heavily upon irrigated agriculture. For example, in Karakalpakistan, cotton could be planted on only 80,000 ha in 2002, compared with 145,000 ha in 1999. The corresponding figures for rice are 100,000 ha in 1999 and 2,000 ha in 2002, in the interest of maintaining seed stocks.[82]

The impacts of socioeconomic drought were noticeable through 2003 in many areas. As noted in the 2003 UN Inter-Agency Appeal for Tajikistan, "*The end of the drought and the increased cereal production are unlikely to be reflected in a greater access of households to food. Low income levels and the dilapidation of assets (including livestock – a buffer in times of hardship) during the difficult drought have not been reversed*".[83]

Food insecurity persisted in many drought-stricken areas, which required the continuation of drought-specific relief and recovery operations in all countries in 2002 and Tajikistan in 2003 (by this date, food aid was mostly for protracted relief and recovery operations).

Drought increased vulnerability to other natural hazards. For instance, the loss of soil moisture for two years, coupled with flood conditions in the year after the drought, exacerbated the intensity of mudslides and landslides, which caused significant damage in many countries in 2002 and 2003. Drought also created favorable conditions for the spread of pests. Proliferations of pests in 2002 included a buildup of locusts in Tajikistan and a plague of termites in Karakalpakistan.[84]

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[81] IFRC, 27 September 2002, *Uzbekistan Drought Appeal No. 27/01, Final Report.*

[82] Ibid.

[83] UN, November 2002, *Consolidated Inter-Agency Appeal 2003*, p. 14.

[84] FAO GIEWS, 7 August 2001, *Special Report:FAO/WFP Crop and Food Supply Assessment Mission to Tajikistan*; IWPR, 19 July 2002, "Termite Plague Hits Karakalpakstan," *Institute for War and Peace Reporting.*

4 CONCLUSION AND STRATEGIC APPROACH

4.1 Remaining Vulnerabilities

The countries of Central Asia and the Caucasus have begun to take measures to improve drought management and mitigation. However, the regions remain at risk of incurring damages on the scale of 2000-01: exposure is high, while significant vulnerabilities remain in terms of structural factors and preparedness and capacity. The following sections analyze these vulnerabilities against the background of the drought of 2000-01, as well as ongoing projects that may help improve drought management and mitigation. These projects are listed in detail in Annex 6.

4.1.1 Exposure

Meteorological and hydrological droughts can be expected to occur with regularity. **There is a high probability that severe drought will occur again within the next decade.** Moreover, if climate change projections are correct, droughts will become more frequent and extreme. The countries of Central Asia and the Caucasus should thoroughly study climate change to determine the likelihood of drought increasing in frequency and intensity. Monitoring and early warning systems must also be upgraded (see below).

4.1.2 Structural Factors

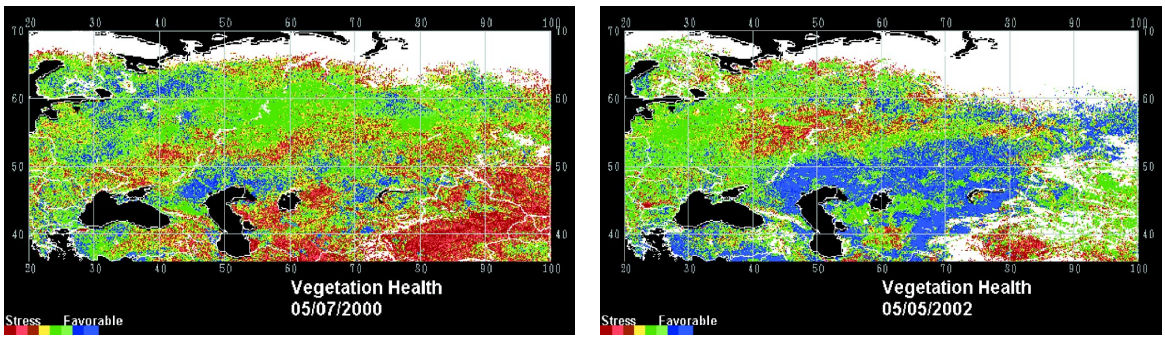
The structural factors that underlay vulnerability to drought have not been adequately addressed. Water management requires significant improvement, while most farmers and herders lack skills and resources required to mitigate drought through agro-technical and other measures. The relationship between the environment and drought remain poorly understood and thus outside the purview of development strategies. Socioeconomic vulnerability to drought remains high. Mechanisms for addressing the financing gap in risk management have not been adequately studied.

Given the present state of water management, scarcity could not be avoided in the event of another severe drought. Transboundary cooperation and integrated basin management are nascent. Due to imperfect incentives, weak institutions, and deteriorated infrastructure, water use remains wasteful. Community-based management is increasingly the focus of official policy, but the institutions require for management transfer will require time to gain in capacity. Planning and management are still based primarily upon "average-year" scenarios, with the result that agencies and stakeholders are largely unprepared for the onset of drought. Moreover, Water Shortage Response Plans (as presented in Annex 6), as well as the legal and institutional frameworks needed for their execution, are in most instances lacking.

Another severe drought would result in large-scale damage to agriculture. Experiments in introducing innovations in agrometeorology are promising (as shown in Box 1 below), yet in most countries the observation network has been decimated and remains unattended. Recent upturns in agricultural production in many countries, combined with efforts to restructure the agricultural sector, improve incentives and market access, strengthen input supply and credit, and increase off-farm employment, will contribute to agricultural diversification and increase coping capacity. However, these efforts are incomplete. Moreover, most farmers and herders lack access to a range of agro-technical drought mitigation measures. Since the

late 1990s foreign and local specialists have tested techniques in on-farm soil and water conservation, crop management, and range and herd management in Central Asia and the Caucasus. Many of these measures have not been studied in depth, and most have not yet been widely adopted. Annex 7 examines the progress in and possibilities of introducing agro-technical drought mitigation techniques into the regions.

Box 1: Remote Sensing and Agrometeorology



Source: NOAA Vegetation Health Archived Image Maps, http://orbit-net.nesdis.noaa.gov/crad/sat/surf/vci/; TACIS, October 2001, *ISEAM Information System*.

Vegetation Health

There have been efforts to compensate for the decline of agrometeorology on the ground with satellite observation, such as use of data from NOAA polar orbiting satellites that is interpreted according to a Normalized Difference Vegetation Index (NDVI). Despite the limitations of NDVI analysis, such as inadequate representation of some local features, it holds great potential for drought monitoring. The Space Research Institute of the Kazakhstan Academy of Sciences is developing drought prediction capabilities with this method, particularly in monitoring pasture resources (as during the 1995 drought). Since 1997 the Space Research Institute has produced wheat yield estimates for Kazakhstan's Ministry of Agriculture using NOAA satellite imagery. Together with projects in Kazakhstan, TACIS sponsored a pilot project in crop monitoring in Uzbekistan in the late 1990s.

Soil Moisture

For an early warning of drought conditions, many space agencies worldwide are developing soil moisture images of the land surface. The Japanese instrument AMSR-E instrument aboard NASA's EOS Aqua satellite provides images based on C band and X band images. International teams (Spain, Italy, the United States and others) are working to develop algorithms combining L, C and X bands. This work involves a tradeoff between the most useful band (L band) versus the bands deployed on global satellites providing freely available data with frequent passes (C and X bands). In addition, the freely available data is at relatively lower resolution. However, C and X have great potential: C band (6 cm) is sensitive to surface moisture; X band (3 cm) is being tested as a means to correct soil moisture images for the effect of vegetation.

Other sectors would suffer from a recurrence of drought. Because water management is not sufficiently integrated, water-using sectors such as hydropower and fisheries would incur damage. These sectors must be included into drought and water shortage planning.

Another drought would contribute to environmental degradation. It remains to study the nature and extent of these little-understood processes.

Socioeconomic damage would be significant, yet less than in 2000-01 due to improvements in relief and recovery operations. Structural vulnerability is still high: poverty remains widespread among villagers, who remain the most vulnerable segment of the population. Food security and access to household water supplies and healthcare remain tenuous is many drought-prone areas. Although the capacity to react to droughts has improved through the bolstering of emergency operations, drought management and mitigation has not been mainstreamed into the great majority of ongoing projects in the food security, water supply, and healthcare sectors that operate in drought prone areas, i.e. they are predicated upon a "business as usual" scenario.

Funding gaps remain significant and financial management capacity weak. Because the countries of the regions have little financial capacity to absorb the blow of catastrophic events, another drought would force them to appeal to the donor community for another round of expensive relief operations. It remains to find a suitable financial instrument to address the funding gap. The weak financial system in rural areas does not permit the introduction of risk financing mechanisms such as rainfall insurance.

4.1.3 Preparedness and Capacity

Although institutions engaged in disaster management planning and operations have gained significant capacity during and after the drought, they are still unprepared for slow-onset disasters such as drought. Emergency management agencies and NGOs increasingly emphasize recovery, exit strategies, and mitigation over relief. Notwithstanding this progress, lack of funding, preparedness, and coordination remain significant constraints. Regional cooperation in information exchange, forecasting, early warning, and capacity building are required. Moreover, past and ongoing natural disaster projects accord inadequate attention to slow-onset disasters such as drought: there has been little vulnerability and capacity assessment, strategy, planning, and capacity building directed specifically at strengthening drought management and mitigation. There is also still too much focus upon recovering from drought rather than being less susceptible to the effects of a drought.

Early warning systems for hydrological and meteorological drought have improved considerably in Central Asia. Since the drought the Gidromets have received significant foreign aid. In the Caucasus, projects with German, USAID and TACIS support are contributing to upgrading the stream flow observation network. In Central Asia, donors have been more active. USAID, NOAA, the Swiss Agency for Development and Cooperation, World Meteorological Organization, and World Bank have made significant investments into various upgrades in the meteorological and hydrological observation and data transmission systems in Central Asia, as well as training Gidromet staff in the new technologies. Most Gidromets in Central Asia report that their communications abilities are greatly improved, with information exchange times reduced as much as tenfold, while the accuracy of river flow forecasts have risen by 20-50% and that of weather forecasts by 5-20%.[85] While bulletins have become more timely overall, they need also to contain essential information necessary for agriculture, since it is the largest water consuming sector, taking into account the stage of the crops, agricultural operations in progress, prevalence of pests and diseases, and the immediate impact of weather on crops.

Although the capabilities of Gidromets have been strengthened, significant needs must be addressed to improve readiness for another drought. Although the monitoring network has improved in Central Asia, there are still critical needs to be addressed, particularly in remote mountain areas of this region.[86] The monitoring network of the Caucasus still requires an overhaul. Moreover, the institutional rigidities that prevented quick reaction by the various agencies are still largely in place because much of the vertical communication and organizational structure has not been changed. There have been sporadic efforts at reforms, but these generally meant that the entities remained with the same tasks and responsibilities and tall vertical structure, without clear points of interface to other agencies at lower levels and a direct channel to the public. Data management is weak in all areas, while data sharing has only begun in Central

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[85] PA Consortium Group, 29 February 2004, *Data Transmission Systems for the Syr Darya and Amu Darya River Basins: Status Report for the period from Inception to February 29,2004*.

[86] V.E. Chub, 2002, "Exchange of Hydrologic Data and Information among Aral Sea Basin States," in ADB, September 2002, *Cooperation in Shared Water Resources in Central Asia: Past Experiences and Future Challenges. Papers Presented at the Asian Development Bank Regional Workshop in Almaty, Kazakhstan 26-28 September 2002*.

Asia and is hardly practiced in the Caucasus. Community involvement in data collection and early warning is nonexistent in most areas.[87]

However, funding is lacking for most of these much-needed improvements. For example, because it could not cover the cost of communications, in 2002 Tajikistan stopped transmitting hydrometeorological information to Uzglavgidromet. According to the head of the latter agency, this has "caused major difficulties in providing information and forecasts on the Amu Darya river basin."[88]

4.2 Towards a Drought Management and Mitigation Strategy

Despite improvements in various aspects of drought management and mitigation since the drought, the countries of Central Asia and the Caucasus remain vulnerable to this natural hazard. **If the status quo is permitted to continue, large-scale damage can be expected from the next significant drought, which will necessitate yet another round of expensive relief and recovery operations. Thus, the countries of Central Asia and the Caucasus would benefit significantly from a drought management and mitigation strategy.**

4.2.1 Approach

A drought management and mitigation strategy should seek to enhance capacity in the most crucial areas of disaster management and address remaining structural vulnerabilities. Because of the significance of structural factors, as well as the many ongoing efforts to address them, the success of the strategy will in part hinge upon the ability to integrate drought management and mitigation into these activities. This in turn will entail significant donor coordination. (Related projects are presented in Annex 6.) A drought management and mitigation strategy should promote a more preventive, risk management approach to drought management, focusing upon improving mitigation through the reorientation of national development programs, as well as the strengthening and coordination of emergency management.

A wide range of plans must be integrated in order to achieve an effective drought management and mitigation strategy. The core of the strategy is a National Drought Plan, which must necessarily be harmonized with food security strategies, water shortage response plans, and master plans for development. The National Drought Plan should in turn be integrated into a Natural Disaster Response Plan. Figure 6 below presents the relationship of the various types of plans that will be required, as well as the agencies responsible for them.

The creation of a drought management and mitigation strategy must involve coordination of inputs and data collection from a variety of agencies. However, there is no need to create new institutions, which will require significant time and effort. A ten-step process,[89] adopted for developing national- or agro-climatic region-based drought preparedness plans by official agencies, could be employed in Central Asia and the Caucasus with appropriate modifications. The steps are as follows:

1. Constituting a National Drought Task Force
2. Announcing the General Purpose and Approaches of the Task Force

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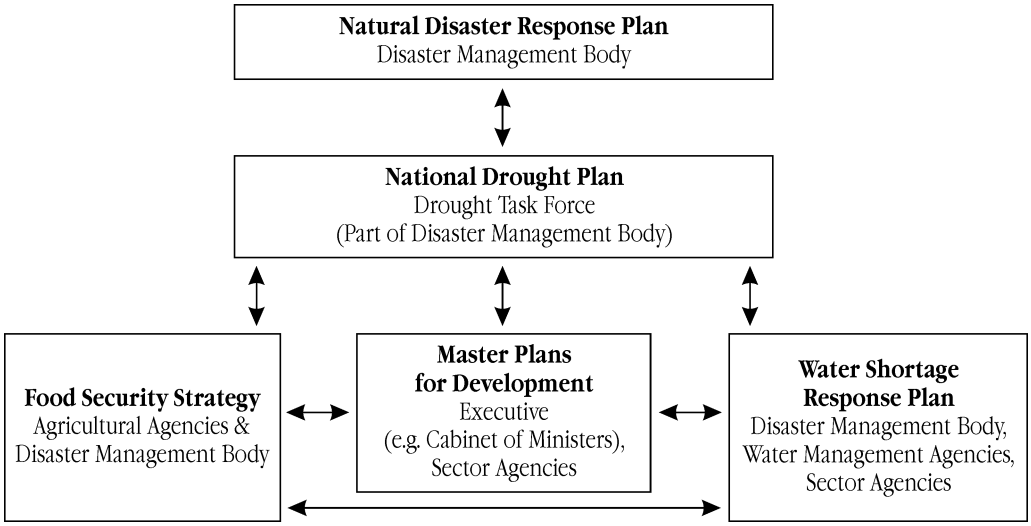
[87] UNECE and GWP, 30 November 2002, *Integrated Water Resources Management (IWRM) Including Transboundary River Basin Issues: Background Paper for the Environment Strategy of the 12 Countries in Eastern Europe, the Caucasus, and Central Asia (EECCA).*

[88] Chub, 2002, "Exchange of Hydrologic Data and Information among Aral Sea Basin States."

[89] The process was originally created by Dr. Donald Wilhite in 1991 and subsequently revised and updated. See: The National Drought Policy Commission's report, Preparing for Drought in the 21st Century, For Wilhite, D.A.; and S.L. Rhodes. 1994. State-level Drought Planning in the United States: Factors Influencing Plan Development. *Water International* 19(1):15–24.

Figure 6: Linkages Between Drought-Related Plans and the Agencies Responsible for Them



Note: The figure specifies only the relationships plans as they relate to drought.

3. Task Force Developing Organizational Structure and Preparing Drought Plan
4. Integrating Science and Technologies, Policy, Filling in Institutional Gaps
5. Develop Organizational Structure and Prepare Drought Plan
6. Integrate Science and Policy, Filling in Institutional Gaps
7. Implement the Plan
8. Develop Knowledge Dissemination Programs
9. Allocate Resources, Coordinate External (International) Aid Funds
10. Post-Drought Evaluation

Annex 5 presents the details of this 10-step process.

Although drought is regional phenomenon, it is infeasible to create new institutions at this level. Given present relations in the regions, regional institutions lack the necessary authority to reconcile conflicting demands. Moreover, in Central Asia, a new regional institution would result in overlaps with regional institutions created by ongoing and pipeline projects that already seek to address structural and other vulnerabilities at regional level. For example, the Strategic Partnership for UNCCD Implementation works towards mitigating desertification, and in Central Asia the Interstate Commission for Water Coordination is responsible for transboundary water allocation (Annex 6 lists these and other related projects). National Drought Task Forces should work in cooperation with these institutions. Regional activities that are feasible include data sharing and regular consultation (which can be facilitated through conferences and workshops).

Increasing stakeholder participation in institutions is essential. Many stakeholders are still excluded from critical aspects of decision-making, management, and implementation. However, as the role of the state has declined in key sectors and areas, the importance of community responses to drought has grown. Moreover, community managed institutions that possess adequate capacity and resources are capable of responding in a more flexible, swift, and well-targeted manner.

An emerging drought mitigating and management strategy for Central Asia and the Caucasus would include the following four pillars:

- **Mainstreaming drought management and mitigation into national development strategies and sector projects.**
- **Strengthening hydrometeorological monitoring, forecasting, and early warning systems**
- **Developing coordinated emergency response and recovery systems**
- **Developing longer term forecasts and strategies to address climate change**

4.2.2 Mainstreaming into National Development Strategies

The first steps in the process are to identify potential sources of the risks associated with drought and to assess their potential cost. Based upon the foregoing analysis, it is clear that the cost incurred from agricultural drought and the expense of relief operations to alleviate the impact of socioeconomic drought in 2000-01 was significant (as shown in Table 18 below). However, the data available to this study is not complete and disaggregated sufficiently enough to precisely identify many risks and impacts. Thus, it remains to determine many important sources of risk (in particular climate change) and costs associated with drought impacts (such as impacts upon livestock, hydropower, fisheries, health, society, and the environment).

The costs and benefits of various drought management and mitigation measures should then be considered in order to target key sectors and drought-prone locales. Targeting is required not only to achieve the greatest effect in reducing structural vulnerabilities and improving response, but also to minimize the amount of inertia and resistance to mainstreaming on the part of various sector and other agencies (the latter of which will inevitably arise as a result of administrative "turf wars" and will require a determined political will to overcome).

Table 18: Costs of Drought in Central Asia and the Caucasus, 2000-01

Countries	Water Deficit, 1999-2000		Losses Due to Drought in 2000-01			Cost of Relief and Recovery Operations, US$ millions, 2000-2002
	cubic km	as % deviation	In US$. million	As % of GDP	As % of Ag GDP	
Armenia	-	-30*	110	2.7	10.1	19.3
Azerbaijan	-	-	110	1	6	
Georgia	-	-	350	6	25.5	40.9
Kazakhstan	-	-				
Kyrgyz Republic	-	-				
Tajikistan	0.7**	-11**	100	4.8	16.8	104.1
Turkmenistan	4.6**	-30**				
Uzbekistan	5.8**	-37**	130	0.8	2.4	22.9

* Kura Araks 1999
** Amu Darya 2000

Drought management and mitigation measures should then be incorporated into strategies for development. Based upon the cost-benefit analyses, measures to reduce structural vulnerabilities and improve response can be included into infrastructure investment decisions, macroeconomic projections (such as for debt repayment), and development plans, implementation strategies, and lending instruments. These analysises should also form part of the work of preparation of Poverty Reduction Strategy Papers (PRSPs) and an assessment of vulnerability to drought should be part of poverty assessment work. They also should be utilized in finding a suitable financial instrument to address funding gaps. International donors should facilitate and support proactive risk management in development planning, as well as adopt a more proactive stance in their own projects (as described below).[90]

[90] For more concerning the assessment of the economic costs of natural disasters and cost-benefit analysis concerning mitigation and risk financing measures, see: Paul K. Freeman, Leslie A. Martin, Reinhard Mechler, Koko Warner, and Peter Houseman, June 2002, *Catastrophes and Development: Integrating Natural Catastrophes into Development Planning, World Bank Disaster Risk Management Working Paper Series No. 4*.

Because of the severe impact of hydrological, agricultural, and socioeconomic drought in many rural areas, strategies and activities in water management, agriculture, rural development, and food security should be at the core of mainstreaming efforts to address structural vulnerabilities. Since public resources are still very limited, the focus needs to be upon supporting policy and incentive measures (such as to use land and water resources rationally), fostering institutional development (such as community based initiatives for developing sustainable land and water management practices), adapting existing technologies to combat drought, and rehabilitating key infrastructure. Activities in these areas have begun in most countries**.** Results need to be carefully monitored and programs adapted and mainstreamed as appropriate into public expenditure programs.[91]

Drought management and mitigation must be integrated into efforts to address structural vulnerabilities and improve response in water management. Water resource management measures for drought management and mitigation can be broadly classified into demand management, supply management, and impact minimization measures. Other dimensions that must be accounted for while planning specific actions include differentiation between proactive (i.e. development planning) and reactive (i.e. contingency planning) measures, as well as clear linkage with specific end users of water resources (sectors, vulnerable populations in drought prone areas). [92]

Given the wasteful management and use of water in Central Asia and the Caucasus, structural vulnerabilities to drought in the water sector could be best reduced through demand management measures. Measures that could reduce demand for water in Central Asia and the Caucasus over the long term include:

- Integration of all sectors, including land management, agriculture, hydropower, and fisheries, into management structures based upon watersheds;
- Introduction of an incentive structure that rewards efficient water use;
- Removal of subsidies and reduced support for programs favoring water-intensive crops and farming practices as opposed to water conserving and rainfed practices.
- Dissemination of sustainable water conservation methods and technologies;
- Transfer of the management of former "on-farm" irrigation and drainage systems to communities, accompanied by long term training of agencies and water users, as well as grants programs for equipment and system upgrades; greater attention to preventative maintenance, scheduling, water measurement, and inexpensive technological upgrades at the local level;[93] and

The most necessary impact minimization measure is the creation of contingency plans for water shortage at the local and national levels. (Annex 3 presents a simple, generic contingency plan.) If regional cooperation develops, contingency plans at this level may eventually become possible and provide further impetus to transboundary cooperation.

Due to the limited funds available for infrastructure development, there is limited scope for expensive supply management measures. Improving the management of hydroelectric dams and other impoundment structures, primarily through reconciling sector, upstream, and downstream interests is

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[91] Examples of programs supported by the World Bank include the Natural Resources and Poverty Alleviation Project in Armenia, the Community Agriculture and Watershed Project in Tajikistan, and the Drylands Project in Kazakhstan. Water management projects include the Drainage and Wetlands Rehabilitation Project in Uzbekistan, which supports improved use of drainage water and restoration of wetlands for fisheries and pasture recovery, and drainage and irrigation rehabilitation. These all support improved water management and conservation.

[92] These are elucidated in greater detail in: Mohammed Bazza, 2002, "Water Resources Planning and Management for Drought Mitigation," FAO Regional Office for the Near East.

[93] For instance, the USAID-sponsored Natural Resources Management Program's On-Farm Water Management component has developed sensor measuring devices and parabolic chutes for water measurement in Uzbekistan at a cost of around $12/ha for installation.

at present more important than developing and refurbishing these structures. Delivery systems, particularly those being rehabilitated in drought-prone areas, might be designed for greater storage and variability of flows. The provision of safe and reliable household water supplies should receive priority in rural infrastructure development to reduce vulnerability to socioeconomic drought. Inexpensive on-farm water harvesting and detention technologies, such as that described in Box 2, should also be introduced.

Box 2: Agro-Technical Measures – Erosion Control and Water Detention

Erosion control and water retention and detention structures take many forms. Simple brushwood or grass hedges can be built across gullies to prevent erosion, prevent water loss and enhance percolation to promote aquifer recharge (see Figure 1 below) Stone check dams are also built across gullies in Kaolinitic Alfisols but not on Montmorillonitic vertizols or high clay or loamy soils and lands with slope of >3%, and with high rainfall intensity. Stone check dams invariably require reinforcement with vegetative brushwood and grass cover to protect scouring around the stone header line. (see Figure 2 below). These are cheap, can be constructed with locally available materials, and do not require a high level of engineering designs and skills for construction. Windbreaks and shelterbelts can also be very useful (Picture 1).

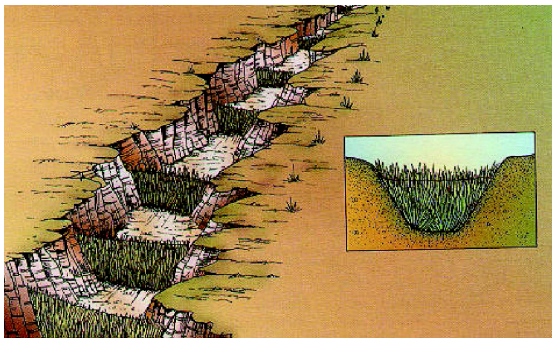


Figure 1. Grass hedges grown across gullies

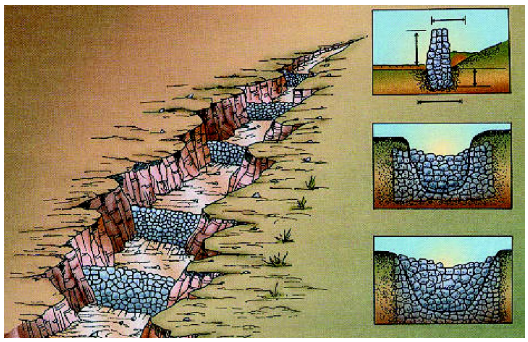
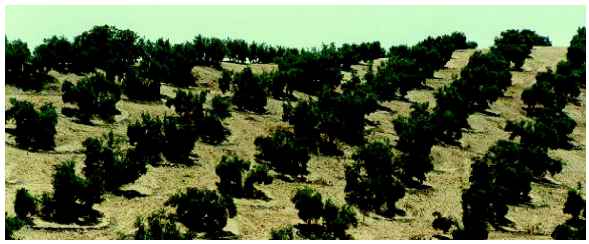


Figure 2. Stone check dams built across gullies

Water retention structures to protect agricultural crops from drought include ridges-and-furrows, basins, and water spreading. Landscape contouring is sometimes used to direct runoff into areas planted with trees, shrubs, and turf. For tree crops, measures include saucer basins (see Picture 2), semi-circular bunds, crescent-shaped bunds, catch pits and deep pitting. Rainwater harvesting collects rainfall or moisture for immediate or eventual use in irrigation or for domestic supplies (part of the rainwater collected from roofs can be stored in a cistern or tank for later use).

Pic 1: Shelterbelts reducing wind evapotranspiration



Pic 2: Soil conservation using rings and basins in and olive grove

Several ongoing projects are making an effort to address areas of water management that will strengthen resilience to drought. However, these efforts are incomplete and are not explicitly linked to drought management and mitigation. If water planning and development continue upon a "business as usual" trajectory, water managers will again be caught off guard by the onset of the next drought.

A range of drought management and mitigation measures can reduce structural vulnerabilities and improve response in agriculture. Future and ongoing activities to restructure the agricultural sector, improve market incentives and market access, strengthen input supply and credit, enhance rural development, and disseminate technologies should consider the costs and benefits of drought management and mitigation measures, and incorporate them when appropriate. Community watershed planning, as practiced for rainfed areas of India, should also be introduced.

All countries would benefit from the dissemination of technologies to combat drought in agricultural production, based upon the various characteristics of agricultural drought impact in different areas. An option in this instance is to support ongoing participatory research by CGIAR institutions such as ICARDA and CIMMYT, in accordance with the vulnerability profile of agriculture in drought-prone areas. A classification of preliminary agro-technical measures for farmers is found in the matrix on the following page. Details concerning measures to be taken by both farmers and herders are presented in Annex 7. Many of these technologies are already employed in the region, but need to be more widely adopted.

Farmers and herders in rainfed areas, owing to their high vulnerability, require special attention. In irrigated areas, the focus of agro-technical measures should be upon reducing the exorbitant level of water use at the field level. But irrigated areas were not hit as hard or as suddenly as remote rural areas relying mostly on rainfed agriculture. In order to prevent catastrophic agricultural drought from repeating itself in these areas, rainfed cropland and rangeland must receive greater attention (heretofore most has been accorded to irrigated agriculture). Farmers and herders in these areas also need to adopt new agricultural techniques that make much better use of the limited rainfall by increasing the vegetative cover, reducing open tillage or plowing, as well as introducing vegetative barriers between parcels with trees and bushes to limit soil erosion from wind and water as well as increase water retention. Lessons that will be learned from implementing the World Bank's Community Agriculture Watershed Management Project in Tajikistan will provide a demonstrative effect from which other mountain areas can learn.

Table 19: Suggested Agricultural Practices Based on Topography and Climate Characteristics in CAC

Rainfed Low Lying Lands	**Rainfed Mountain Areas**
Altitude: < 750m altitude – **Annual Precipitation** ~660 mm	***Altitude*** *>750m and* 1250m altitude and ***Precipitations****: < 660 mm precipitations*
■ Establish Community Watershed Association and prepare a watershed based resource conservation and utilization plan. ■ Enhance in situ water harvesting structures to recharge the soil profile and aquifers through gully plugs and bunds. ■ Establish non smothering hedge trees (preferably leguminous) as wind break to maintain microclimate and reduce evapotranspiration, and providing green fodder for feeding livestock during drought, timber and fuel from lopping; ■ Take up geological survey for the aquifers, demarcate the area and arrange to tap the aquifer through boreholes and deep immerse pumps for a) drinking water and if adequate water is there for limited irrigation wells. ■ Improve soil organic matter level by incorporating stubbles and crop residues back in to the field and encourage farm yard manure water use ■ Improve on-farm irrigation efficiency; if possible recycle the drainage water mixing with fresh irrigation water. ■ Adopt multiple cropping systems and introduce inter-cropping. ■ Establish sustainable farmer's service association such as WUAs, watershed association, seed association, as dissemination instruments	■ Establish Community Watershed Association and prepare a watershed based resource conservation and utilization plan. ■ Delineate forest area, and mark out wooded lands and develop water harvesting structures like ponds and water bodies to hold the runoff water. Plant series of hedge plants at 1 to 1.5 m contour fall and reinforce with inter sub-biological bunds using deep rooted non-runner grasses such as *Jiji grass (Achnatherum splendens (Trin),* at 0.3 to 0.5 m contours. ■ Adopt Watershed based community activity to conserve soil and water, to share the water ways and to use stored water collectively micro water harvesting systems in the upper catchments. ■ Level out all the on-farm rills and use contour based terrace/bed formation across the major slope of the land – make the water to crawl across the slope than to allow it to run along the major slope. Introduce on the terrace trees of economic importance-(fruits/nuts) with intercropping of annuals preferably rotating with pulses with cereals. ■ Introduce Intensive pasture development in upper catchments, with rotational compartmental grazing within the community lands as a whole and on private land and livestock production ■ Within the terrace adopt ridge and furrow system for cropping. ■ Farm land be adopted to promote essentially horticulture or livestock based or mixed farming system

Arid Irrigated Lands
Altitude: < 750m
Annual Precipitation: ~500 mm

- Establish sustainable farmer's service association such as WUAs, watershed association, seed association
- Establish non smothering hedge trees (preferably leguminous) or mulberry trees along the canals and farm boundaries as wind break to maintain microclimate and reduce evapotranspiration, besides getting green fodder for feeding livestock during drought, mulberry leaves for silk worm rearing to get additional income and timber and fuel through lopping;
- Improve on-farm irrigation efficiency, if possible recycle the drainage water mixing with fresh irrigation water
- Adopt multiple cropping system and introduce inter-cropping .
- Improve productivity, with improved varieties and more intensive agriculture, adopt multiple cropping system and introduce inter-cropping with early maturing high yielding hybrid crops – enhance the current cropping intensity of less than 80% to 160 by mixing invariably rotation of cereal, pulses, commercial crops like cotton, oilseeds, or medicinal crops.
- Improve soil organic matter level by incorporating stubbles and crop residues back in to the field to enhance quality and the water holding capacity of the soils, adopt IPM method
- Establish the farmer's service organizations for input supply including the high yielding variety of seeds and quality fertilizers.

Irrigated Lands
Altitude: < 750m
Annual Precipitation: > 660 mm

- Establish sustainable farmer's service association such as WUAs, watershed association, seed association
- Establish sustainable farmer's service association such as WUAs, watershed association, strive to expand area under protective irrigation.
- Improve conveyance efficiency of main and secondary irrigation canals by lining of canals from the current less than 60% to above 80%; improve on farm irrigation efficiency from the current less than 50% to above 75% by adopting the border strip method of land configuration and using ridge and furrow method for crop management,
- Wherever possible, recycle the drainage water mixing with fresh irrigation water
- Improve soil organic matter level by incorporating stubbles and crop residues back in to the field. of the increasing the Farm Yard manure water use
- Adopt multiple cropping system and introduce relay cropping and intercropping to enhance cropping intensity from the current less than 80% to at least 200%.
- Adopt intensive agriculture practices and enhance the current cropping intensity level of less than 80% to 200% by introducing a commercial crop of 145 days (cotton) followed by a crop of oilseed (Peanut) or hybrid Sunflower or sesame, or relay crop with region peas and invariably rotating of cereal, pulses. Commercial crops adopting always improved varieties and more intensive agriculture, adopt multiple cropping system and introduce inter-cropping with early maturing high yielding hybrid crops –
- Establish farmer's service organizations to cater to the needs of the farm input/output.

Drought mitigation should be built into food security strategies. Strategies should focus upon nutritional needs in drought-prone areas, likely drought impacts, and long-term mitigation measures (many of which are described above), as well as information and early warning systems (which are described below).

Financial systems, especially in rural areas, are too weak for the introduction of risk financing mechanisms such as rainfall insurance. However, the development of savings and credit, especially in remote areas, would improve resiliency to drought. Activities aimed at the development of financial systems should be designed to facilitate the smooth introduction of risk financing mechanisms after a sufficient stage of development has been reached.

Environmental assessment and amelioration efforts should seek to explore more fully ways to mitigate the effects of drought upon the environment. The first step in this process is to better establish the linkages between drought and the environment. Then measures can be worked out and implemented. This process should be coordinated with and incorporated into ongoing projects in desertification, biodiversity, land degradation, water quality, and climate change.

Social welfare and outreach initiatives should be directed towards improving resiliency in drought-prone areas. Measures should be targeted to help the most vulnerable population withstand the impact of drought *before* it occurs. For example, social funds and community works projects could incorporate drought management and mitigation into their "menu of options" especially in rainfed areas where

livelihoods can be quickly threatened by lack of timely rains. A major gap remains "mainstreaming" community outreach into drought planning and mitigation programs.

4.2.3 Hydrometeorological Monitoring, Forecasting, and Early Warning Systems

Hydrometeorological monitoring, forecasting, and early warning can benefit from several types of measures. These are listed below:

- Further identification of and filling gaps in the observation network;
- Institutional reform of the vertical communication and organizational structure through decentralization, improved coordination, and increased public participation.
- Involvement of the population and civil society organizations in data collection;
- Creation of community-based and intermediate level early warning systems, including the examination of formal and informal institutions in districts and communities for suitability as agents of local level early warning in drought-prone locales;
- Rehabilitation of agro-meteorological networks and examination of the feasibility of introducing new technologies, such as NDVI observation (as described in Box 1 above);
- Improvement of data management;
- Facilitation of regional and local level exchange and coordination of data and dissemination of data to the public, which should be part of data exchange for disaster management;
- Prioritization of decision support systems to transform the collected data into operative information; and
- Creation of monitoring products that are better adapted to the needs of specific end users (see Box 2 below concerning bulletins for crop production).

The highest priority for improvement is in the Caucasus region, especially regarding information exchange between countries and for system improvement within Georgia. Given the frequency of floods and frost, these aspects of disaster management must also be taken into account while making improvements in meteorological, hydrological, and agrometeorological early warning systems.

Box 3: Drought Bulletins for Crop Production

Bulletins need to be prepared in consultation with the experts of the Ministry Agriculture and broadcast over National Radio and TV system. Agromets in the various countries and for the various regions may try to develop an aridity anomaly index (AI) developed on the lines of Thornthwaite's concept used to monitor the incidence, spread, intensification, and recession of drought.

AI is given as

$$AI = [(PE - AE)/PE] \times 100$$

Where PE is potential evapotranspiration calculated with the help of Penman's formula, which takes into account mean temperature, incoming total solar radiation, relative humidity, and wind speed. AE is actual evapotranspiration calculated according to Thornthwaite's water balance technique, taking into account PE, actual rainfall, and field capacity of the soil.

The aridity anomaly is calculated by using the normal Aridity Index for all the met stations over the country. The arid areas are demarcated as follows:

Aridity Anomaly	Areas
0 or Negative	Non-Arid
1-25	Mildly Arid
26-50	Moderately Arid
> 50	Severely Arid

Biweekly aridity anomaly reports are to be prepared for the country as a whole during the main (precipitation) season. These anomaly reports need to be widely circulated to various users.

4.2.4 Coordinated Emergency Preparedness, Response and Recovery

Emergency preparedness, response, and recovery should focus more upon medium- and long-term measures. Many emergency response efforts do not accord enough attention to prevention and mitigation efforts. This has delayed economic growth and resulted in repeat emergency loans and reconstruction.[94] Medium- to long-term recovery components of emergency response operations should be harmonized with mainstreaming efforts in the sectors noted above.

Planning for emergency response should become more coherent and comprehensive. Legislation, procedures, and authorities for emergency relief measures and management of the economy must be worked out *before* the onset of drought. All affected sectors should be taken into account. Logistics for relief operations should be as simple as possible, rapidly executable, and unburdened by conditionality. Procurement procedures should be flexible.[95] It also remains to integrate drought management and mitigation measures into general natural disaster response plans, as well as to link drought management and mitigation measures with associated natural disaster phenomena. These include floods and mudslides, which commonly follow droughts, especially in mountain areas, as well as snow blizzards (*zud*) that often kill livestock which have not been sufficiently fattened during summer months.

The strengthening of vulnerability and capacity and impact assessments would make emergency response more effective. Vulnerability and assessments are required to target relief/recovery expenditures most effectively when disasters occur. However, accurate assessments are lacking in most countries. Improving assessment capacity will also aid the data collection and cost-benefit analysis required for mainstreaming drought management and mitigation into development strategies to address structural vulnerabilities.

Institutional strengthening and coordination are required to streamline operations and make them more flexible and responsive. Most countries have improved their disaster management institutions, but they need to be reinforced, with real information exchange and cooperation between agencies at both the central and local levels. The fragmented institutional structure should be made coherent and coordinated. This will necessarily be a medium- to long-term process.

Community involvement in drought response actions is critical. Much greater community participation and support are required to increase the effectiveness of response, while empowerment of stakeholders is needed to ensure that populations in drought-prone areas do not become permanently dependent upon relief operation aid. [96] Capacity building efforts should include measures to train stakeholders in risk planning and management. (For farmers and herders, this can be done through mainstreaming drought management and mitigation into initiatives to establish or improve advisory services.)

Rainfed areas, especially in the mountain areas of the Caucasus and Central Asia contain some of the most vulnerable populations to drought and are often subjected to catastrophic floods and mudslides that frequently follow drought. These communities need to be much more aware of their vulnerability and must be better integrated into disaster prevention and management.

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[94] Roy Gilbert and Alcira Kreumer, 1999, *Learning from the World Bank's Experience of Natural Disaster Related Assistance*, *Disaster Management Facility Working Papers Series No. 2*, May 1999.

[95] These are lessons learned from previous World Bank drought relief and recovery projects. See: World Bank, 2002, *Technical Annex for a Proposed Credit to the Republic of Malawi for an Emergency Drought Recovery Project*, September 30, 2002; World Bank, 2002, *Technical Annex for a Proposed Credit to the Republic of Zambia for an Emergency Drought Recovery Project*, October 28, 2002; World Bank, 1995, *Zimbabwe Drought Recovery and Mitigation Project (Credit 2399-ZIM): Implementation Completion Report*, December 20, 1995

[96] Where these are lacking, as in some areas of Zimbabwe, households "receive drought relief more or less permanently, which has tended to reinforce these households' dependency on government largesse and to act as a disincentive for them to prepare for future droughts." See: World Bank, *Understanding Poverty and Human Resources in Zimbabwe: Changes in the 1990s and Directions for the Future*, *Human Development Group Discussion Paper No.* 25490, December 1996, p. 41.

It is critical that the knowledge from the first two "pillars" of the proposed strategy flows into the third. For example, hydrometeorological monitoring is required to provide information to trigger responses (as shown in the sample contingency plan Annex 3). Precipitation 15% below normal would lead to more intensive monitoring of water resources, crops and pastures; reductions of 15-25% would activate impact task forces, media campaigns, a revision of reservoir operations and ground-water extraction regimes and water and crop restrictions, and more extreme droughts to inter-agency and relief responses and financial analyses of impact on output and government revenues. It is important that all stakeholders understand the triggers and measures linked to them. Lessons learnt from the 2000-2001 drought concerning inter-agency cooperation need to be taken into account in developing emergency preparedness programs.

Food security data management and early warning systems are required to determine the amount of aid necessary and target it effectively. Crop-yield prediction and the harmonization, collection, transfer, and management of data must be improved. Important data, such as quantities of required storage and food quality, is often inaccurate or absent. Food security early warning systems have been established in Karakalpakistan and some locales of Tajikistan. However, these are lacking in many other drought-prone areas.

4.2.5 Climate Change

The governments of Caucasus and Central Asia should adopt strategies to make their economies more robust to long-term climate change. At the moment, Central Asian agriculture is heavily dependent on snow and glacier melt. Present, very imperfect forecasts indicate that in the medium term, as glacier melt accelerates, there may be increased water available, but in the longer term greater dependence on precipitation will increase seasonal and annual variability. Agriculture must adapt itself to the level of water resources supplied by regional precipitation. Second, hydrological forecasting must be set on a firmer base. According to the IPCC (International Panel on Climate Change) report, *Regional Impacts of Climate Change,* climate change scenarios as yet do not provide a basis for prediction of how regional hydrology will change. Given the complex feedbacks in the system, observation will provide an answer before modeling does. It is therefore of great importance that hydrological networks be restored, the countries of the region improve data sharing and cooperation, and hydrological models be updated, to give direction to further adaptation measures. These efforts should be coordinated with and integrated into ongoing activities to explore various dimensions of climate change, such as the UN Convention to Combat Climate Change.

4.2.6 Short-, Medium-, and Long-Term Measures

In order to properly sequence measures, they should be conceived in various dimensions. Chief among these is categorization into short-, medium-, and long-term measures. The matrix below presents such a classification of these measures. Another dimension to be considered is the split between cyclical and structural changes. The former are more are more organizational in nature, while the latter often have significant policy implications.

Table 20: Matrix of Short-, Medium-, and Long-Term Drought Management and Mitigation Measures

	Short Term	Medium Term	Long Term
Preparation of Drought Strategy	Create National Drought Task Force Prepare Drought Plan Implement Drought Plan Develop knowledge dissemination programs	Implement Drought Plan Update Drought Plan Integrate	Implement Drought Plan Update Drought Plan Assess effectiveness of Drought Plan following drought and adjust accordingly

Mainstreaming into National Development Strategies	Identify potential risk sources and assess of potential costs of the risks Cost-benefit analysis of measures Incorporate drought management and mitigation into master plans for development (CAS, PRSP, CEM)	Implement drought-conscious master plans for development Mainstream and fund national institutions and Academia to evolve technologies for alternate farm production models and water conservation technologies	Implement drought-conscious master plans for development Assess effectiveness of master plans for development following drought and adjust accordingly
Mainstreaming into Water Management	Develop contingency plans Improve transboundary cooperation Strengthen management of dams Improve incentive structure in water use Disseminate water conservation methods and technologies Improve design of I&D systems targeted for rehabilitation Provide safe and reliable household water supplies	Integrate sectors into basin management Improve transboundary cooperation Strengthen management of dams, reservoirs, and conveyance infrastructure Improve incentive structure in water use Disseminate water conservation methods and technologies Promote and organize local agencies to provide safe and reliable household water supplies Transfer management to communities	Integrate sectors into basin management Transfer management to communities Assess effectiveness of measures following drought and adjust measures accordingly
Mainstreaming into Agriculture	Restructure production cooperatives Eliminate production quotas Improve incentives and market access Adopt policies to promote and strengthen input supply and credit through active private sector participation Disseminate mitigation technologies Introduce community watershed planning	Restructure production cooperatives Eliminate production quotas Improve incentives and market access Strengthen input supply and credit Diversify production systems Create off-farm employment Disseminate mitigation technologies Introduce community watershed planning Create participatory institutions	Diversify production systems Create off-farm employment Create participatory institutions Assess effectiveness of measures following drought and adjust measures accordingly
Mainstreaming into Food Security	Assess nutritional needs Assess likely drought impacts Develop mitigation measures and coordinate with ongoing efforts in agriculture Improve data management Create early warning systems	Support mitigation measures in coordination with ongoing efforts in agriculture Improve data management Create early warning systems	Support mitigation measures in coordination with ongoing efforts in agriculture Assess effectiveness of measures following drought and adjust measures accordingly
Mainstreaming into Financial Management	Eliminate directed credit	Develop financial systems capable of handling risk financing mechanisms	Develop financial systems capable of handling risk financing mechanisms Introduce risk financing mechanisms Assess effectiveness of measures following drought and adjust measures accordingly

Mainstreaming into Environmental Assessment and Amelioration	Establish linkage between drought mitigation and NEAP. Establish linkages between drought and environmental degradation Incorporate drought management into ongoing projects in desertification, biodiversity, land degradation, water quality, and climate change Work out and implement mitigation measures for the environment	Incorporate drought management into ongoing projects in desertification, biodiversity, land degradation, water quality, and climate change Promote policies to implement mitigation measures for the environment	Implement mitigation measures for the environment Assess effectiveness of measures following drought and adjust measures accordingly
Mainstreaming into Social Development	Integrate drought management and mitigation into targeting for social programs in drought-prone areas Establish and implement drought mitigation measures for social funds and community works projects Create drought-conscious community outreach programs Integrate with long-term recovery measures of emergency response efforts	Implement drought mitigation measures for social funds and community works projects	Assess effectiveness of measures following drought and adjust measures accordingly
Strengthening of Hydrometeorological Monitoring and Forecasting Systems	Identify and fill gaps in observation network Involve population and civil society organizations in data collection Create community-based and intermediate level early warning systems Improve data management Facilitate regional and local level data sharing and coordination of data dissemination to public Prioritize decision support systems Create monitoring products tailored to specific end-users	Reform communication and organizational structure Create community-based and intermediate level early warning systems Facilitate regional and local level data sharing and coordination of data dissemination to public	Reform vertical communication and organizational structure Assess effectiveness of measures following drought and adjust measures accordingly
Development of Coordinated Emergency Response and Recovery Systems	Improve planning and integrate into national disaster response plans Integrate planning with mainstreaming efforts Strengthen vulnerability and capacity and impact assessment Establish legislative framework Improve community participation and empower stakeholders	Integrate planning with mainstreaming efforts Establish legislative framework Strengthen emergency management institutions and coordination Improve community participation and empower stakeholders	Integrate planning with mainstreaming efforts Strengthen emergency management institutions and coordination Assess effectiveness of measures following drought and adjust measures accordingly

Development of Longer Term Forecasts and Strategies to Address Climate Change	Improve climate change and impact forecasting Improve hydrological forecasting Establish measures required for adaptation and impact mitigation	Mainstream measures required for adaptation and impact mitigation	Mainstream measures required for adaptation and impact mitigation Assess effectiveness of measures following drought and adjust measures accordingly

4.3 Preliminary, Broad Sub–Regional and Country Strategies for the Caucasus

A priority for the **Caucasus** region is to support regional information exchanges and strengthening of regional capacity in hydro-meteorological monitoring and forecasting and these institutions capacity to reach end-users, and improving regional water resource management. A second priority is to support regional workshops to determine the possibility of coordinating National Water Shortage Response plans and relief measures.

Armenia has a positive water balance, but distribution of rainfall is uneven, thus much of the country depends on irrigation for agriculture. Armenia has a functioning Department of Emergency Situations, but to be more effective against drought the country needs to establish agroclimatic maps integrating per capita water availability for each region to develop regional and national water shortage response plans. For this Armenia needs to improve monitoring of the Arpa, Akhurian and Darb river flows and recharge levels of the Akhurian, Karnoot reservoirs, including lake Arpi in the East, and Aparan, Hrazdan reservoirs in the Center of the country and the Hairhair, Spandarian, Angeghakot, Tolors, Shomb and Arachadzor reservoirs in the South East. This along with improved irrigation and irrigation management will improve water use efficiency. Armenia will need to maintain and expand support for integrating drought management into land and water management programs by improving water retention in hillsides. This will include the reforestation of hillsides at the upper ends of watersheds, and improve pasture management and rain-fed agricultural technologies and extension programs to improve productivity and sustainability at the mid-valley levels and valley bottoms. The strategy should support capacity building in mitigation and emergency response measures among local communities and improve regional food level reserve monitoring. Ultimately, a policy which will require a multi-stakeholder approach, will the balancing the use of Lake Sevan water between the requirements of agriculture, energy, recreation and ecosystems conservation and will have to be developed.

Georgia has plenty of rainfall in the mountains of the West, but needs irrigation for effective agriculture in the East. Georgia also has a department of emergencies, which needs to integrate drought management into broader disaster management planning and response systems with emphasis of risk management at the local level of high drought risk areas, including food reserve monitoring for both the population and livestock, especially in the raions of Kaheti, Mtsketa-Taneti, Smathkhe-Javakheti, akhalkalaki, Kvemo-Kartli and Shidakarali Kaspakareli. Georgia also needs to substantially upgrade its hydro-meteorological monitoring systems to better monitor water flows from West to East and the respective reservoirs. It is also important to improve channeling of rivers and rehabilitate irrigation canals especially in Eastern Georgia where these have the potential to be economically viable, and support establishment of effective water user associations and more efficient use of irrigation water.

Georgia needs to improve integration of drought management into broader agricultural and rural development strategies, with an emphasis upon improving agrometerological models reflecting the actual agroclimatic variations of the country, introducing appropriate cropping patterns, emphasizing intercropping to reduce evapotranspiration, adopting flexible irrigation techniques such as alternate furrow irrigation in drought years, and maximizing climate conditions of the Southwest by testing orchard crops such as tea and citrus fruits. Georgia is especially vulnerable to floods in the West as well as droughts in the East, so

flood and drought mitigation strategies will need to go hand in hand and need to be adapted to the respective regions with appropriate measures.

Azerbaijan has an uneven distribution of precipitations, which is highest along the northern border of the country, while remainder of the country is dependent on irrigation for agriculture. Azerbaijan will need to introduce permanent institutions for risk mitigation and disaster planning and especially needs to get a better handle on food reserves at the Baladiya level, with a risk model categorizing each regions in accordance with risks of shortages in case of drought. This especially applies to the raions of Fizuli, Tarter, Kedabek, Bylagan, Gusar and Guba. In water management, being the lower riparian country in the Caucasus, almost fully dependent on irrigation for agricultural production, it will be very important to (i) develop a river flow monitoring system in the Kura and Arakh and Samur Rivers, (ii) rehabilitate and modernize irrigation systems, not only of higher order level, but especially lower order level in order to use water efficiently so that tail ender schemes and farmers will not end up without water during periods of low water flow; and (iii) develop sustainable water user associations that build incentives for more effective irrigation water use.

Azerbaijan has significant fisheries in Kate, Zagatala, Muhu, Gah, Seki, Okuz, Gebele, and Southern Ganja and Samkir, as well as in the reserves, of Yardimili and Hirakan. Sensitivity analysis of these areas to drought need to be fully integrated in the water management plan. In the agricultural sector, Azerbaijan needs to invest in good extension services with a focus on advice for appropriate cropping patterns and water management and to maximize the advantages that can be drawn from the highly varied agronomic-climatic conditions of the country, including adopting new types of crops and better use of available water resources.

4.4 Preliminary, Broad Sub–Regional and Country Strategies for Central Asia

For Central Asia improved information sharing and upgrading of hydro-meteorological monitoring systems is a priority throughout the region. Improvements in legislation regulating water extraction levels, uses, and release, including contamination levels will be necessary. Investments planned and ongoing to increase the efficiency of water management at the sub-basin level (e.g. the Syr Darya/Northern Aral Sea control project, the planned investments in the Ferghana valley and other programs to improve river regulation) should also be supported. The countries already have in place a system for managing water in the basins under drought conditions, but earlier and systematic information- sharing would permit more effective planning and drought mitigation measures.

Although **Tajikistan** has plenty of water for it irrigation, it remains highly vulnerable to drought, owing to the large rainfed agricultural areas located in the foothills and higher-level valleys. Some of the priorities include a rebalancing of public expenditure support and policy away from large-scale irrigation and cotton cultivation towards measures that conserve water on both irrigated and rainfed land. Water Users' Associations and community-based watershed management measures, as well as reasonable water pricing, will be crucial for the implementation of water conservation measures. As a large net provide of water to its neighbors, there is a need to rebuild the meteorological forecasting capacity, especially in relation to snow covers so as to be able to more effectively assess available water resources for its power generation, irrigation, and water quantities of riparian countries. While Tajikistan has a Ministry of Emergencies that works with the security services and the army, there is a great need to improve early warning systems and better coordinate emergency response efforts, especially with other agencies and local governments, and to better coordinate NGO efforts and make communities an active stakeholder in the drought and emergency management process. Due to its topography, the country needs to be able to prepare for extreme weather events that often result in avalanches, mudflows, land slides and flooding, especially in areas where former mining activities have dramatically increased the potential for leaching of toxic substances.

The Agencies managing the emergency situations need to develop programs with the assistance of the Academy of Agricultural Sciences and Ministry of Agriculture, in order to mitigate disasters especially, land and mudslides from heavy rains that irremediably follow drought periods. While techniques such as pasture forestry and intercropping have been successfully introduced, they need to be more widely used not only to hedge against crop failure in rainfed areas, but also to reduce the risks associated with landslides.

Picture Showing Land use based on soil-moisture retention and gradient to prevent erosion (Tajikistan).

Multiple Cropping system adoption to avoid risk of crop failures under rainfed conditions (Tajikistan)

Uzbekistan benefits from very little precipitation, and large areas of the country are dependent exclusively on irrigation, with water coming largely from Tajikistan and Kyrgyzstan. Uzbekistan has largely maintained the old central command drought planning and management techniques and maintained many institutional arrangements established under the Soviet Union. Its hydro-meteorological monitoring, as well as its emergency systems, including reserve food storage, are largely functional, yet require much greater community involvement and would be improved by better coordination. Because of its exclusive reliance on water from upstream countries, Uzbekistan is particularly exposed to poor management practices upstream, but also suffers from its own wastefulness. Investments in water management infrastructure to restore delta ecosystems and improve drinking water supply in the drought-prone northwestern areas of the country will reduce exposure. However, a mix of policy reform and rehabilitation of drainage and irrigation systems with a focus on increased involvement of end-users to improve irrigation water management and less reliance on large scale mono-cropping would greatly improve the rural population's ability to manage the effects of drought. Such policy changes, together with greater community outreach and involvement in drought planning and mitigation measures could have the largest benefits. Similarly, an added focus on improved pasture

management on rainfed lands to improve productivity but also to ensure sustainability, especially in the Ferghana foothills and the rainfed lands in other parts of the country would greatly reduce the exposure of the rural population.

In agriculture, Uzbekistan still maintains a control and command regime with the government stating quotas for most commercial crops. This has lead to large scale mono cropping and poor crop rotation and variation. Some 50% of arable land is suffering from salinization. More appropriate agronomic techniques such as relay cropping with low water consuming crops and furrow irrigation to reduce the very high (12,000 m3/ha) water application are necessary to render the country less vulnerable to drought. A review of policy with the aim to provide stronger incentives to reduce water consumption in agriculture would greatly reduce vulnerability as well.

Kazakhstan is a huge country with large differences in precipitations, with significant irrigated agriculture, but with most of the country exposed to the vagaries of drought, including deserts, large areas of steppe lands and tundra (all of which is rainfed). Kazakhstan has prepared a national drought planning and mitigation strategy with the participation of a range of stakeholders. The country also has effective emergency institutions, but to minimize risks where they are most prevalent, monitoring of food reserves and maintaining of warehouses, particularly in the West would need to be considered. Kazakhstan also has significant irrigated schemes in the South, along the Syr Darya of which some are being rehabilitated under Bank projects, reducing losses in these schemes. Improving efficiency in water delivery at the field level is a major priority, which, together with planting of appropriate crops, could significantly mitigate the exposure to the effects of drought.

In agriculture, crop production potential of irrigated areas in the eastern and northern sections of the country needs to be maximized by improving crop rotation with fast maturing varieties of oilseeds and soybean for soil regeneration and cropping intensity. In irrigated arid areas along the Syr Darya River in the southern part of Kazakhstan, cotton hybrids together with oil seeds such a safflower and sunflower should be more effectively rotated to minimize crop failures and regenerate soils. Much of the country's challenge is to improve natural resource management in the rainfed lands, including measures to address desertification and restore degraded pasture and forestlands, together with improved water management, while simultaneously ensuring sustainable livelihoods for the populations that live in some of the most remote areas of the world. A number of efforts are planned, and substantial investments have already begun. In these new endeavors, it will be crucial to involve local communities so that they become the major stakeholders in the planning and implementation of strategies, and to build capacity to support large-scale implementation.

The Kyrgyz Republic has plenty of precipitation, especially in the high mountains bordering Tajikistan, but rainfalls are highly uneven regionally and seasonally, irrigation is therefore essential for most of its agriculture. Although the country is not water scarce, it has to conserve water in order to serve lower riparian countries in an equitable manner. Therefore modernization of irrigation systems is important, as well as the development of sustainable water user associations that can manage water efficiently. The Kyrgyz Republic could strengthen its resilience to drought by improving water retention on hillsides and increasing shelterbelts vegetative coverage on pre alpine lands so as to improve rainfed land productivity in a sustainable manner. It is important for the country to rebuild it meteorological capacity so to be able to again properly monitor snow fall levels and reasonably accurate forecasts on snow melts and estimate water recharge of its large Togtogul and Uchkorgon reservoirs that provide it not only with electricity but also irrigation water for much of the Aral Sea basin.

The upper Ferghana valley, in Jalalabad, Osht and Naryn oblast is very densely populated, with very little agricultural land available. A major challenge for the country is to ensure sustainable agricultural practices in these areas and simultaneously improve productivity with proper soil and water conservation techniques to feed the large local populations. In these areas, food reserves monitoring and adequate warehousing so as to be able to forestall sharp drops in agricultural production ought to be considered, once crop losses from

drought has reached a predetermined threshold. Due to its topography and relatively densely populated areas, in addition to drought, Kyrgyzstan needs to improve its forecast for bad weather which often results in avalanches, mudflows, land slides and flooding, especially in areas where former mining activities have dramatically increased the potential for leaching of toxic substances. Drought management and mitigation should be incorporated into ongoing efforts to improve natural disaster response planning and capacity.

Turkmenistan has extremely low precipitations, and modern sedentary life is only possible as a result of water canalization. Water originates from the Amu Darya River, primarily, but also form the Murghab River originating in Afghanistan, and the Aenjen from Iran. Significant irrigation networks exist in Turkmenistan, however conveyance losses are tremendous since water travels long distances along earthen canals. With over 97% of cropland dependent on irrigation, the priority is improved management of irrigation and drainage water through policy and rehabilitation measures. Proper monitoring of reservoir levels and a graded intervention plan as droughts take place will be essential to ensure a reasonably sustainable livelihood for rural populations. Irrigated agriculture needs to take particular care to ensure proper vegetative coverage by more intensive intercropping between furrows and introduction of low water absorbing crops such as safflower, millet and sunflower. Similarly, having large areas of marginal land with mediocre precipitation between 120 and 280 mm, improved management of these lands with proper grazing patterns and soil and water conserving practices such as increasing salt and drought resistant vegetation such as saxaul could help mitigate the effects of drought and reduce resulting desertification.

4.5 World Bank Strategy for Support to Drought Management and Mitigation in Central Asia and the Caucasus

In general, World Bank support for drought management and mitigation should be integrated into broader development programs and policies, rather than regarded as "stand-alone" projects. The World Bank's rural development and water management strategies for the Europe and Central Asia region specify that the mitigation of drought and other natural disaster phenomena are to be included into planning and projects for these sectors. However, these efforts are nascent. There is also a need for the integration of drought management and mitigation into the production of Country Assistance Strategies (CASs), Poverty Reduction Strategy Papers (PRSPs), Country Economic Memorandums (CEMs), and regional (Europe and Central Asia) strategies and policies. The identification of financing gaps is of direct relevance to macroeconomic projections such as external debt projections utilized in Highly Indebted Poor Country proposals.

World Bank can facilitate the mainstreaming efforts of the governments of Central Asia and the Caucasus. As part of the CAS and PRSP process, support can be provided to the first steps of the mainstreaming process described above, data collection and cost-benefit analysis. This can be achieved over the short term. Because mainstreaming into development planning follows this process and requires a significant change in the way that decision makers approach development, this endeavor should be conceived as a medium- to long-term process.

There is an opportunity to draw other international financial institutions, donors, and non-governmental organizations into the mainstreaming process. For example, the International Monetary Fund should be brought on board in mainstreaming drought management and mitigation into the creation of CASs and PRSPs. As part of climate mitigation strategies, the GEF may be a source of funding for meteorological upgrading, especially where the benefits are sub-regional. Given IDA limitations and the new GEF operational programs that support measures to address land degradation, there is also scope for seeking grant funding from this source and others to support these programs. Drought management and mitigation should also be placed on the agenda of donor coordination meetings (such as that held on quarterly basis for water management in Uzbekistan). The Bank should work closely with other international financing agencies to synergize approaches.

Drought management and mitigation should be incorporated into conditionality for various lending instruments. For example, data sharing, coordination, and institutional strengthening might be utilized as criterion for better governance.

Mainstreaming into development planning can be operationalized over the short term through integration of drought management and mitigation measures into ongoing and pipeline projects. As shown in Annex 6, there are several ongoing projects that can reduce structural vulnerabilities. Examples include community watershed, irrigation and drainage, water management and forestry and agricultural services projects, which will be more effective if they are more specifically targeted to reduce critical structural vulnerabilities that will improve drought management and mitigation. It will be important to ensure that this aspect of project design is not neglected. Teams already in place can implement this strategy.

After the costs and benefits of various drought management and mitigation measures have been determined, World Bank, together with other donors, can support projects to address needs in drought management and mitigation. At present it appears that the greatest scope for such projects lies in upgrading hydro-meteorological monitoring and early warning systems and capacity building for emergency response and recovery.

Further dissemination of drought management and mitigation knowledge is required within World Bank. For country teams and other units within World Bank to mainstream drought management and mitigation into development, they first need to become better acquainted with what is required. Dissemination efforts may include presentations (such as at brown bag luncheons and retreats), teleconferences with country teams, the production of short pamphlets describing the needs and ways to address them in individual countries and regions, and country team agendas, and Regional LT presentations.

4.6 Involving the Stakeholders

Further involvement of stakeholders is required in the development of drought management and mitigation strategies. The broad sub-regional strategies presented above were conceived exclusively with World Bank input. In order to refine these strategies and develop country ownership of them, all stakeholders should have an input.

Stakeholders can be involved through the dissemination of the World Bank's preliminary strategy and follow-up studies conducted by the individual countries. The stakeholders of the eight countries can discuss the report at regional conferences in the Caucasus and Central Asia.[97] The agenda of the conference would include reports from local specialists from a variety of fields and institutions (within and without the government) concerning their conceptions of needs in drought management and mitigation, roundtable discussions to obtain reactions to the preliminary strategy, and presentations by the World Bank team and representatives of other donors concerning what is required to strengthen drought management and mitigation in various sectors (including best practices worldwide) and in the work of the World Bank. The team should also provide a full explanation of the next steps in its work and seek input concerning its feasibility.

Individual country Vulnerability and Capacity Assessments can be utilized to develop country ownership, refine the preliminary World Bank strategy, and begin process of the data collection and cost-benefit analysis. Several steps should be taken:

1. Local consultants will collect and analyze indicators for meteorological, hydrological, agricultural, and socioeconomic drought, as well as early warning, food security, disaster response, and water manage-

[97] The conference for the Caucasus would be located in Georgia, while the conference for Central Asia would be held in Tashkent (with a possible second conference in Astana, depending upon relations between countries).

ment (these are listed in detail in Annex 8). Data should be disaggregated to the district level, in order to account for local impacts of drought and facilitate the eventual creation of local level plans.

2. Parallel to the collection of statistical data, the study will acquire qualitative information. Fieldwork will be conducted as focus group discussions with various types of stakeholders, as well as simple participatory exercises. The stakeholder analysis will provide a fuller picture of the impact of drought upon vulnerable populations, the needs and capabilities of various profiles stakeholders in drought management and mitigation, and the formal and informal institutions that are involved in early warning, response, water management, and agricultural extension.
3. Based upon the collection of quantitative and qualitative data, local consultants will then produce country-specific drought management and mitigation strategies.
4. The World Bank team will then synthesize the individual country strategies into broader regional strategies and refine World Bank preliminary strategies for individual countries.
5. The results of the preliminary draft of the final study will be the subject of regional stakeholder workshops at the sites of the previous conferences. At the workshop, the local country teams will provide reactions to the refined World Bank strategies and make suggestions concerning the next steps to be taken in their respective countries.

Caucasus	Drought Management to avert Disaster	Forecasting & Early warning	Regional & National Water Management	Food Security Early Warning and Relief Operations	On-Farm Agro-Technical Measures	Environment
All Countries	**Support regional information exchange and capacity building • Assess feasibility of regional strategy. Vulnerability and Capacity Assessment, Task Force, Information Center, Strategy and Response Plan. Coordinate with and integrate into disaster management projects.**	**Coordinate with regional initiatives and fill gaps in observation network. • Facilitate information exchange. Rehabilitate and modernize agro-meteorological network. Create monitoring products for end users (bulletins, etc.) Establish community-based early warning in drought prone areas.**	**Overhaul, water management infrastructure to reduce water losses. Hold workshops to determine possibility of coordinating National Water Shortage Response Plans.**	**Improve terms of regional trade to facilitate import and export of foodstuff. Assess and support food security early warning efforts. Support capacity building of NGOs focused upon mitigation measures in drinking water, and health in drought-prone areas.**	**Support ICARDA and CIMMYT regional network. Support research and training in soil and water conservation in drought-prone rainfed and irrigated areas; establish linkage with WUA training and relevant projects**	**Support Drought precipitation/drought forecasting efforts in UNCCC and drought mitigation in UNCCD**
Armenia	Prepare agroclimatically demarcated zones and sub-zones of the country based on soil moisture vulnerability by superimposing population density and per capita water availability maps for the country, and integrate vulnerability and capacity assessment in ***JRMP drought management component***	Monitor the Akhurian river flow and inflow in to Akhurian and Karnoot reservoirs. Monitor recharge levels in Apran and Harazdan reservoirs. Monitor Arpa and Darb river flows and recharge into Spandariyan, Angeghakot Tolors and Shomb reservoirs. Reservoir level monitoring will help in assessing water availability for release for irrigation during the main crop season.	Coordinate WUAs training and on-farm irrigation management with **Irrigation Development Project**, especially under Samur - Apsheraon canal, Upper Karabakh canal	Prepare the raion municipality wise assessment of reserves of food grains in warehouses and make information available to the Disaster Monitoring center for drought management to stock up or move the food grains in the event of sever drought.	Limit cultivation of high gradient slopes, increase permanent pasture and fodder production. Adopt mixed production models with livestock and a variety of crops that improve water retention of soil and reduce erosion and risk of land slides	Integrate drought management and mitigation into forestry project in the northern part of Greater Caucasus foot hills, especially in South Osetia region, Svanetia, Kodori,Egrist and Rachi ranges in the Northwestern areas and Maskhetia range of Southwestern part of Armenia
Azerbaijan	Introduce reliable institutional arrangements for risk mitigation and disaster planning at the Baladiya level and categorize each baladiya according to risks for water, food grains and pasture shortages at various degrees of drought criticality	Monitor the seasonal inflow of Kura and Iora rivers and recharge of Mingechever reservoir. Monitor the seasonal level and asses the availability of water availability for the Upper and Lower Karabakh canals for irrigation.	Review the Kura, Arakh and Samur river flows and maintain and disseminate fortnightly data on the flows into Mingechiver dam, Shamakhir reservoir, closely monitor the Zeironbaton reservoir supplying drinking water to Baku city. Coordinate WUA training and on-farm irrigation management with ***Irrigation System Distribution and Management Project.***	Review the conditions of the warehouses at Baladiya level in Agdam Fizuli, Tarter, Kedabek, Bylagan, Gusar and Guba where drought might cause serious crop failures and make arrangement to stock the minimum food grains required at the ROL positions.	Increase crop varieties and take advantage of the broad spectrum of the country's agro climatic conditions to develop a broad based market with a large variety of produce. Improve efficient water utilization at the farm level through effective water users association and water pricing reflective of costs.	Integrate drought management and mitigation into fishery areas of Kate, Zagatala, Muhu, Gah, Seki, Okuz, Gebele, Sothern Ganja, Samkir, and in Yardimli and Hirakan Reserves. Strengthen conservation practices of wooded lots and tree plantations to lower illegal logging as a result of fuel shortages. Provide wider vegetative cover to halt the desertification process were trees have been felled. Introduce vegetative barriers across slopes by planting the sub-tropical grasses such as "Jijigrass" that are cold tolerant.

Georgia	Initiate institutional arrangements for risk mitigation and disaster management planning at the regional level and group the regions with common risks level for water, food grains and pasture shortages at various degree of drought criticality	Initiate agrometeorological time series for all the 48 centers and develop models for each center rather than a simple two area classification focusing on Eastern and Western Georgia. Such models will better address the micro details of all the agro climatic sub regions to address and improve local drought response.	Improve overall water monitoring, including river flows and ground water levels, including close attention to water quality as reduced levels tend to increase contamination concentration. Improve monitoring of reservoirs, and improve distribution as well power generation efficiency, including dam safety. Further strengthen management of water resources with riparian countries. Coordinate WUA training and on-farm irrigation management with ***Irrigation and Drainage Community Development Project.***	Grain warehouses reserves in sub-raion level need to be monitored as the drought indications are felt in Raions of Eastern Georgia where risks of crop losses due to drought are high. The priority raions are Kaheti, Mtsketa-Taneti, Smatskhe-Javakheti, Akhalkalaki, Kvemo-Kartli, Shidakarali Kaspakareli where food grains stocks need to be kept at ROL level to avoid distress to the population.	Improve soil moisture conservation by mulching take up ring and basin method of irrigation in orchards. Introduce intercropping between furrows to reduce evapotranspiration and maximize benefits of furrow irrigation. Introduce early maturing varieties of horticultural crops for intercropping. For annual furrow crops follow rational irrigation system, introducing contour border stripping and ridge and furrow system of irrigation switching to alternate furrow irrigation and spot irrigation methods to enhance water use efficiency in case of drought.	Integrate drought management and mitigation into forestry project. In the western watershed region which represents more sub-tropical character, introduce sub-tropical orchards such as Citrus and tea. Emphasize of grain maize with fast growing intercrops to have two harvests on same plot. Introduce broad leaved quick growing trees and vegetative barriers along slopes to trap and arrest soil erosion and enhance the water holding capacity of soil profiles. Interspersed uncultivated areas with the native wood lots to enhance pastures.

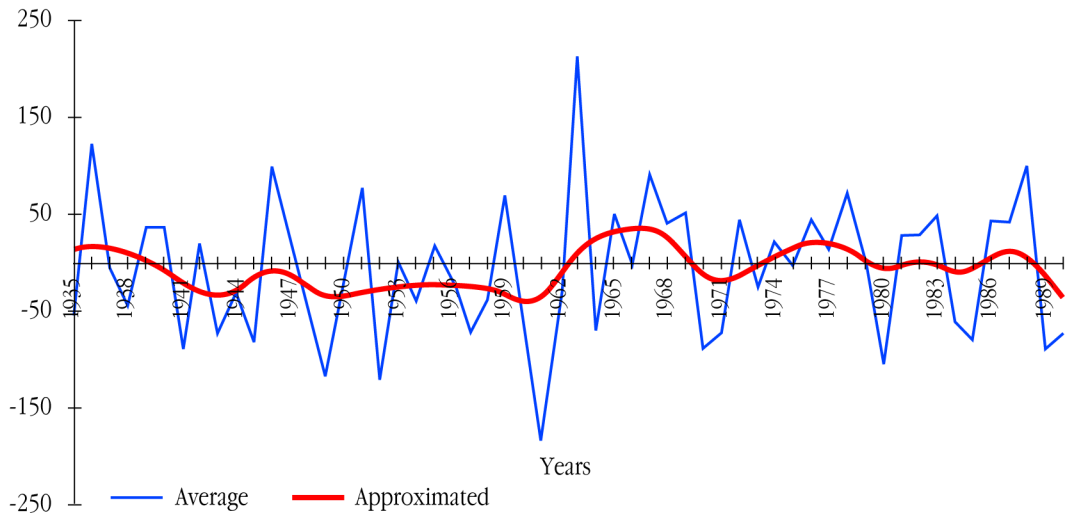
Central Asia	Drought Management to avert Disaster	Forecasting & Early warning	Regional & National Water Management	Food Security Early Warning and Relief Operations	On-Farm Agro-Technical Measures	Environment
	Support regional information exchange and capacity building. Undertake national vulnerability and capacity assessments create national Task Team and Information Center, and develop a national Strategy and Response Plan. Coordinate with and integrate into disaster management projects	**Assess progress of regional initiatives and fill gaps in observation network. Facilitate information exchange. Rehabilitate and modernize agro-meteorological network. Create monitoring products for end users (bulletins, etc.). Establish community-based early warning in drought prone areas.**	**Hold workshops to determine possibility of coordinating National Water Shortage Response Plans. WUA training in O&M and On-Farm Water Management in drought-prone areas.**	**Agree on improved terms of regional trade to facilitate import and export of foodstuff. Assess and support food security early warning efforts. Support capacity building of NGOs focused upon mitigation measures in drinking water, and health in drought-prone areas.**	**Support ICARDA and CIMMYT regional network. Support research and training in soil and water conservation and livestock breeding in drought-prone rain fed and irrigated areas; establish linkage with WUA training and relevant projects.**	**Support precipitation/ drought forecasting efforts in UNCCC and drought mitigation in UNCCD and various projects, promote action against desertification programs, by promoting watershed based a forestation programs and greening of forest lands, and initiate pasture land development programs.**
Kazakhstan	Actively participate into the IFAS programs and get more information on the International Forum for AS programs to enhance efficiency of the Aral sea basin. Monitor the Syr Darya water inflow at Chardharin reservoir and coordinate with the Russian precipitation data for the Omsk Irtysh river upper catchments and also Urals upper catchments area.	Assess the Kalbinsky range and Its river flow to assess the soil moisture levels in North East Kazakhstan, Iris valley data along with the inflow in to Karchagy reservoir, as also Nura river flow into Kurgaldshi reservoir need to be monitored at the national level besides the rainfall decadal precipitation data of Northern Ural river valley to assess the moisture levels of the North eastern part of Kazakhstan in Ural valley	Make an estimate of all the water resources in the north, of all the river flow and the Syr Darya in the south and based on that make an assessment of the drought and regulate water releases from the reservoirs to avert the risk of crop failures or drinking water problem that will emerge by end august sand September.	Maintain reserve warehouses in Western part of the country especially Mangistau Oblast, Turgay and Djeskazgan Oblast in central Kazakhstan, Southern parts of Semipalatinskya Oblast specially, Kaynar, Karaul and in Barshatuz and Chagan raions so that enough grains are stored to avoid any distress situation due to absence of food grains during August to March.	Promote CYMMYT research center in Almaty to continue the crop research in collaboration with the local NARP institute under the Academy of Agricultural Sciences. Focus on developing early maturing hard Duram wheat to promote exports. Develop cotton hybrid, as well as canola and soybean varieties with high oil contents, to introduce as multiple cropping program (in rotations) to minimize risk of crop failures and to stabilize the production. Shorter maturing safflower need to be developed for the Southern parts in Amu Darya valley and fast maturing sunflower are needed in the Northern Pavlodar and Kustany areas.	Promote the National Strategy drawn under the NEAP and CEP programs drawn for A,B,and C zones by the Ministry of Ecology and Natural Resources along with the international agencies, including UNDP, the World Bank, EU and OECD, USAID, JICA, and TACIS. Activities envisaged in Zone "C" of umbrella project for elimination main environmental problem of the region by developing rational use of water, and to reduce runoff losses of water and soils, etc, under projects such as USAID's, improvement of water resource management of Balkhash-Alakol river basin; JICA's, Rehabilitation of water protection zone of Syr Darya river; GEF's funded In-situ conservation of Mountain agro biodiversity, conservation of wetlands, sustainable development of Aral Region" are all to be implemented as contemplated in an integrated manner .

Kyrgyzstan	Redefine the role of emergency situation management center, reestablish the earlier functioning met centers and collect snow fall and melt data, Get more information on the International Forum for both Naryn river management and Togtogul power station working programs to stored water. Activate Farganah valley forum with neighboring countries	Assess and monitor the water levels in Uch-Kurgon and Togtoul reservoir, seasonal met report to assess weekly precipitation of the Chui, Issukkul, Osh and Jalalbod oblasts where 75% of the national irrigated lands are situated. It is also essential to monitor the strategic action program to conservation of targeted 15% of water savings by the end of 2008 over 1998 levels.; create incentives for preventing deforestation in At Bashy range in Narin Oblast, Oy Tal river vally and Alay river valley in Southeren Osh oblast; Kirov Reservoir catchment area in upper Talas river in Talas Oblast, etc.	Since 1,1 million ha of the 1.4 million ha (>75%) of Kyrgyz land is dependent on irrigation for production, any impact on irrigabilty of these lands will have direct impact on the production and supply system in rural area. Hence management of drought depend essentially on the performance of Togtogul and Uch-Kurgon dams. There is therefore need for active participation implementation of "Strategic Action Program" under the auspices of the Interstate Commission for Water Coordination within the International Fund for Saving Aral Sea Basin is essential as part of overall national plan.	Osh oblast with a rural population of about a million with an irrigated land of only 150,000, Jalalabad with the population of 670,000 with only 142,000 ha under irrigation and Naryn Oblasts with only 127,000 ha where poverty rate is above 65%, it is necessary to take up prepare a consistent it is necessary to invest with adequate incentives to conserve soil and water, maximize efficient utilization of land for productivity enhancement through community based watershed programs. It is also necessary to locate warehouses in these oblasts including Batken and storing food grains for distribution during July to September of the year to avoid any impact on price rise during the years of drought if any.	Promote through crop research institute under the Academy of Agricultural Sciences programs to evolve for each of the agro climatic regions of the country, crop diversification and introduction of crop varieties that are cold and drought tolerant in collaboration with the CGIAR system. Introduce better varieties and early maturing crops of potatoes production for hill areas of Issukkul Alley valley, promote growing of Mulberry and silk production to increase additional income of farmers in Talas, Jalabad and Osh Oblasts.	The Scientific and Technical Council of the Ministry of Ecology and Emergencies of Kyrgyz Republic although essentially has made elaborate arrangement s to monitoring the dangers and risk arising out from Seismic, Landslide, Avalanche, Flooding, and Mudflow but programs to deal with the drought is essential. Beside International donor supported programs for NEAP it is also necessary to promote watershed management programs to promote water and soil conservation and enhance productivity on a sustained manner.
Tajikistan	Redefine the role of emergency management unit reporting to the Deputy Prime minister to include the drought management also, interact with IFAS and international organizations to get the snow fall data on a regular basis, review the river inflow of Karakul and Farhad for regulating the water supply in the Northern Sughdh Oblast. Similarly monitor the river flow in Pyanj and Vakshvalley at Nurekh and Sangtuda reservoirs. Beside monitor the data of inflow in to Monitor Yashilkul and Lake Sarez valley.	Assess and monitor the water levels in Kairakum, Farhad on Syrdarya in the North and Karatag, Dushanbe, Nurek, Vaksh, Bartang, Kafornihon river that flow in southern Tajikistan in to the Amu Darya need to be monitored. The Vegetation index (NDVI) images at one kilometer resolution from the SPOT-4 satellite, which depicts vegetation vigor and extent, may be used to compare vegetation conditions during the growing period comparing to the previous years to predict the moisture conditions of the crops to take precautionary measures to avert the negative impacts of the drought and to take mitigate measures quite in advance. .	since majority of the crop land of about 900,000 ha of the total crop land is irrigated, the cereal (wheat or barley) producing lands in the hill area are invariably rainfed. So the drought essentially hit those hill area people and causes squalor and misery in 32 of the 58 raions as witnessed during 2000 drought.	Generally since 80% of the country hilly terrain with human populations settled in valleys the inter valley transportation is a problem during the emergency and is time consuming. To avoid the transportation problems the country should priorities and prepare the list of network of warehouses in 32 raions and stock the minimum gains required for the population especially during may to July months to meet the need of drought to provide relief to the population.	Introduce drought tolerant facultative varieties of wheat that is suitable for both winter and Spring seasons to avoid the risk of carrying over stocks of seeds from two different types of seeds to catch up with eh climatic conditions. Promote through crop research institute of Tajik Academy of Agricultural Sciences programs to spread in each of the agro climatic regions of the country's crop diversification programs to tide over the mid season break in the precipitation. Take up vigorously introduction of crop varieties that are cold and drought tolerant in collaboration with the CYMMIT and ICADRDA centers. Introduce better varieties and early maturing crops of potatoes production for hill areas of Issukkul Alley valley, promote growing of Mulberry and silk production to increase additional income of farmers in Talas, Jalabad and Osh Oblasts.	UNDP, AKF, World bank and other donor promoted NEAP and watershed based Natural resource development programs be expanded to cover as much of area as possible involving the Jomat activities. Weekly bullet tins on the weather performance be disseminated widely for the benefit of farmers and private input suppliers to meet the challenges of the drought locally. The research institute should adopt the local farmers community group to provide advice as to how address the drought situation.

Turkmenistan	Entire country being an arid desert and the country's agricultural production is entirely dependent on the Amu Darya that flows in the country from Tajikistan/Uzbekistan from the east tapped in to the country by Karakul canal and in the south Murghob river flow from Afghanistan and Aedzhen from Iran providing the major source of water in the country	Since Amudarya is the main source for water to the country with almost 80% of the country occupied with Karakum desert, with an annual average precipitation of around 120 to 280 mm a constant eye on the measuring gauge Kelif point where the Kairakum canal originates and provides 22 BCM of water. The water is stored in to 18 reservoirs and major being the Hauz-Khan and Kopetdag reservoirs of 1310 Mm^3. There is need for active participation in the implementation of "Strategic Action Program" under the auspices of the Interstate Commission for Water Coordination within the International Fund for Saving Aral Sea Basin is essential as part of overall national need.	In view of the desert Arid agriculture practice, with 97% of the agriculture is irrigation dependent there is need for responsibility of water management rests with the Government. There is a need for the entire attempt to enhance water use efficiency and drainage losses (almost 30% of the 22 BCM tapped through canal is lost through drainage system and the canal built through desert also looses heavily. There is a need to regulate these losses to avert any reduction in inflow of water in to the Amudarya Flow due to drought in the catchments area.	Since nearly 54% of the country's population live in rural area their drinking water and rural employment becomes a problem in rural Turkmenistan. Agriculture is the only engagement for the rural Turkmen, their primary need for water and food need to be met specially during drought. No efforts are made to introduce more xerophytes, low water demanding crops like safflower, sunflower, millets, are being promoted. For cotton, in Dashkoze area flat-bed flood irrigation method should be discontinued, instead furrow irrigation alone be practiced with protective irrigation system.	Since water management of almost importance there is need for close coordination between the Ministry of Water Resources, Ministry of nature protection, State committee for Turkmen Geology, Ministry of Construction and Building that regulate water supply and sewerage management, Hakimliks who regulate allocation of water to the farms, there is need for cross sect oral coordination to manage the water efficiently.	National Program for the reduction of conveyance losses in the Kairakum canal water and soil salinity management and improvement in drinking water supply are the priority areas that required attention and the need for international financing/donor agencies are required.
Uzbekistan	The entire Uzbekistan is fed by Amu Darya, Surkahndarya KashkaDarya Zarafshan rivers of Amu Darya valley in the south and Syr Darya valley in the north, the Uzbek government has to very actively monitor the precipitation in the upper catchments of these two rivers very carefully as the country is fully dependent on the water from these rivers only as the country is arid desert in most of its place.	Since trans-boundary rivers namely Syr Darya and Amudarya, Kashka Darya and Zarafshan and their tributaries are the main source of water for Uzbekistan and its agriculture production covering about 4.3 million ha any drought in the catchments of these trans-boundary river affects Uzbekistan severely. Consequently, the main problem during any drought year Uzbekistan faces inherent trans-boundary problems with a disputes over the division of operational and maintenance costs responsibilities among riparian.	In view of the dependence on the external water resources for its sustainable farm production and absence of adequate incentives for water conservation and lack of maintenance of infrastructure in years of economic transition due to budget constraint and leading to inefficient and unsustainable water use, during drought years rural population are subjected enormous stress.	The land use pattern indicate that essentially the cotton crop is sown over 1.6 million ha and wheat over 1.5million ha with an average yield of 2.5 tons/ha the country produces well over 4.5 million tons of wheat annually. The country has well maintained warehouses and	The country has to adopt better irrigation technologies to save water and improve efficiency. Improve water management techniques along with the drainage system. Nearly 50% the irrigated land suffers from salinity. Relay cropping and furrow irrigation system with better cropping system to use minimum per/ha water consumption is required. There is a need to evolve and introduce more of salt tolerant and drought tolerant varieties of cereals and oilseeds to reduce more water demanding crops like cotton and in some pockets paddy. Use of 10,000 M^3 of water need to be reduced drastically in the interest of the sustainability of the crop and more so under saline conditions during drought the crop suffers severely due high evapo-transpiration under the arid conditions of Uzbekistan.	Lining of feeder and main canal, improved drainage systems, irrigation infrastructure rehabilitation need to be taken up as priority and if there is budgetary constraints with the external aid such schemes are to be implemented. Gradually, mono-cropping systems need to be replaced by multiple and row cropping system, with early maturing varieties. Wider publicity to create awareness among the rural population towards rational use of water need to be taken up so that the farmers could make an informed decision on the cropping pattern based on the availability of water.

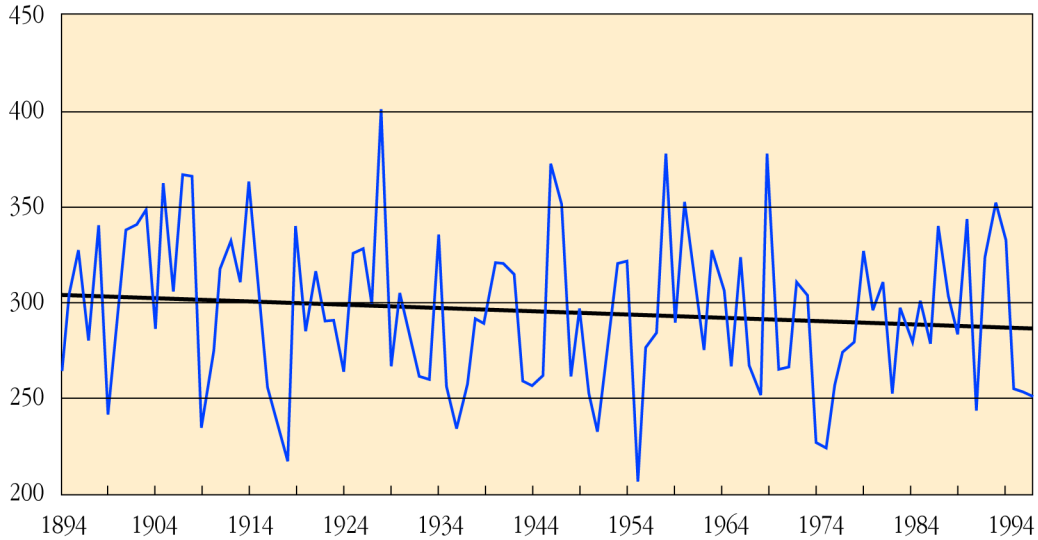
Annex 1:
ADDITIONAL FIGURES AND TABLES

Figure A1: Long Term Precipitation Patterns in Armenia (mm/year)



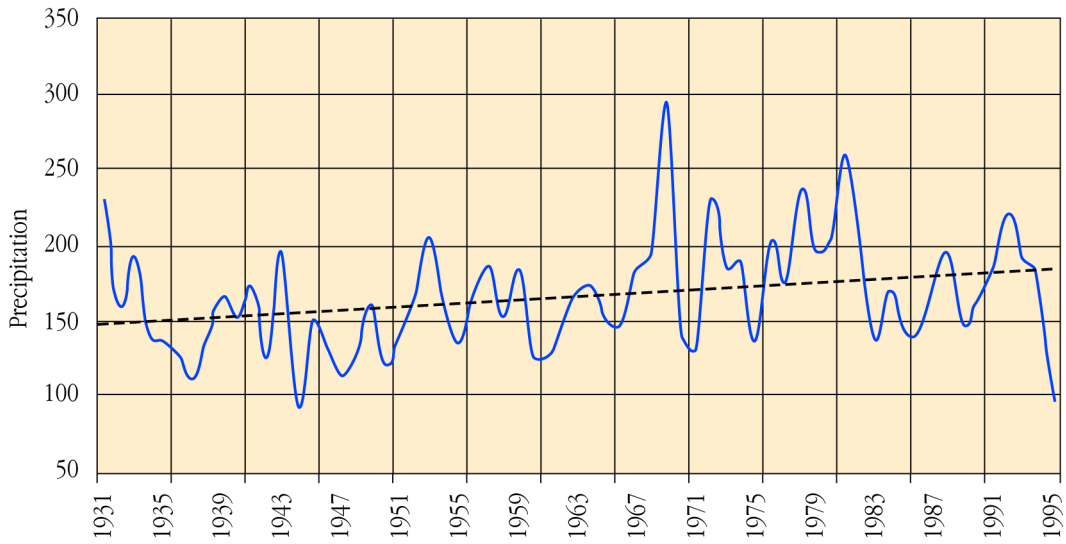
Source: Ministry of Nature Protection of Armenia, October 1998, *First National Communication of the Republic of Armenia under the United Nations Framework Convention on Climate Change*, p. 54.

Figure A2: Long Term Precipitation Patterns in Kazakhstan (mm/year)



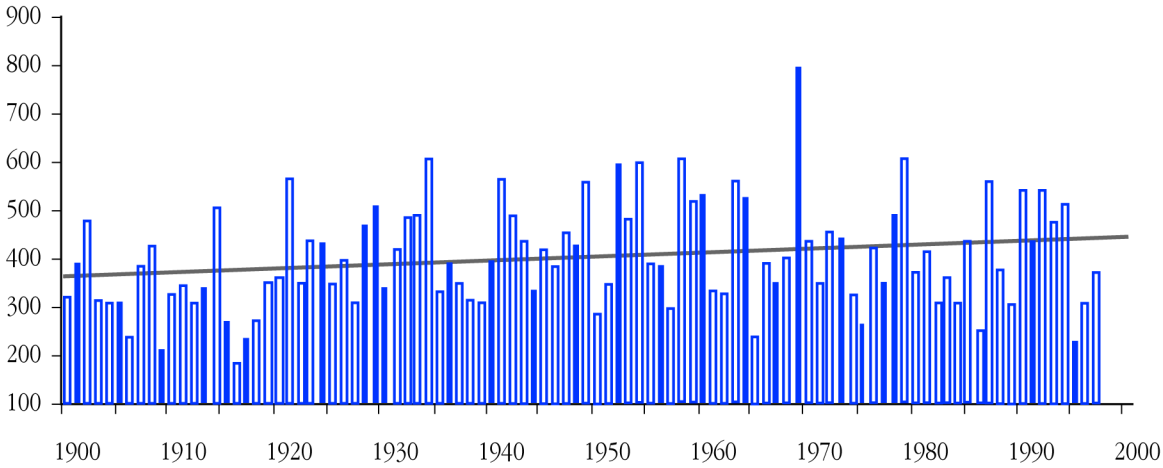
Source: Government of Kazakstan, 1998, *First National Communication of the Republic of Kazakstan under the United Nations Framework Convention on Climate Change*, p. 33.

Figure A3: Long Term Precipitation Patterns in Turkmenistan (mm/year)



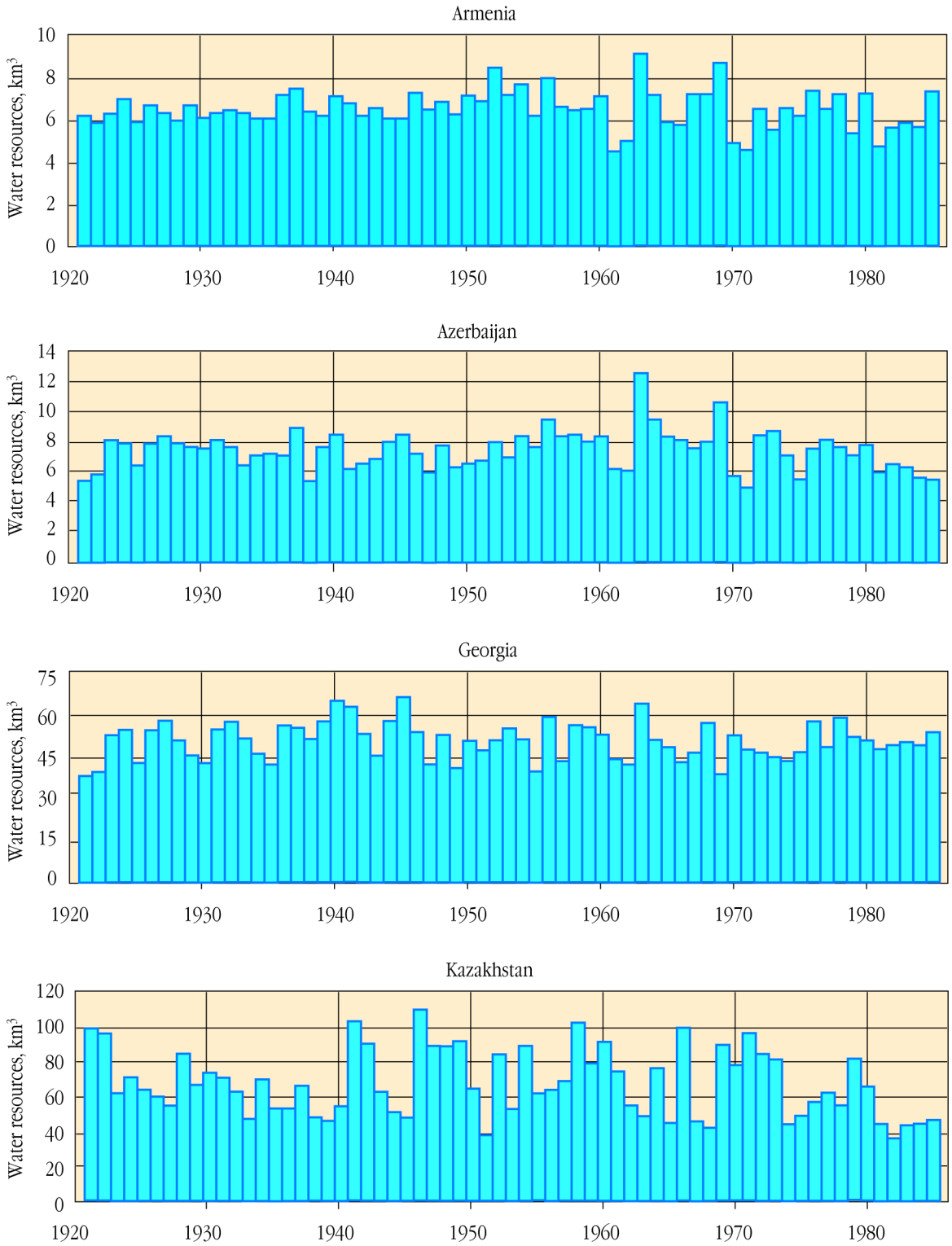
Source: Ministry of Nature Protection of Turkmenistan, ***First National Communication of the Republic of Turkmenistan under the United Nations Framework Convention on Climate Change*, p. 34.**

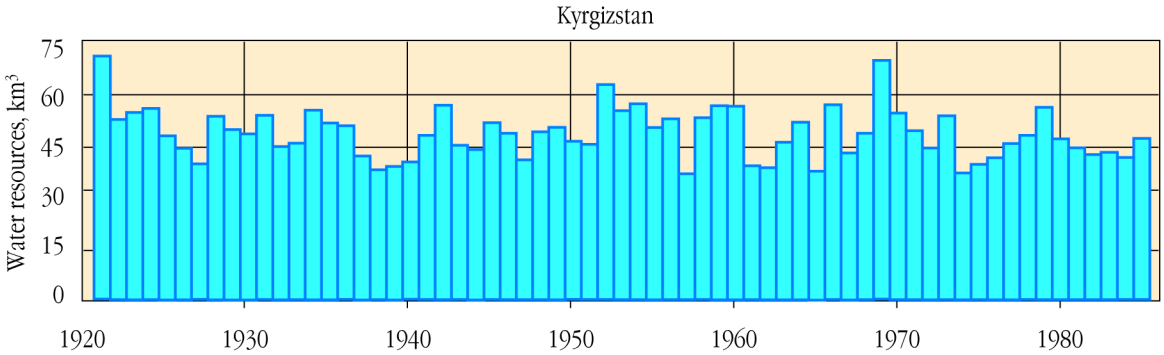
Figure A4: Long Term Precipitation Patterns in Uzbekistan (mm/year)

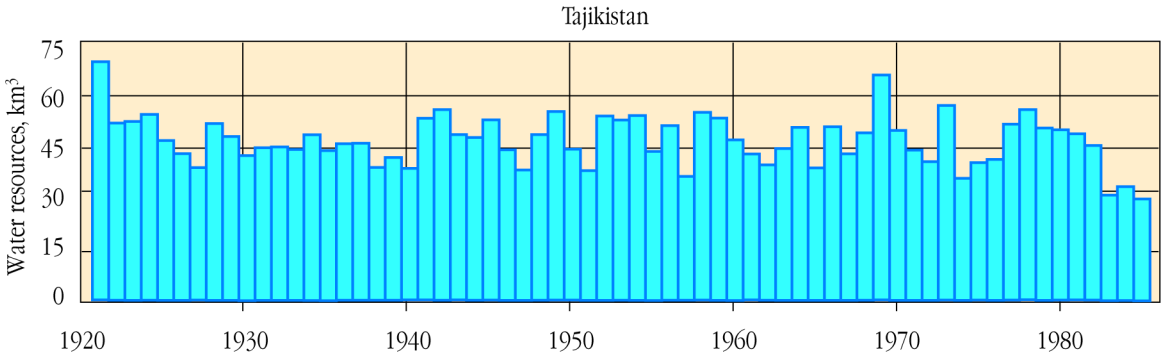


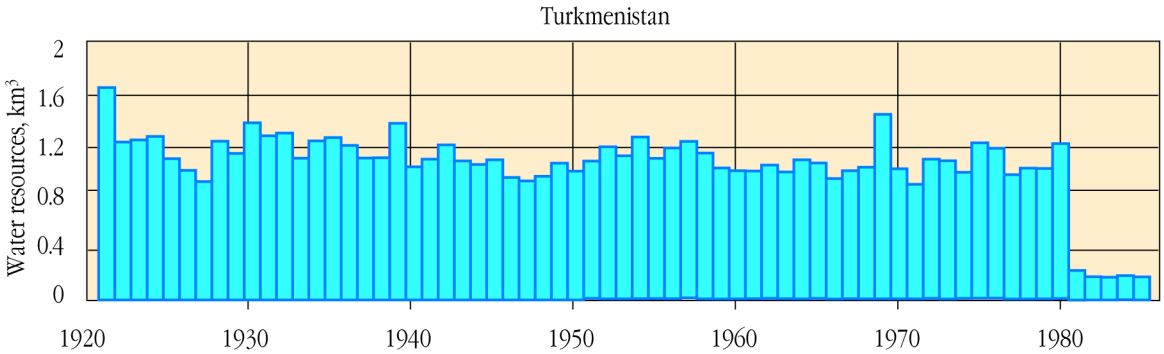
Source: Government of Uzbekistan, ***First National Communication of the Republic of Uzbekistan under the United Nations Framework Convention on Climate Change*, p. 75.**

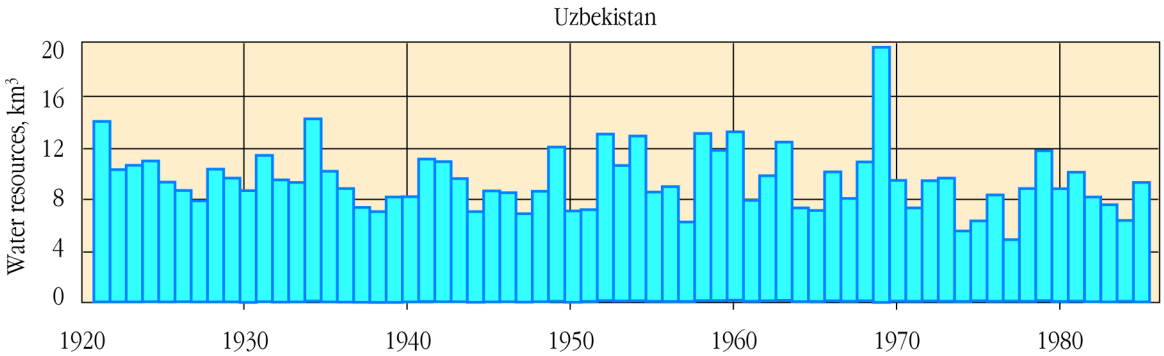
Figure A5: Water Resources in Countries of Central Asia and the Caucasus, 1921-1985 (km3)





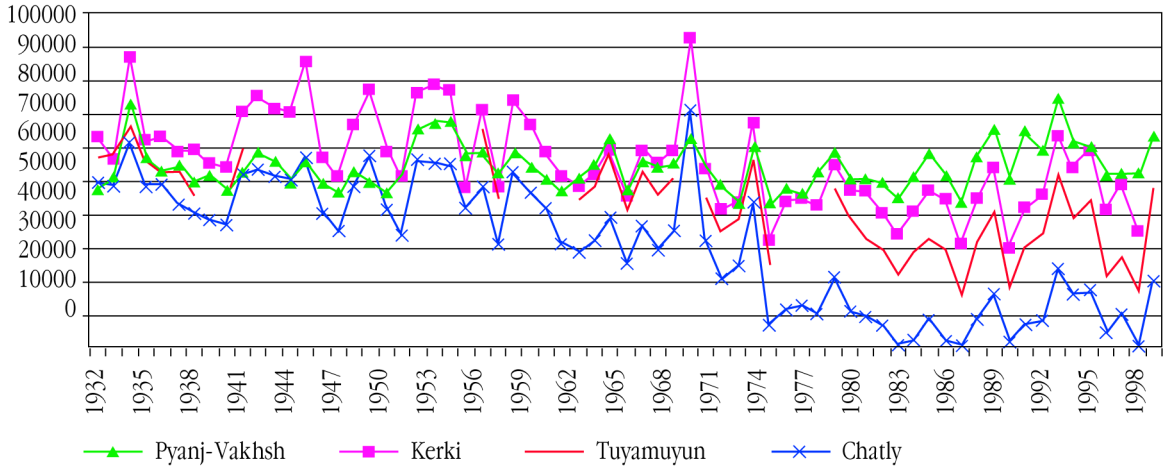






Source: St. Petersburg Hydrological Institute.

Figure A6: Flow of the Amu Darya River at Various Points, 1932-98 (million m3)



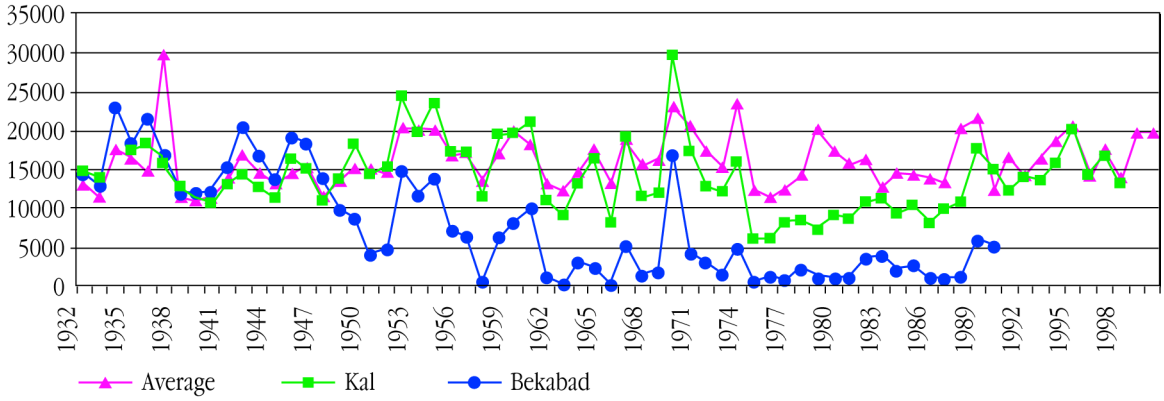
Source: WEMP Uz, p. 12.

Table A1: Long-Term Trend of Irrevocable Abstraction of Amu Darya Flow at River Sections (million m3)

Years	Upstream (to Kerki)	Midstream (Kerki -Tuyamuyun)	Downstream (Tuyamuyun –Kyzyldjar)	Total
1946-50	410	1260	8170	9840
1951-55	380	1420	8170	9970
1956-60	190	3820	9460	13470
1961-65	190	6430	11350	17970
1966-70	-	9340	14380	23720
1971-75	350	1280	17670	30870
1976-80	450	18450	18640	37570
1981-85	750	22740	19935	43425
1986-90	1120	24380	15650	41150
1991-99	1300	22990	19645	43935

Source: NWG by Glavgidromet data, 2000 in UzWMP, p. 11

Figure A7: Flow of the Syr Darya River at Various Points, 1932-99 (million m3)



Source: WEMP Uz, p. 12.

Table A2: Long-Term Trend of Irrevocable Abstraction of Syr Darya Flow at River Sections (million m3)

Year	Upstream (to Kairakkum Reservoir)	Midstream (to Chardara Reservoir)	Total (to Chardara Reservoir)
1946-50	4160	1545	5705
1951-55	6400	2080	8480
1956-60	9500	1890	11390
1961-65	11860	3660	15520
1966-70	10380	3560	13940
1971-75	12650	5860	18510
1976-80	12960	6280	19240
1981-85	12330	6820	19150
1986-90	6910	6310	13220
1991-99	7380	7292	14672

Source: NWG by Glavgidromet data, 2000 in UzWMP, p. 11

Table A3: Annual Availability of Water Resources in the Syr Darya and Amu Darya River Basins (km3 per year)

	Probability of Exceedance	
	50%	90%
Syr Darya Basin		
Main River and Tributaries	13.35	10.33
Other	22.71	16.68
Total	36.06	27.01
Amu Darya Basin		
Main River and Tributaries	64.75	53.04
Other	13.59	10.54
Total	78.34	63.58
Aral Sea Basin		
Main River and Tributaries	78.1	63.37
Other	36.3	27.22
Total	114.4	90.59

Source: World Bank and Uzbekistan Ministry of Agriculture and Water Resources, *Republic of Uzbekistan Irrigation and Drainage Sector Study*, Annex 2, p. 3

Table A4: Annual Availability of Water Resources in Kyrgyzstan (km3 per year)

River Basin	Provinces	Probability of Exceedance		
		Average	75%	95%
Chu	**Chu**	3.73	3.40	2.99
Talas	**Talas**	1.35	1.18	1.00
Assy	**Issyk Kul**	0.19	0.17	0.14
Syr Darya	**Osh, Jalalabad, Naryn**	27.42	22.82	18.45
Amu Darya	**Osh**	1.25	1.10	0.93
Issyk Kul	**Issyk Kul**	3.33	3.00	2.62
Ili	**Issyk Kul**	0.36	0.31	0.24
Tarim	**Issyk Kul**	6.50	4.87	3.56
Total	**All**	44.46	37.53	30.62

Source: Kyrgyz Republic NEAP, p. 46

Table A5: Annual Availability of Water Resources in Azerbaijan (million m3 per year)

	Probability of Exceedance		
	50%	75%	95%
Mingechevir	15,077	13,214	10,332
Mouth of Araks	8,963	8,044	6,069
Mouth of Kura	1,147	1,012	790
Kura Basin Total	25,187	22,270	17,191
Samur Basin	2,143	1,824	1,436
Caspian Region	826	644	456
Lenkoran	890	701	403
Total	29,046	25,439	19,486

Source: Azgiprovodkhoz.

Table A6: Flow of the Kura River, 1961-90 and 1991-90 (million m3)

	Period				
	Winter	Spring	Summer	Fall	Year
	XII-II	III-V	VI-VIII	IX-XI	XII-XI
Kura-Tblisi					
Natural (1961-90)	98	429	251	136	230
Observed (1961-90)	86	382	198	107	192
Observed (1991-99)	119	351	185	115	190
Alazan-Ayrichai					
Natural (1961-90)	74	169	149	107	127
Observed l (1961-90)	74	151	126	89	109
Observed (1991-99)	77	126	110	86	104
Araz-Gyvrag					
Natural (1961-90)	86.6	399	181	99	190
Observed (1961-90)	67.5	305	142	76.9	148
Observed l (1991-99)	105	211	69.0	91.0	119
Kura-Salyan					
Natural (1961-90)	403	1528	897	527	840
Observed (1961-90)	495	615	410	342	466
Observed (1991-99)	500	510	332	334	411

Source: Regional'nyi ekologicheskii tsentr, 2002, *Mezhdunarodnoi konferentsii po problemam zasukhi i opustynivaniia: doklady uchastnikov konferentsii, predvaritel'naia publikatsiia*, p. 87.

Table A7: Past and Present Operation of Toktogul Reservoir

	Inflow km3	Losses km3	Release		Total km3	Average Annual Storage Balance km3
			Non-Vegetation Season km3	Vegetation Season km3		
Design: Early 1970s	11.8	0.3	2.8	8.5	11.3	0.2
Annual Average: 1975-91	11.3	0.3	2.7	8.1	10.8	0.2
Annual Average: 1991-2001	13.0	0.3	7.2	6.1	13.3	-0.6
2000/01	12.8	0.3	8.4	5.9	14.3	-1.8

Source: BVO Syr Darya, in WEMP Main Report, p. 31.

Table A8: Cropping Patterns in Central Asia, 1990 and 2000

Country	Year	Cropping Pattern (%)									
		wheat	rice	cotton	maize grain	potato	vege-table	odder	fruit	other	Total
Kazakhstan	1990	21	14	16	1	1	2	22	8	15	100
	2000	13	12	28	0	3	7	21	8	8	100
Kyrghizstan	1990	15	6	30	8	2	10	18	11	0	100
	2000	40	2	11	4	6	7	9	8	13	100
Tajikistan	1990	4	2	40	7	2	7	9	8	20	100
	2000	10	3	37	2	0	2	9	9	29	100
Turkmenistan	1990	5	1	47	4	0	5	17	4	17	100
	2000	43	7	36	1	1	1	4	3	5	100
Uzbekistan	1990	5	4	44	5	1	6	20	13	4	100
	2000	29	3	37	1	1	4	10	10	4	100
% of total	1990	7	4	40	5	1	6	18	10	9	100
	2000	30	5	35	1	1	4	9	8	7	100

Source: WEMP Main Report Supporting Volume, p. 20.

Table A9: Cropping Patterns in Armenia, 1997-2001

	Percent of Total					1,000 ha				
	1997	1998	1999	2000	2001	1997	1998	1999	2000	2001
Grain	59.4	61.4	53.5	59.7	64.2	198.8	198.8	175.6	181.1	203.4
Commercial	0.1	0.1	0.5	1.0	0.5	0.4	0.5	1.6	2.9	1.5
Potatoes	9.8	10.1	9.7	11.3	10.0	32.9	32.7	32.0	34.2	31.8
Vegetables	5.9	6.0	6.4	6.6	6.2	19.7	19.3	20.9	20.0	19.8
Melons	1.1	1.0	1.3	1.1	1.0	3.6	3.3	4.2	3.4	3.3
Fodder	23.7	21.4	28.6	20.3	18.1	79.6	69.2	93.7	61.6	57.3
Total	100	100	100	100	100	335.0	323.8	328.0	303.2	317.1

Source: Arm Goskomstat 2002.

Table A10: Cropping Patterns in Georgia, 1997-2002 (1,000 ha)

	1996	1997	1998	1999	2000	2001	2002
Grain & Legumes	280.7	437.2	415.8	378.8	386.4	380.1	398.9
Commercial	38.4	39.7	59.0	75.8	69.8	46.7	43.5
Potatoes	23.6	27.1	34.4	34.1	37.3	37.4	38.9
Vegetables	28.3	32.3	41.6	43.4	46.1	40.9	39.9
Melons	2.9	3.0	8.7	8.2	9.3	7.6	7.9
Fodder Crops	78.4	57.7	56.6	54.4	61.5	51.8	49.9
Total	452.8	597.5	616.1	594.7	610.8	564.5	579.0

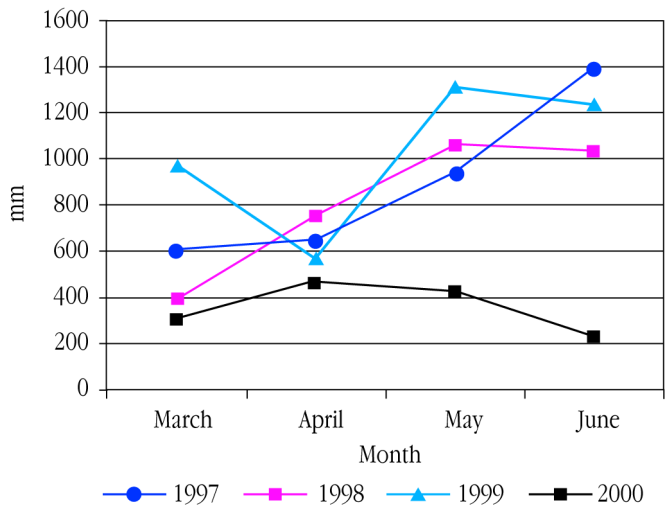
Source: Ge Goskomstat.

Table A11: Cropping Patterns in Azerbaijan, 1995-2001

	Total (1,000 ha)	Grain		Technical		Potatoes, Vegetables, & Garden Crops		Fodder Crops	
		Total (1,000 ha)	% Sown Area	Total (1,000 ha)	% Sown Area	Total (1,000 ha)	% Sown Area	Total (1,000 ha)	% Sown Area
1995	1207.9	609.4	50.5	227.0	18.8	49.4	4.1	322.1	26.7
1996	1207.4	639.4	53.0	233.3	19.3	61.3	5.1	273.4	22.6
1997	1077.9	659.6	61.2	227.0	21.1	63.2	5.9	128.1	11.9
1998	920.4	595.0	64.6	170.1	18.5	76.9	8.4	78.4	8.5
1999	832.7	519.2	62.4	105.0	12.6	107.4	12.9	101.1	12.1
2000	1041.5	648.2	62.2	118.2	11.3	136.1	13.1	139.0	13.3
2001	1162.3	760.7	65.4	99.2	8.5	151.2	13.0	151.2	13.0

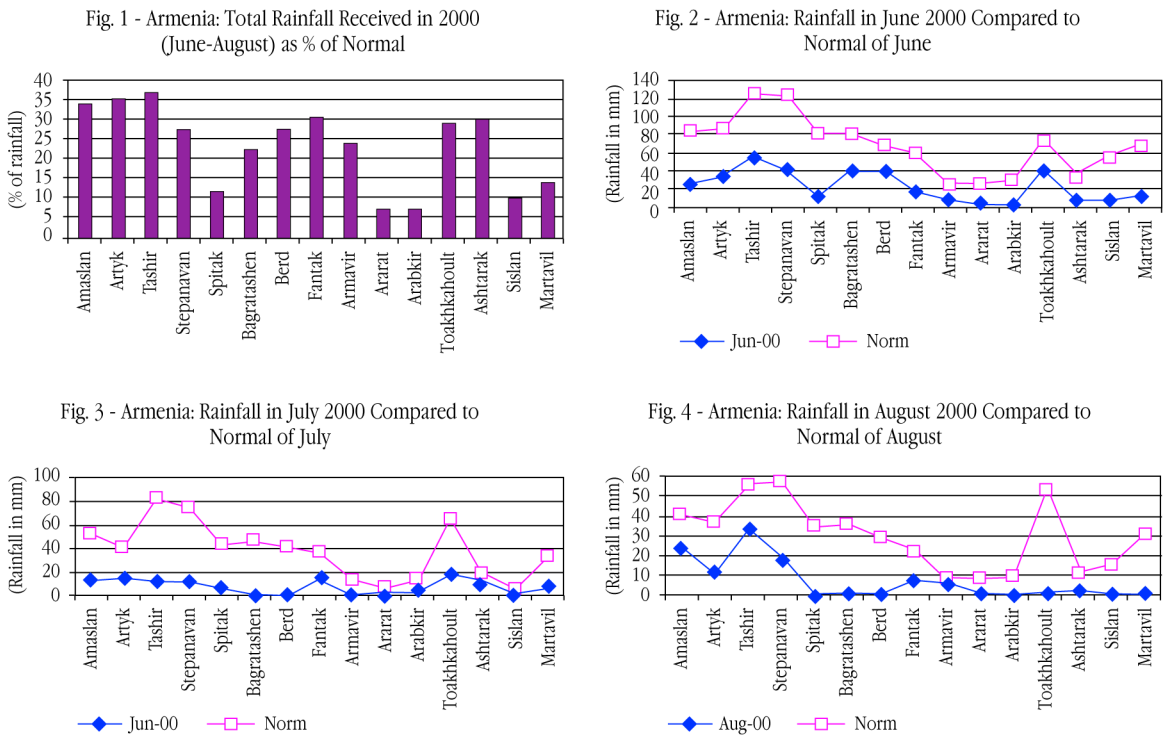
Source: State Statistical Committee of Azerbaijan, *Food Security in Azerbaijan 2002 (Statistical Yearbook)*, http://www.azstat.org/statinfo/foodsecurity/yearbook/2002/en/index.shtml.

Figure A8: Precipitation in Georgia during Spring (March-June) 1997-2000



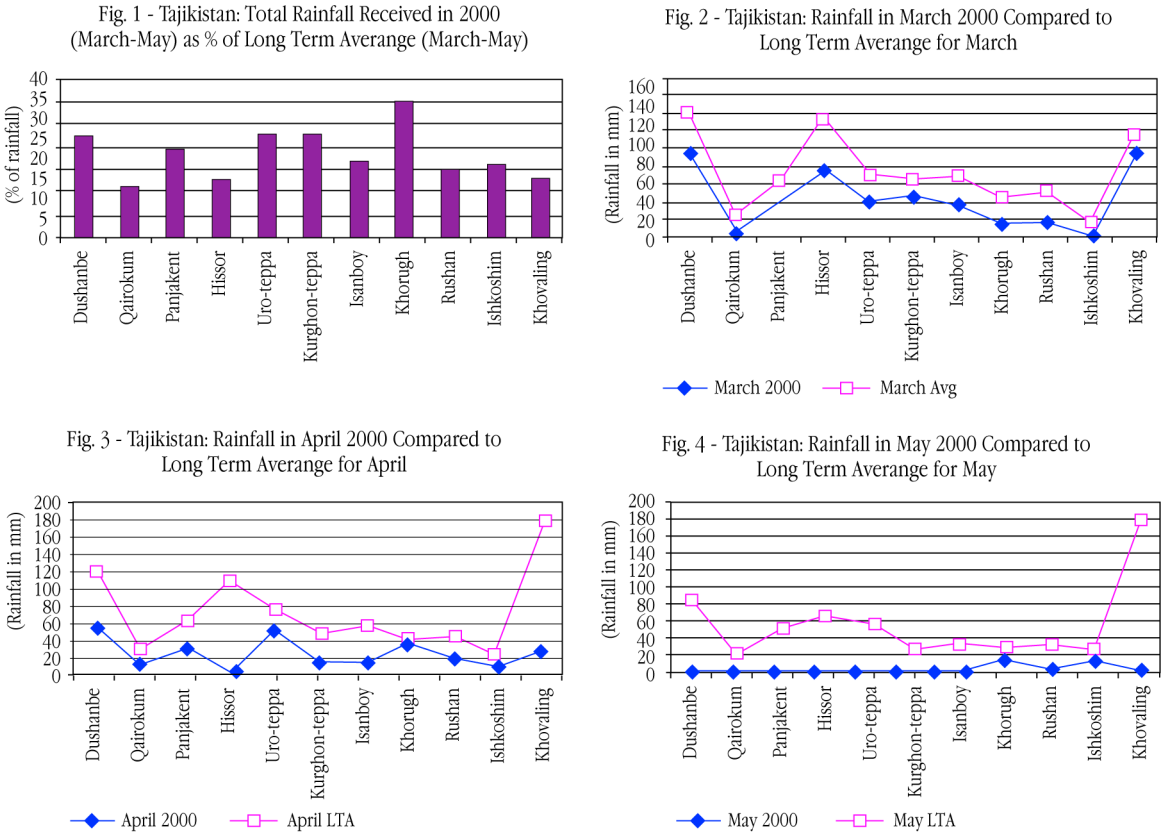
Source: FAO GIEWS, 8 September 2000, *Special Report: FAO/WFP Crop and Food Supply Assessment Mission to Georgia.*

Figure A9: Rainfall in Armenia in Summer (June-August) of 2000 Compared to Normal



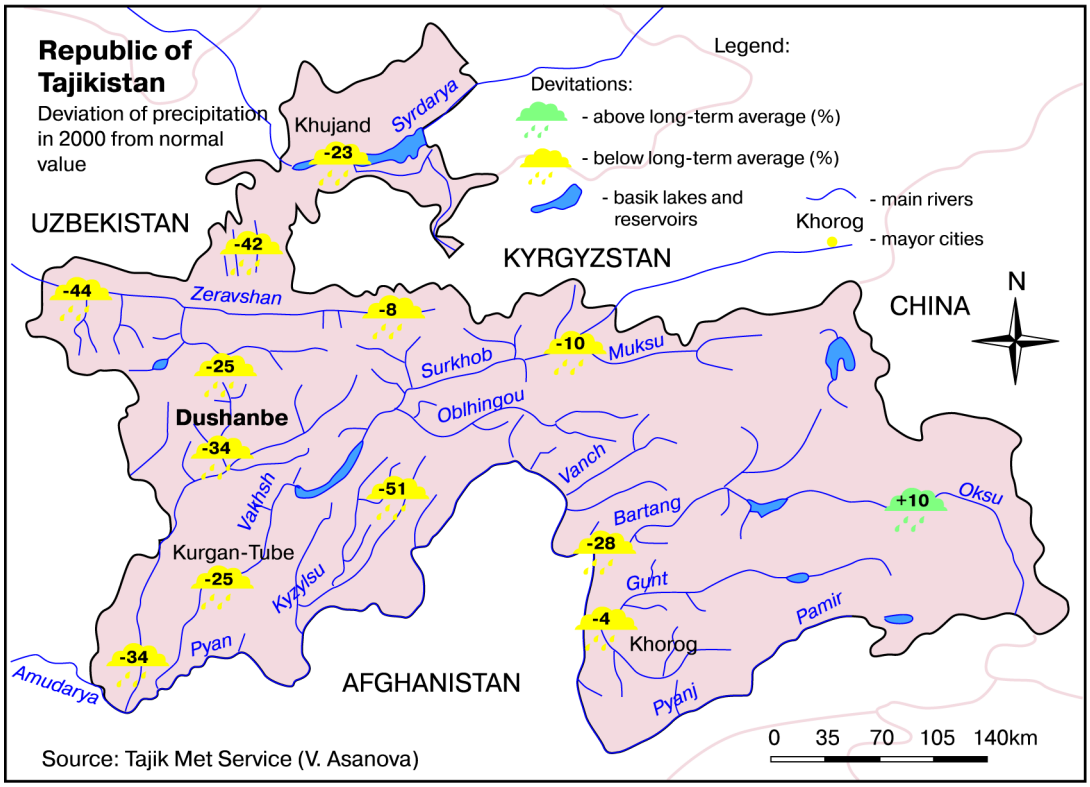
Source: FAO GIEWS, 5 October 2000, *Special Report: FAO/WFP Crop and Food Supply Assessment Mission to Armenia.*

Figure A10: Rainfall in Tajikistan in Spring (March-May) of 2000 Compared to Normal



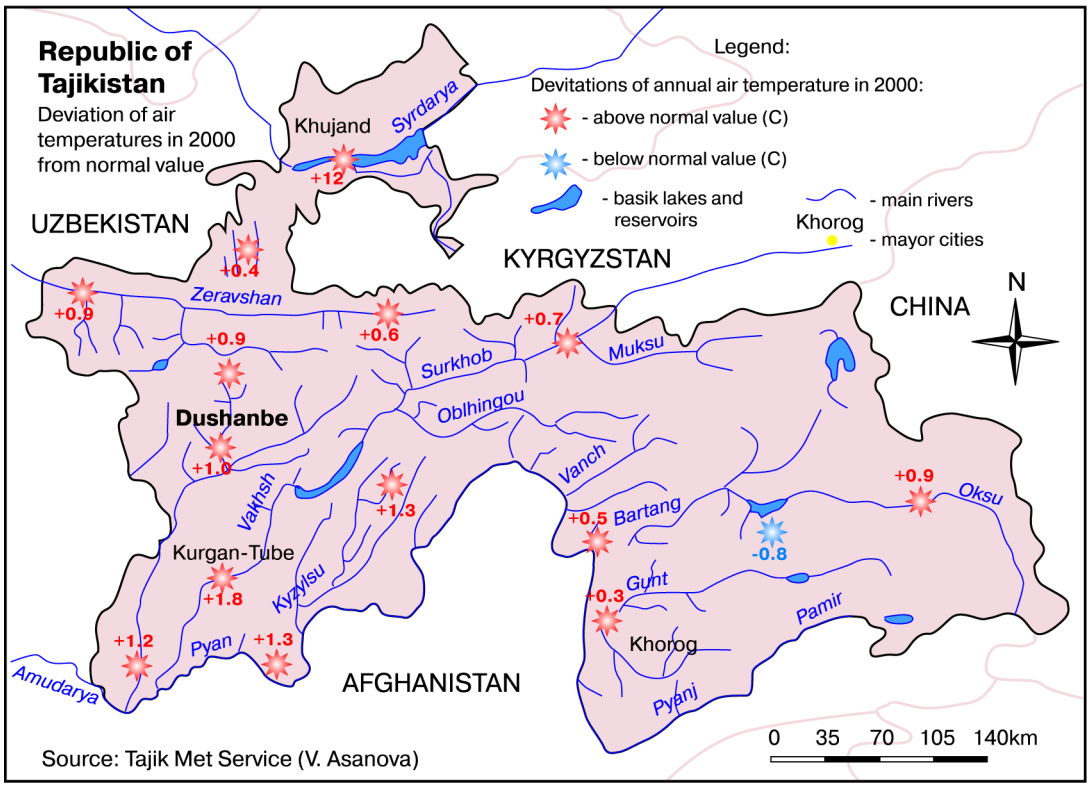
Source: FAO GIEWS, 27 July 2000, *Special Alert No. 310: FAO/WFP Crop and Food Supply Assessment Mission to Tajikistan.*

Figure A11: Deviation of Precipitation in Tajikistan from the Norm in 2000



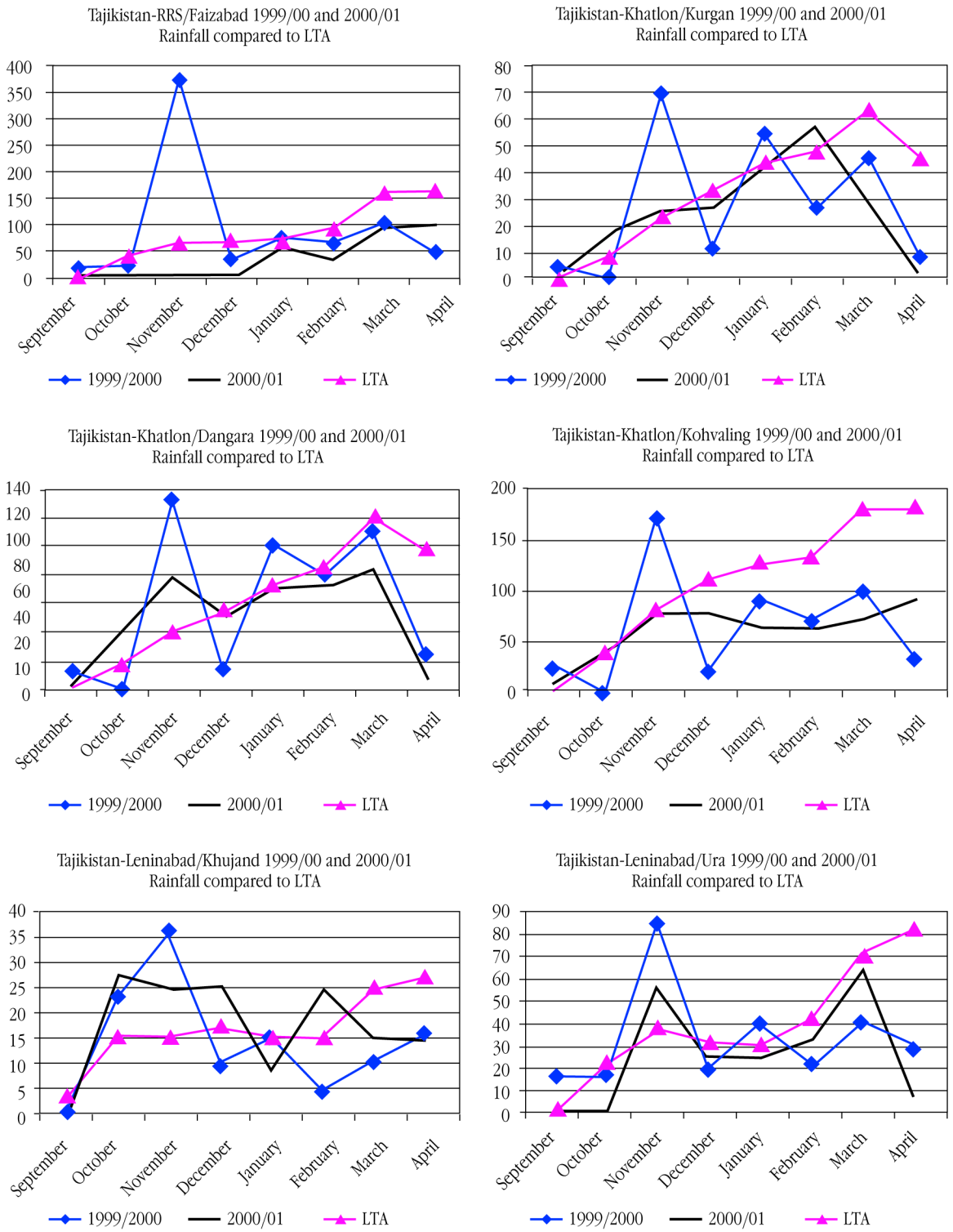
Source: Tajikistan SOE 2002.

Figure A12: Deviation of Temperature in Tajikistan from the Norm in 2000



Source: Tajikistan SOE 2002.

Figure A13: Rainfall in Tajikistan in 2000-01 (September-April) Compared to Normal



Source: FAO GIEWS, 7 August 2001, *Special Report:FAO/WFP Crop and Food Supply Assessment Mission to Tajikistan.*

Table A12: Crop Areas Damaged by Drought in Districts of Karakalpakistan and Khorezm Province

Districts	Sowing Plan (ha)	Actually Sown (ha)	Area On Which Crops Died (ha)	Percent Planned Area Actually Sown (ha)	Percent Sown Area On Which Crops Died (ha)
Karakalpakistan:					
Turtkul	22,613	19,203	2,115	85%	11%
Beruni	28,509	23,378	3,891	82%	17%
Ellikali	20,391	15,690	1,392	77%	9%
Amudarya	33,623	29,598	3,596	88%	12%
Khodjeili	27,551	20,123	7,421	73%	37%
Shumanai	14,514	4,145	2,078	29%	50%
Kanlikul	10,186	6,560	1,237	64%	19%
Kungrad	15,975	8,340	4,730	52%	57%
Muinak	3,411	680	155	20%	23%
Nukus	15,718	12,221	3,226	78%	26%
Kegeili	13,933	6,195	2,719	44%	44%
Chimbai	21,956	7,204	3,107	33%	43%
Karauzyak	14,080	5,819	1,228	41%	21%
Takhtakupyr	13,060	8,675	3,285	66%	38%
Bozataus	12,255	3,047	782	25%	26%
City of Nukus	212	9	9	4%	100%
Town of Tahaus	76	0	0	0%	100%
Total	268,063	170,885	36,811	64%	22%
Khorezm Province:					
Bogot	17,862	15,239	1,538	85%	10%
Gurlen	24,155	19,602	1,934	81%	10%
Kushkupyr	23,698	20,498	3,135	86%	15%
Urgench	24,617	21,212	2,907	86%	14%
Khazarasp	22,473	19,491	2,519	87%	13%
Khanki	22,832	20,580	1,346	90%	7%
Khiva	15,213	14,127	1,973	93%	14%
Shavat	23,313	20,208	1,643	87%	8%
Yangiaryk	13,729	11,837	1,930	86%	16%
Yangibazar	19,258	18,308	2,103	95%	11%
Total	207,600	181,554	21,034	87%	12%

Source: Tahir Mamadaliev, Norboy Ghoyipnazarov, Gulchehra Zununova, 2001, *Assessment of the Drought's Impact Upon Agriculture and Drinking water in the Republic of Karakalpakistan and Khorezm Viloyat.*

Annex 2:
CLIMATE CHANGE IN CENTRAL ASIA AND THE CAUCASUS

	Observed Climate Change	Expected Climate Change by 2100	Water Resources Impact	Agriculture Impact	Environment Impact
Kazakstan*	Temperature rose 1.3 C during 1894-1997, while precipitation fell 5%. During 1961-90 temperature rose significantly, while precipitation shows no tendency.	Rise in temperature of 4.5-6.9 C Precipitation will rise in spring and fall (total 2-24%). Evaporation will rise significantly while humidity falls.	If precipitation rises 20% and temperature by only 2-3 C, the quantity of water resources in North and East Kazakstan will remain stable. Otherwise, reduction by 23-27% is possible.	Grain crops will fall by 6-23%. Pasture productivity will rise with a 1 C increase in temperature, but fall with 3-4 C rise. Lamb output will fall by 5-25% and wool productivity will drop by 10-20%	Desertification will intensify. Erosion will intensify; reservoir sulitation. Soil salinization will intensify.
Kyrgyz Republic	Temperature rose by 1.6 C 1900-2000, while precipitation increase by 6%.	Rise in temperature of 1.8-4.4 C. Precipitation estimates range from –6% to +54%.	Water resources are expected to increase, due to higher precipitation and melting of glaciers.	Crop yields and livestock productivity are expected to rise.	The upper boundary of forest, meadow, desert, and steppe belts will rise 150-200m. Forest cover will expand.
Tajikistan**	1961-90 temperature rose 07.1-2 C. Except for Karategin and Eastern Pamir, precipitation fell by as much as 20%.	Temperatures will rise 2-3 C. Precipitation estimates vary.	Glacial melt will accelerate, with many losing 3-25% of mass. Decline in stream flow of 7-10%.	Irrigation norms will rise by 27-38%. If water is available, productivity of cotton and wheat growing will rise. If precipitation falls, pastures will degrade significantly.	Desertification will intensify. Deforestation will intensify. Erosion will intensify; reservoir siltation. Soil salinization will intensify.
Turkmenistan	1961-1990: temperature rose 0.2-0.6 C; increase in winter precipitation, decrease in summer precipitation.	Temperatures will rise 4.2-6.1 C, while precipitation will fall 4-56%.	Decline in stream flow of 17-51% in smaller rivers.	Cotton crops will require 16-71% more water.	No prognosis available.
Uzbekistan***	1900-2000: temperature rose 1.2 C; alteration of dry and humid periods.	Temperatures will rise 4-6 C. Precipitation will vary 89-126% of the 1960-90 average.	Amu Darya flow falls 0-40%. Syr Darya flow grows 1% or falls 2-28%.	If water is available, productivity of cotton and wheat growing will rise. If precipitation falls, pastures will degrade significantly.	Desertification will intensify. Erosion will intensify; reservoir siltation. Soil salinization will intensify.

* Prognosis is for 2075. ** Prognosis is for 2050. *** Prognosis is for 2030.
Note: Base norm is 1961-90.

	Observed Climate Change	Expected Climate Change by 2100	Water Resources Impact	Agriculture Impact	Environment Impact
Armenia	No observable tendency in temperature; 1935-90 precipitation decreased by 5.8%.	Temperature increase to 1.7 C, precipitation decrease of 10%, and evaporation increase of 3-5%. Extreme weather events become more frequent and severe.	Lake Sevan loses 250 million m3/year Precipitation falls from 17,000 mm3/yr to 15,300 mm3/yr; evaporation from 9,800 to 10,400; sources 8,600 to 7,300. Glaciers recede at an accelerated pace.	Crop yields 8-14% below normal Pasture productivity diminish by 4-10% and the cattle herd by 30%	Desertification will intensify: alpine, sub-alpine, and forest vegetation zones will recede, while steppe, semi-desert, and desert zones will expand. Erosion will intensify. Soil salinization will intensify.
Azerbaijan	Temperature rose 0.3-0.6 C in 1961-90.	Temperature rise of 2-5.1 C; stable or insignificant drop-off in precipitation year-round, although summer precipitation declines	River flow declines by 10-20%, depending upon the rise in temperatures and reduction of snowpack; deficit of water resources will grow from 5 km3 at present to 9.5-11.5 km3 by mid-century.	Soil moisture deficiency will increase irrigation norms by 3,500-4,000 m3/ha in lowland areas. If water is available, cotton productivity rises, wheat and grapes remain stable; pasture productivity stable.	Little impact upon forests Area flood by Caspian. Sea expands 2.8 times. Increase of eroded areas by 10-15%. Soil salinization will intensify.
Georgia	Temperature climbed 0.1-0.5 C in Eastern Georgia and fell by 0.1-0.5 in Western Georgia (1906-95). Precipitation declined 5-15% in most of the country (1964-90).	Temperature increase of 1-2 C. Precipitation decreases in Eastern Georgia and rises in Western Georgia. Droughts and floods become more frequent and severe.	Glaciers melt and recede at an accelerated pace. Increase of river runoff by 15.1% in Western Georgia and 9.32% in Eastern Georgia.	Tea production and viniculture can expand in Western Georgia., In Eastern Georgia viniculture is threatened, and crop loss of wheat and maize may reach 30-60% and 20-30%, respectively.	Flooding and erosion of Black Sea coastline. Desertification will intensify in Eastern Georgia. Erosion will intensify Soil salinization will intensify.

Note: Base norm is 1961-90.

Sources: *Global Change, Sustainable Development, and Environmental Management in Central Asia, Tashkent, Uzbekistan 20-22 January, 2004*; *Initial Communication Under the Framework of the United Nations Framework Convention on Climate Change* (individual reports for Armenia, Azerbaijan, Georgia, Kazakstan, Kyrgyz Republic, Tajikistan, Turkmenistan, and Uzbekistan); UNDP, UNEP, and GEF, *Thematic Workshop on Vulnerability and Adaptation Assessment, Chisinau, Moldova, 26-28 January 2000*.

Annex 3:
TRIGGERING MECHANISMS AND RESPONSE TO DROUGHT

Drought Stage	Minimal/Advisory	Moderate/Watch	Severe/Warning	Critical/Emergency	Exceptional/Disaster
Drought Stage Characteristics and Assessment Criteria	15% Water Supply Reduction: SPI 0 to -0.99; VT Index 36-45. Coming Into Drought: Short tern dryness slowing planting and growing crops or pastures; fire risk above average. Coming out of drought: lingering water deficits; pastures or crops not fully recovered.	15-25% Water Supply Reduction: SPI -1.0 to -1.49; VT Index 26-35. Damage to crops and pastures; fire risk high; streams, reservoirs, or wells low; water shortages developing or imminent.	25-35% Water Supply Reduction: SPI -1.5 to -1.99; VT Index 16-25. Donor triggering mechanisms introduced. Crops or pasture losses likely; fire risk very high; water shortages common.	35-50% Water Supply Reduction; SPI -2.0 or less; VT Index 6-15. Major crop and pasture losses; extreme fire danger; widespread water shortages.	Over 50% Water Supply Reduction; SPI -2.0 or less; VT Index 1-5. Exceptional and widespread crop and pasture losses; exceptional fire risk; shortages of water in reservoirs, streams, and wells, creating water emergencies.
Institutions	MES/Ministries Community Early Warning Institutions Local Governments	Activate Impact Task Force. Select media contacts.	Activate Interagency Coordinating Group. Activate coordination with Donors.	Monitor coordination.	Extend tenure of Impact Task Force and Interagency Coordinating Group
Assessment	Accelerate monitoring of water resources, crops, and rangeland. Preparedness for relief and recovery measures.	Food security and health. Financial analysis of impacts on sectors and communities.	Financial analysis of impacts on environment, government revenues, and credit needs.	Financial analysis of impacts on GDP and balance of payments; Monitory ability to implement short-term contingency measures.	Monitor effectiveness of response measures. Assess need for medium- to long-term recovery measures
Water Supply		Leak detection and repair. Evaluate groundwater supplies and conjunctive use of surface and groundwater.	Use reservoir dead storage. Deepen wells. Supply pumps and pipes for distribution.	Mix fresh and low quality waters. Recycle drainage water.	Utilize low quality waters where appropriate. Haul water in tanks to critical areas.
Water Demand	Voluntary measures to reduce 5-10%.	Review reservoir operations. Review sector trade-offs and transboundary agreements. Voluntary water use restrictions mandatory measures possible if shortage forecast to grow.	Ration water for agriculture and drinking. Conservation ISF rates. Increase penalties for violations. Transfer of water between sectors and areas.	Priority use only: extensive restrictions on water use to reduce demand 40-50%.	Priority use only: extensive restrictions on water use to reduce demand 50-60%.
Impact Mitigation		Conflict resolution. Measures for rainfed crops: input packets. Measures for livestock: water hauling; emergency forage; herd reduction. Increase preparedness for fire suppression.	Emergency potable water supplies for communities. Food and medical aid programs. Farm aid and tax relief. Appeal to outside sources if government budget insufficient.	Expand relief and recovery measures.	Expand relief and recovery measures.
Public Awareness	Message on water shortage.	Weekly updates on weather and water supply conditions. Publicize preparedness measures and health dangers of drought.	Weekly updates on supply conditions and mandated conservation measures.	Daily or weekly updates on emergency response.	Expand updates and activate awareness campaign concerning long-term recovery and mitigation measures.

SPI/Standard Precipitation Index: precipitation deviation from the norm in a particular location. VT Index: Satellite Vegetation Health Index.

Annex 4:
DROUGHT IMPACTS IN 2000 AND 2001

			Drought Impacts in 2000			
	Weather	**Water**	**Agriculture**	**Food Security**	**Health**	**Drinking Water**
Armenia	P: 28% of below normal in summer; 65% annual. T: 2.2-6 C above avg. in summer	River flow decreased by 40-50% In August-September, volume of water is 31% less than previous year.	Wheat and barley harvest reduced 27%, potatoes 40%. In affected communities, 88% of farms significantly damaged, 60% lost all crops and grazing for livestock. "Vast areas of cultivated but non-productive land left un-harvested, particularly in the northern regions" (10/00) Shortage of seed and feed. 54,000 ha mountain grasslands devastated, pasture productivity down 48%. Livestock under-nutrition and slaughtering lower numbers by 20,000 head. Survey estimates $67 million damage by August.	Expected to impact one-third of rural population (10/00). 297,000 in need of critical food assistance (45% of population of affected areas) Chronic malnutrition among children from 13% in 1998 to 22% in late 2000.	Malnutrition	Drinking water supply diminished by 35-35% in May-October in affected marzes.
Azerbaijan	P 8% below avg., but only 40% of avg. in summer	Kura flows down 3x. Mingechevir declined to 8.6 km3 from 10 km3 in 1999.	Spring planted crop losses, but aggregate wheat yields rise. 15 districts lose 30% of wheat harvest; Rainfed/, mountain, downstream, and pump-irrigated areas suffer most. Summer pastures on mountain slopes degraded. Fodder becomes more scarce. Sturgeon and salmon breeding decimated. $110 million damage.	Few farmers significantly affected. No food aid required, except for vulnerable groups such as IDPs..	Malnutrition	na
Georgia	P: 52-66% of avg. in East T: 2-4 C above average.	"Serious effect on the amount of water available for irrigation" (09/00).	Wheat harvest decreases 58% from 1999 to 89,000 t. 57% of districts obtained wheat yields below 1t/ha. Losses in some districts 10% in west, 66% in central, and 95% in east. Rainfed areas suffer. Potato yields down, crop totally lost in rainfed areas. 4,100 t wheat seed available, 26,000 t import required. Fodder prices rise fourfold, feed use falls twofold. Pasturelands degraded. Slaughter of livestock. $260 million damage.	1,308,700 affected by drought (55% of affected population in affected districts, 28% of total population); 696,000 "seriously affected." 60% of households in drought-affected districts food insecure.	na	na
Tajikistan	P: 20-45% of average,	Upstream supply;. Infrastructure deterioration and management are main constraints.	Wheat harvest down 20% from 1999 (35% in Khatlon, where half of districts severely affected) Rainfed wheat crop almost totally failed. Cotton and livestock production stable. Government estimates $49 million damage to agricultural sector. Seeds in short supply or of low quality.	3,011,786 affected (58% of rural population), of which 1,336,190 Khatlon. 1,871,425 million in need of critical food assistance, of which 841,799 in Khatlon and 600,000 in Sughd.	Waterborne diseases, diarrhoea, brucelloses, and anthrax increase, esp. Khatlon	Springs and shallow wells dry out in foothills. Many are forced to drink water from canals and rivers.
Uzbekistan	P; 33-85% below normal	Amu Darya flow 30% below normal (over 50% in downstream areas)	Output of grain fell by 10%, cotton 17%, rice by 60%. 200,000 farms (1,000,00 people) lost crops; Ministry of Economy estimates $50 million damage to agriculture. In Karakalpakistan sown area declined 14% to 334,000 ha, of which 210,000 ha damaged (164,00 totally, 46,00 ha partially); 85% of rice, 75% of maize and 33% of cotton lost. In Khorzem, rice down 84%, potatoes, melons, and fruits 40%, and cotton 32%. Crop failures also in Bukhara, Navoiy, Kashkadarya, Surkhandarya, and Samarkand Provinces.	In Karakalpakistan share of rural population requiring assistance doubled to 20%. Farm households purchase greater share of food in markets, but prices rise. 45,000 in Karakalpakistan in need of food aid.	Diarrhoea and intestinal diseases more frequent, but most health statistics inconclusive.	Transport of water by tanks where canals, wells,and other sources dry. TDS above 1 g/l

Table 3: Drought Impacts in 2001

	Weather	Water	Agriculture	Food Security	Health	Drinking Water
Armenia	P: 58% of avg. in winter, 87% spring, 64-67% summer/fallT 2 C above avg. in winter and spring		Seed shortage. Area sown to winter crops fell by 30% to 70,000 ha. Area sown to spring crops did not expand. Grain output rose to 417,000 t from 225,000 t in 2000. Potato production same as in 2000. Some losses in southern marzes bordering Iran and Azerbaijan. $43 million losses to agriculture.	EMOP merged into PRRO, 140,00 per year.	Malnutrition	na
Azerbaijan		By spring and summer of 2001 the Kura River was at approximately 30% of its normal flow.	Farmers switch to winter grains that mature in June before hot, dry weather begins.		Malnutrition	na
Georgia	Fall P in west 49% of norm, east 59%; drought till March 2002.	Depletion of reservoirs so severe that electricity must be rationed in the capital city.	Seed shortage, rodent proliferation. 62% of normal area planted is sown. Grain output rises to 719,000 t (391,000 t in 2000). Partial or complete loss of spring crops (maize, vegetables, beans) in some western areas. Effects of drought into 2002 in western Georgia. $90 million damages to sector from drought and hail.	Lower beneficiary number of 540,300 adopted by WFP. EMOP being finalized in September (65% funded). Food assistance and FFW in West Georgia.	na	na
Tajikistan	P 60% of average	Snow reservoirs on glaciers 40-60% of normal levels (as in 2000) AD and SD flows 50% of average	Seed shortage, but sown area stable (345,000 ha). irrigated wheat declined by 11% (17% in Khatlon), rainfed by 7%. Wheat output 77% of 1999; greatest losses in Khatlon, where recovery still incomplete in 2002. Rainfed wheat almost totally destroyed. Estimated $50 million in damages to sector.	1,036,073 people in critical need of food assistance	Malnutrition	na
Uzbekistan	Record hot and dry weather conditions	Amu Darya and Syr Darya at 40% of normal flow by spring and summer.	Wheat harvest 23% below 1999, rice 76% lower. Sown area in Karakalpakistan 44% below 1999; grain output 80% below 1999. Losses higher than in 2001. Farmers irrigate with drainage water. 79,000 farm households unemployed in Karakalpakistan, 21,000 in Khorezm; outmigration. $80 million in crop losses in Karakalpakistan and Khorezm.	Over 1,000,000 affected; 600,000 in Karakalpakistan and Khorezm need food aid.	Increasing incidence of infectious, acute respiratory, and waterborne diseases.	Karakalpakistan: level of groundwater recedes to 10-15 meters, many artesian wells useless.

Note: Drought significantly affected Mary and Dashhawuz Provinces of Turkmenistan, Southern Kazakhstan, and some areas in southern portion of the Kyrgyz Republic. These areas are not included into Tables 2 and 3, due to lack of data.

Sources: FAO GIEWS; Tahir Mamadaliev, Norboy Ghoyipnazarov, and Gulchehra Zununova, *Assessment of the Drought's Impact Upon Agriculture and Drinking water in the Republic of Karakalpakistan and Khorezm Viloyat*; Regional'nyi ekologicheskii tsentr, 2002, *Mezhdunarodnoi konferentsii po problemam zasukhi i opustynivaniia: doklady uchastnikov konferentsii, predvaritel'naia publikatsiia*.

Annex 5:
DEVELOPING DROUGHT MITIGATION STRATEGIES

Although drought is a natural hazard, CAC countries can reduce their vulnerability to drought impacts and lessen the risks associated with it through adoption of appropriate mitigation and preparedness (risk management) plans. Planning ahead proactively to mitigate drought gives the Government a chance to avert the most suffering at the least expense. Reacting to drought in "crisis mode" decreases self-reliance and increases dependence of the Government and the people for external aids from donors.

Planning for drought is therefore essential, but the major impediments to drought planning for CAC countries are its cost. Officials may find it difficult to justify the costs of a plan, which are immediate and fixed, against the unknown costs of some future drought. However, experiences has shown in the past that crisis-oriented drought response efforts have been largely ineffective, poorly coordinated, untimely, and inefficient in terms of the resources allocated. Drought planning efforts should use existing political, administrative and institutional structures, and strategies can (and should) be incorporated into general natural disaster or water management plans, thus reducing the cost of planning effort. The complexity of drought impacts requires a preventive, anticipatory approach to risk reduction. How can governments reduce vulnerability to drought? The first steps involve the formulation of a drought policy with clearly stated objectives and the development of a preparedness plan that lays out a strategy to achieve these objectives.

Drought preparedness strategies promote a more preventive, risk management approach to drought management. They reduce vulnerability to drought and reorient future national development programs and strengthen dovetail coordinate emergency assistance from different international organizations. The process of developing a plan will identify vulnerable areas demarcating clearly zones, raions, and jamaots areas, population groups, and economic and environmental sectors. The process also seeks to identify data and informational gaps and research and institutional needs. Ultimately, preparedness strategies will improve coordination within and between various agencies both government and non government; procedures for monitoring, assessing, and responding to shortages of essential needs– water food and fodder; information flow to primary users; and efficiency of resource allocation. The goals of these plans are to reduce water, food and fodder shortage impacts, personal hardships, and conflicts between water and other natural resource users. These plans should promote self-reliance by systematically addressing issues of principal concern at the raion, oblast, the region or at national level. To be successful, drought preparedness plans must be integrated between levels of government and with other national plans or strategies, such as those to ensure food security and soil and natural resource management practices to combat desertification.

Drought preparedness plans shall contain three critical components: (1) a comprehensive early warning system; (2) risk and impact assessment procedures; and (3) mitigation and response strategies. These components complement one another and represent an integrated institutional approach that addresses both short- and long-term management and mitigation issues.

A ten-step process[98] (originally created by Dr. Donald Wilhite in 1991 and subsequently revised and updated) adopted for developing national or agro-climatic region based drought preparedness plans by the

[98] The National Drought Policy Commission's report, Preparing for Drought in the 21st Century, For Wilhite, D.A.; and S.L. Rhodes. 1994. State-level Drought Planning in the United States: Factors Influencing Plan Development. *Water International* 19(1):15–24.

national governments, with appropriate modifications. The process emphasizes strengthening existing institutions rather than developing new ones.

Ten Steps for Drought Planning

- Constituting a National Drought Task Force
- Announcing the General Purpose and approaches of the Task Force
- Task Force Developing Organizational Structure and Preparing Drought Plan
- Integrating Science and Technologies, Policy, Filling in Institutional Gaps
- Develop Organizational Structure and Prepare Drought Plan
- **Integrate Science and Policy, Filling in Institutional Gaps**
- Implement the Plan
- Develop Knowledge Dissemination Programs
- Allocate Resources, coordinate external (international)aid funds
- Post-Drought Evaluation

Step 1: Constituting a National Drought Task Force

A national level drought planning process is initiated through appointment of a drought task force by the President of the Republic, as a part of on going Disaster Management Body. The task force has two purposes. First, the task force supervises and coordinates development of the plan. Second, after the plan is developed and during times of drought when the plan is activated, the task force coordinates actions, implements mitigation and response programs, and makes policy recommendations to the Government. The task force should reflect the multidisciplinary nature of drought and its impacts, and it should include representatives of lead cabinet Ministers, essentially Minister for Irrigation and Water Resources, Environmental Protection, Agriculture, Food, Labor, Health, Public Transport and distribution system, NGOs, Academy of Agricultural Sciences, etc. The actual makeup of this task force would be highly variable between states, reflecting the national political and economic character. The task force needs to incorporate people who know how to conduct effective two-way communication with the public, a public participation practitioner who can help establish processes that accommodate both well-funded and disadvantaged groups.

Step2: Announcing the General Purpose and approaches of the task force:

As its first official action, the Drought Task Force should state the general purpose for the drought plan. The members of the Task Force should proactively consider many questions as they define the purpose of the plan and role of the government in drought mitigation and response efforts. The Task force should cover the following aspects:

- scope of the plan;
- most drought-prone areas of the country;
- historical impacts and responses of drought;
- most vulnerable economic and social sectors;
- role of the plan in resolving conflict between water users and other vulnerable groups during periods of shortage;
- current trends (e.g., land and water use, population growth) that may increase/decrease vulnerability and possible conflicts in the future;
- resources (human and economic) that the country is capable of investing in to the planning process;
- legal and social implications of the plan; and
- principal environmental concerns caused by drought.

A generic statement of purpose for a plan is to reduce the impacts of drought by identifying principal activities, groups, or regions most at risk and developing mitigation actions and programs that alter these

vulnerabilities. The plan is for the government with an effective and systematic means of assessing drought conditions, developing mitigation actions and programs to reduce risk in advance of drought, and developing response options that minimize economic stress, environmental losses, and social hardships during drought.

Step 3. Task Force Developing Organizational Structure and Preparing Drought Plan

The task force should then select the organizational set up from the line ministries that fit in to the specific objectives that support the purpose of the plan. Drought plan objectives will, of course, vary between zone/district in the country and should reflect the unique physical, environmental, socioeconomic, and political characteristics of each zone/district or region. Objectives for the may be considered for inclusion:

- Collect and analyze drought-related information in a timely and systematic manner.
- Establish criteria for declaring drought emergencies and triggering various mitigation and response activities.
- Provide an organizational structure and delivery system that assures information flow between and within levels of government.
- Define the duties and responsibilities of all agencies with respect to drought.
- Maintain a current inventory of state and federal programs used in assessing and responding to drought emergencies.
- Identify drought-prone areas of the state and vulnerable economic sectors, individuals, or environments.
- Identify mitigation actions that can be taken to address vulnerabilities and reduce drought impacts.
- Provide a mechanism to ensure timely and accurate assessment of droughts impacts on agriculture, drinking water to the population, industry, forests, wildlife, health, and other areas.
- Keep the public informed of current conditions and response actions by providing accurate, timely information to mass media in print and other media (e.g., News papers, Bulletins, Notice Boards in Public places, TV, and radio,).
- Establish and pursue a strategy to remove obstacles to the equitable allocation of water during shortages and establish requirements or provide incentives to encourage water conservation.
- Establish a set of procedures to continually evaluate and exercise the plan and periodically revise the plan so it will stay responsive to the needs of the state.

Social, economic, and environmental values often clash as competition for scarce water resources intensifies. Therefore, it is essential for the task force members to identify all citizen groups that have a stake in drought planning (stakeholders) and their interests. These groups must be involved early and continuously in order for a fair representation and effective drought management and planning. Discussing concerns early in the process gives participants a chance to develop an understanding of one another's various viewpoints, and to generate collaborative solutions. Although the level of involvement of these groups will vary notably from state to state, the power of public interest groups in policy making is considerable. In fact, these groups are likely to impede progress in the development of plans if they are not included in the process. The task force should also protect the interests of stakeholders who may lack the financial resources to serve as their own advocates.

Public participation takes many forms. Time and money may constrain how actively the task force can solicit input from stakeholders. One way to facilitate public participation is to establish advisory councils as a permanent feature of the drought plan, to help the task force keep information flowing and resolve conflicts between stakeholders. Another way is to invite stakeholders to serve on working groups of the risk assessment committee at various levels from Jamaot, Raion, Oblast zone and state level.

Step 4: Scientific Inventory of Natural resources

Scientific inventory of natural, biological, and human resources and determine the vulnerability of these resources to periods of water shortage that result from drought. The most obvious natural resource of importance is water: where is it located, how accessible is it, and of what quality. Biological resources refer to the quantity and quality of, orchards, animal species, grasslands/rangelands, forests, wildlife, and so forth.

It is also imperative to identify constraints to the planning process and to the activation of the plan in response to a developing drought. These constraints may be physical, financial, legal, or political. The costs associated with the development of a plan must be weighed against the losses that will likely result if no plan is in place. The purpose of a drought plan is to reduce risk and therefore economic, social, and environmental impacts. In drought planning, making the transition from crisis to risk management is difficult because, historically, little has been done to understand and address the risks associated with drought. To solve this problem, areas of high risk should be identified, as should actions that can be taken before a drought occurs to reduce those risks. Vulnerability is defined by social factors such as land use patterns, social behavior, water use, population, and economic development, diversity of economic base, cultural composition, and so forth.

Step 5: Develop Organizational Structure and Prepare Drought Plan

This step describes the process of establishing relevant committees to develop and write the drought plan and develop the necessary organizational structure to carry out its responsibilities. The drought plan should have three primary components: monitoring, risk assessment, and mitigation and response. A well-established communication and information flow between committees and the task force is a necessity to ensure effective planning.

Specific responsibilities of the task force at this point are to:

- Determine mitigation and response actions for each of the principal impact sectors, in close cooperation with the risk assessment committee.
- Assess of drought mitigation technologies and transferability of these technologies to specific situations at the grassroots level needs to be evaluated further because they may not be directly transferable in some cases.

Working with the Scientific institutions, domestic and foreign and international, the task force should come up with recommendations for addressing drought both short and long term responses scales:

- Short-term responses to implement during drought, such as voluntary water conservation guidelines, a ready-to-roll hay, streamlined administrative procedures for evaluating emergency assistance applications, and pre-produced guidelines to farmers on best farm management practices.
- Long-term drought mitigation projects, such as programs to give various audiences the background they need to interpret drought news reports or scientific drought management programs to persuade people to adopt measures that enhance organic content in soil, conserve soil water, and otherwise boost the resilience of natural and social systems that are vulnerable to drought, action against desertification, enhancing micro-catchment based water harvesting system, efficient pasture and forest management, multiple or strip cropping system, adoption of farm forestry, and biological soil conservation system to enhance greening of area etc. List out different forms of assistance available from local, state government during severe drought. The task force should evaluate these programs for their ability to address short-term emergencies and long-term vulnerability to drought. Assistance should be defined very broadly to include all forms of technical, mitigation, and relief programs available.

Work with the monitoring and risk assessment committees to establish triggers. The monitoring committee can advise the task force on which drought and water supply indices are most relevant for the state or region. It is helpful to establish a sequence of descriptive terms for water supply alert levels, such as advisory, alert, emergency, and rationing and allocation of available water. The task force should review the position

with reference to local utilities, national and international river basin water availability, and especially the central Asian Countries with International Fund for Aral Sea (IFAS) that are consistent in areas where authorities may have overlapping regional responsibilities. Government may seek international donors and financing agencies to provide for technical assistance for resolving drought related problems.

Establish drought management areas (i.e., subdivide the state into more conveniently sized districts by agro-climatic or administrative boundaries, commonly shared hydrological characteristics, climatologically characteristics, or other means such as drought probability risk, etc.) with local monitoring committees. These subdivisions may be useful in drought management since they may allow drought stages and mitigation and response options to be regionalized. Climatic divisions are the most commonly used subdivisions at the national level, but they may not be the most appropriate, given topographic features, land use patterns, or water use characteristics. The task force should work closely with the monitoring committee with the risk assessment committee to understand the impact of various degrees of droughts effects on different economic sectors and social groups to provide mitigation support.

Local Monitoring Committee

A reliable assessment of water availability and its outlook for the near- and long-term is valuable information in both dry and wet periods. During drought, the value of this information increases markedly. The monitoring committee should include representatives from agencies with responsibilities for monitoring climate and water supply. It is recommended that data and information on each of the applicable indicators (e.g., precipitation, temperature, evapotranspiration, long-range weather forecasts, soil moisture, stream flow, ground water levels, reservoir and lake levels, and snow pack, etc.,) be considered in the committee's evaluation of the water situation and outlook for the area. The agencies responsible for collecting, analyzing, and disseminating data and information will vary according to the state organizational structure and by geographic region.

The monitoring committee should meet regularly, especially in advance of the peak demand season. Following each meeting, reports should be prepared and disseminated to the drought task force at the national level, relevant ministries, institutions and service agencies, and the media. The chairperson of the monitoring committee should be a permanent member of the drought task force. The monitoring committee should work closely with public information specialists to keep the public well informed.

Risk Assessment Committee

Drought impacts cut across many sectors and across normal divisions of responsibility of local, and national agencies. The membership of the risk assessment committee should represent economic sectors, social groups, and ecosystems most at risk from drought. The committee's chairperson should be a member of the task force. The most effective approach to follow in determining vulnerability to and impacts of drought is to create working groups under the aegis of the risk assessment committee. The responsibility of the committee and working groups is to assess sectors, population groups, and ecosystems most at risk and identify appropriate and reasonable mitigation measures to address these risks. Working groups would be composed of technical specialists in the area of water, soils, crop, animal husbandry, public health, and stakeholders representing farmers, NGOs, private service sector areas. The chair of each working group, as a member of the risk assessment committee, would report directly to the committee. Following this model, the responsibility of the committee is to direct the activities of each of the working groups and make recommendations to the drought task force on mitigation actions. The number of working groups will vary considerably between CAC countries.

Step 6: Integrate Science and Policy, Close Institutional Gaps

An essential aspect of the planning process is integrating the science and policy of drought management. The policy maker's understanding of the scientific issues and technical constraints involved in ad-

dressing problems associated with drought is often limited. Likewise, scientists generally have a poor understanding of existing policy constraints for responding to the impacts of drought. In many cases, communication and understanding between the science and policy communities must be enhanced if the planning process is to be successful. Integration of science and policy during the planning process will also be useful in setting drought mitigation priorities and synthesizing current understanding. The drought task force should consider various alternatives to bring these groups together and maintain a strong working relationship.

As research needs and gaps in institutional responsibility become apparent during drought planning, the drought task force should compile a list of those deficiencies, involving and interacting with international research institutes of CGIAR, FAO, and make recommendations to national planning system to set priorities in allocation of budget or seek international donor/financing assistance. For example, the monitoring committee may recommend establishing national level weather monitoring remote sensing system, strengthening of national agromet network system enhancing a ground water monitoring program, promoting research on evolving drought tolerant high yielding varieties suited to each of the agro-climatic region, mass media dissemination system. Another recommendation may be to initiate research on the development of a climate or water supply index to help monitor water supplies and trigger specific actions by local government.

Step 7: Publicize the Proposed Plan, Solicit Reaction

Successful Drought management is achieved by establishing a good national communication system with the public throughout the process of establishing a drought plan and its implementation. A better-than-normal awareness of drought and drought planning is essential by the time the task force recommends various drought mitigation and response options. Themes to emphasize in writing news releases and organizing informational meetings during and after the drought planning process could include:

- How the drought plan is expected to relieve impacts of drought. Stories can focus on the human dimensions of drought, such as how it affects a farm family; on its environmental consequences, such as reduced wildlife habitat; and on its economic effects, such as the costs to a particular industry or to the state's overall economy.
- What it will cost to implement each option and how it will be funded.
- What changes people might be asked to make in response to different degrees of drought, such as restricted lawn watering and car washing, or not irrigating certain crops at certain times.

In subsequent years, it may be useful to do drought plan refresher news releases at the beginning of the most drought-sensitive season, letting people know whether there is pressure on water supplies or reason to believe that there will be shortfalls later in the season, and reminding them of the plan's existence and history and any associated success stories. It may be useful to refresh people's memories ahead of time on circumstances that would lead to water use restrictions. During drought, the task force should work with public information communication professionals to keep the public well informed of the current status of water supplies, whether conditions are approaching trigger points that will lead to requests for voluntary or mandatory use restrictions, and how victims of drought can access assistance. All pertinent information should also be available on the state's drought website so that the public can get information directly from the task force without having to rely on mass media.

Step 8: Implement the Plan

Once the task force and any external constituencies have agreed on the plan, the task force and its designated representatives should oversee implementation of both the short-term operational aspects of the plan and long-term mitigation measures. Periodic testing, evaluation, and updating of the drought plan will help keep the plan responsive to the local dynamic needs. An ongoing or operational evaluation keeps track of how changes such as new technology, new research, new laws, and changes in local leadership may

affect drought risk and the operational aspects of the drought plan. Drought risk may be evaluated quite frequently while the overall drought plan may be evaluated less often. It is important to remember that drought planning is a process, not a discrete event.

Long-term mitigation measures, such as implementing policies that require conjunctive use of ground and surface water, long term research program etc., may require drafting new legislation and finding funds to support new monitoring and regulation efforts. In any case, it is essential to recognize that reducing long-term vulnerability to drought will require a sustained long term anti desertification effort, although it may be a matter of long-term programs undertaken by a variety of agencies.

Step 9: Develop Education Programs

A broad-based education program to raise awareness of short- and long-term water supply and drought mitigation issues will help ensure that people know how to respond to drought when it occurs and that drought planning does not lose ground during non-drought years. It would be useful to tailor information to the needs of specific groups (e.g., university, and higher secondary school education, small business, industry, local village level utilities). The drought task force or participating agencies should consider developing presentations and educational materials for events such as a water awareness week, forestry development week, community observations of Earth Day, relevant trade shows, specialized workshops, exhibition and other gatherings that focus on natural resource stewardship or management.

Step 10: Post-Drought Evaluation

A post-drought evaluation assessment and response actions of government, nongovernmental organizations, and other institutions, provides for a mechanism to and adoption of recommendations will help for improving the system. Post-drought evaluations should include an analysis of the climatic and environmental aspects of the drought; its economic and social consequences; the extent to which pre-drought planning was useful in mitigating impacts, in facilitating relief or assistance to drought stricken areas, and in post-recovery; and any other weaknesses or problems caused or not covered by the plan. Attention must also be directed to situations in which drought-coping mechanisms worked and where societies exhibited resilience; evaluations should not focus only on those situations in which coping mechanisms failed.

Evaluations of previous responses to severe drought are also a good planning aid.

To ensure an unbiased appraisal, and dispassionate assessment, governments may wish to place the responsibility for evaluating drought and societal response to it in the hands of nongovernmental organizations such as universities and/or specialized research institutes.

Annex 6:
RELATED PROJECTS

	Disaster Management	Forecasting and Early Warning	Water Management
Caucasus		South Caucasus Water Management (USAID, TACIS, UNDP – 2001) Caspian Environment Program (UNDP, TACIS, WB) Caspian-HYCOS (WMO – Pipeline) Hydrometeorological Safety of TRACECA (WMO)	Water Management in the South Caucasus (USAID, TACIS, UNDP – 2001) Caspian Environment Program (UNDP, TCAIS, WB)
Armenia	Consolidated Support to National Disaster Preparedness System (UNDP – 2003) Dam Safety (WB – 1999) Irrigation Dam Safety II (WB – Pipeline) Country Assistance Strategy (IFRC 2000)		Irrigation Development (WB – 2001) Armenia Water Management (USAID – 2000)
Azerbaijan	National Program for Developing and Reorganizing the System for Disaster Management Training (UNDP – 1999) Flood Mitigation (ADB – 2001) Country Assistance Strategy (IFRC – 2000)	Flood Mitigation (ADB – 2001)	Rehab. & Completion of Irrigation and Drainage Infrastructure (WB – 2000) Irrigation Distribution System & Management Improvement (WB – Pipeline)
Georgia	Disaster Management Capacity Building (UNDP – 1999) Country Assistance Strategy (IFRC – 2000)		Irrigation and Drainage Community Development Project (WB – 2001)
Central Asia	Regional Drought Preparedness Network for Asia and the Pacific (UN) Sub-Regional Initiative for South-West and Central-Asia (UNDP) First DIPECHO Action Plan for Central Asia (DIPECHO – 2003) Ferghana Valley Disaster Preparedness (ECHO/ Mercy Corps)	Improved Management of Critical Natural Resources (USAID, NOAA – 2001) Regional Center of Hydrology in Central Asia (SADC – 1995) Aral-HYCOS (WMO – Pipeline) Hydrometeorological Safety of TRACECA (WMO)	Improved Management of Critical Natural Resources (USAID – 2001) Integrated Water Resources Management in the Ferghana Valley Water User Association Support Project (USAID – 2004)
Kazakstan			Irrigation and Drainage (WB – 1996)
Kyrgyzstan	Disaster Hazard Mitigation (WB – Pipeline) Strengthening the Capacity of the Government for Disaster Mitigation and Preparedness (UNDP – 1997)		Irrigation Rehabilitation (WB – 1998) On-Farm Irrigation (WB – 2000)
Tajikistan	Disaster Preparedness Action Plan (CARE) Community Based Food Security and Poverty Allevation in Tajikistan (ACTED – 2004) Country Assistance Strategy (IFRC – 2000) Lake Sarez Risk Mitigation (WB-2000) Preparatory Assistance (UNDP – 2003)		Rural Infrastructure Rehabilitation (WB – 2000) Ferghana Valley Water Resources Management (WB – Pipeline) Farmers Irrigation Project (CARE)
Turkmenistan			
Uzbekistan	Advisory Services to the Government for Drought Prevention (UNDP – 2003)		Drainage, Irrigation and Wetlands Improvement Phase I (WB – 2003) Amu Zang Irrigation Rehabilitation (ADB – 2003)

Caucasus	Agro-Meteorology	On-Farm Soil and Water Conservation
Armenia		Farmer to Farmer (ACDI/VOCA – 1992) Natural Resources Management and Poverty Reduction (WB – 2002) Marketing Assistance (USDA –) Agricultural Services (IFAD – 2001)
Azerbaijan		Farmer to Farmer (ACDI/VOCA – 1996) Northeast Development Project (IFAD – Pipeline) Rural Development Program for Mountainous and Highland Areas (IFAD – 2000) Irrigation Distribution System & Management Improvement (WB – Pipeline)
Georgia		Sustainable Livelihoods in Adigeni and Adjacent Rayons (CARE) Agricultural Research, Extension and Training (WB – 2000) Agricultural Assistance (USDA) Farmer to Farmer (ACDI/VOCA – 1996) Seed Enterprise Enhancement and Development (ACDI/VOCA – 1997) Rural Development Program for Mountainous and Highland Areas (IFAD – 2000)
Central Asia		On-Farm Soil and Water Management (ICARDA) Regional Network of Wheat Variety Promotion and Seed Production (ICARDA) Integrated Feed and Livestock Production (ICARDA) Livestock Development and Rangeland Conservation Tools (UC Davis) Farmer-to-Farmer Program (Winrock)
Kazakstan	ISEAM (GAF – 1999)	Drylands Management (WB – 2003) Agricultural Competitiveness Project (WB – Pipeline)
Kyrgyzstan		Agriculture Support Services (WB, IFAD – 1998) On-Farm Irrigation (WB – 2000) Rural Livelihood Development (ADB – 2004) Second Agriculture Area Development (ADB – 2004)
Tajikistan		Community Agriculture and Watershed Management (WB – Pipeline) Ferghana Valley Water Resources Management (WB – Pipeline) Agriculture Rehabilitation Project (ADB – 2000) Water Resources Development and Rehabilitation (ADB – 2002) Rural Poverty Reduction (CARE –) Food and Agriculture Consortium (CARE) Varzob Highlands Food Security and Capacity Building (CARE) Food and Economic Security (CARE)
Turkmenistan		Participatory Desertification Control (BMZ – 1995)
Uzbekistan	ISEAM (GAF – 1999)	Crop Irrigation Management for Combating Irrigation Induced Desertification (EC – 2000) Ak Altin Agricultural Development (ADB – 2001) Grain Productivity Improvement (ADB – 2003) Farmer To Farmer (Uzbekistan)

	Food Security Early Warning and Relief Operations	Drinking Water	Environment
Caucasus	World Food Program RESAL (EU)	Caspian Environment Program (UNDP, TCAIS, WB)	UN Convention to Combat Desertification
Armenia		Social Investment Fund II (WB – 2000) Municipal Water and Wastewater (WB – 2004)	Natural Resources Management and Poverty Reduction (WB – 2002)
Azerbaijan		Rural Investment (WB – 2004) Baku Water Supply (WB – 1995)	
Georgia		Second Social Investment Fund (WB – 2003) Tbilisi Water Supply (WB – Pipeline)	Forests Development (WB – 2002)
Central Asia	World Food Program RESAL (EU)	Community Action Investment (ACDI/VOCA, CHF, Mercy Corps, AKF, UNDP)	UN Convention to Combat Desertification
Kazakstan		Rural Water Supply and Sanitation Sector (ADB – 2003) Kazakhstan Community Loan Fund (ACDI/VOCA – 1996) Atyrau Pilot Water Supply and Sanitation (WB – 1999)	Forest Protection and Reforestation (WB – Pipeline)
Kyrgyzstan		Village Investment (WB – 2003) Rural Water and Sanitation (WB – 2001) Small Towns Infrastructure and Capacity Building (WB – Pipeline)	Kyrgyz-Swiss Forestry Support Program (SADC)
Tajikistan	Food For Work, with Materials (CARE)	Dushanbe Water Supply (WB – 2002) Second Poverty Alleviation (WB – 2002)	
Turkmenistan			
Uzbekistan	Development Support Services Program: Drought Mitigation and Emergency Actions to Mitigate Drought Consequences (UNDP – 2001)	Rural Water Supply & Sanitation (WB – 1997) Bukhara and Samarkand Water Supply (WB – 2002) Western Uzbekistan Rural Water Supply Project (ADB – 2002) Aral Sea Area Drought Relief (ADB – 2002) Kashkadarya and Navoi Rural Water Supply Project (ADB – Pipeline)	

Annex 7:
DROUGHT MITIGATION MEASURES FOR FARMERS AND HERDERS

During the drought agricultural producers in Central Asia and the Caucasus would have benefited significantly from mitigation measures designed to reduce the impact of agricultural drought. There is wide range of measures that can be introduced and developed in all sub-sectors of agriculture. In the 1990s local and foreign specialists in Central Asia and the Caucasus tested many of these measures, including techniques in on-farm soil and water conservation, crop management, and range and herd management. However, not all of these measures have been studied in depth, and many have not yet been widely adopted.

Improving and Diversifying Production Systems. Perhaps the best measure available for agriculturalists to combat agricultural drought is diversification of production, which allows them to spread the risk among activities, such as livestock, silk production, and tree crops. Diversification was the hallmark of successful survival strategies in Georgia and elsewhere. Most subsistence farmers in Central Asia and the Caucasus already employ a mix of crop and livestock production, yet other combinations might be found that will serve better in areas where drought is frequent. [99]

Farm restructuring and land reform are expected to lead to greater productivity over the medium and long term. Farm restructuring will provide farmers with the ability to choose their own production system, which, if appropriate, will contribute to drought mitigation. Land consolidation will lead to greater productivity reduce the number of vulnerable subsistence farms, as well as provide opportunities for collateralization and investment into mitigation. Creation of off-farm employment is required not only to absorb excess labor that is shed from restructured and consolidated farms, but also to contribute to diversification of farm incomes.

Much less attention has been paid to production systems for livestock producers. Following the collapse of the collective and state farm structure (in most countries of the Caucasus and many in Central Asia), there is an organizational vacuum in pastoral production systems, which hinders the coordination of drought (and other risk) management and mitigation by herders. There is a need to facilitate the creation of formal and informal organizational structures that support collective action in risk management as part of pastoral economic development. Improving pasture tenure arrangements, such as establishing multi-year leases to encourage investment, rationalizing the seasonal allocation of pasture, and strengthening conflict management, will also enhance preparedness for drought. Tenure arrangement should also facilitate the creation of grazing reserves for emergency situations. Customary institutions should not be overlooked, as these are often the primary protection for herders against natural disasters.[100]

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[99] Marginal cropland might even be converted in some instances to a mixed crop-livestock use or even perennial grasses, legumes, and woody trees (as in some areas of India). See; H.P. Singh, 2001, "Developing Farming Systems and Best Practices for Drought-Prone Areas," *FAO Asia-Pacific Conference on Early Warning, Prevention, Preparedness and Management of Disasters in Food and Agriculture, Chiangmai, Thailand, 12-15 June 2001*, pp. 5-7, 16-17.

[100] Phillip Brylski, Tjaart Schillhorn-van Veen, and Paavo Este, 2001, *Kyrgyz Republic Mountain Rangeland and Forest Sector Note, World Bank ECSSD Working Paper No 33, September 10,* 2001; Steven Baas and Jeremy Swift, "Pastoral Institutions and Approaches to Risk management and Poverty Alleviation in Central Asian Countries in Transition," FAO Rural Development Division; —, 2001, "Pastoral Risk Management for Disaster Prevention and Preparedness in Central Asia, with Special Reference to the Case of Mongolia." *FAO Asia-Pacific Conference on Early Warning, Prevention, Preparedness and Management of Disasters in Food and Agriculture, Chiangmai, Thailand, 12-15 June 2001*, pp. 12, 17. These articles focus primarily upon the cases of the Mongolia and the Kyrgyz Republic.

Improving Market Incentives and Access. Farmer and herders require better market information in order to prepare for and respond effectively to drought. State purchasing quotas for "strategic crops" such as cotton should be eliminated, as they limit the diversification of production systems. Market access should be extended to remote rural areas as much as possible.

Rural Finance. There is an urgent need for savings, credit, and insurance institutions, particularly in remote areas. Farmers and herders are in need of appropriate savings mechanisms and credit for working capital, which will provide resources needed for mitigating the impact of drought and speeding recovery from it. The rural financial systems of the countries of Central Asia and the Caucasus are too weak for the introduction of risk transfer mechanisms such as rainfall and animal insurance. Therefore, rural financial institutions should be developed over the medium- to long-term in a manner that permits farmers to employ these institutions in risk management.

Cropland Management. Provided with the right techniques, farmers in Central Asia and the Caucasus can prepare of the land for crop production in ways that would diminish the impact of drought. In rainfed areas, conservation tillage and moldboard plowing after winter wheat harvests have been found to be an economical way to maintain greater soil moisture content and obtain higher yields under dry conditions. In irrigated areas where plow pans have accumulated, deep ripping has improved irrigations and yields significantly. The testing of tillage methods for both rainfed and irrigated conditions is ongoing in several countries.[101]

Ground cover helps to prevent moisture loss, as well as prevent erosion and mudslides that commonly follow drought. In steppe and desert areas, shelterbelts of trees can provide up to 20% reduction in evapotranspiration. Hedges between parcels and increased vegetative cover conserve soil moisture and prevent erosion in mountain areas. These methods are being explored under the auspices of the World Bank's Community Agriculture Watershed Management Project in Tajikistan. In addition to increasing cover of cropland, parcels in drought-prone areas with especially poor soils might be retired and converted to rangeland or some other use.

Land can be configured for water conservation. Leveling of fields is required in most irrigated areas to distribute water more evenly and prevent salinization when soils dry. Terracing and mulching with plant residues have proven to be an efficient method of conserving soil moisture in sloped areas of Tajikistan. Plastic mulch, as practiced in western China for cotton planting, may help to conserve heat and water as well as suppress weeds without pesticides. In Uzbekistan, *joyaks*, zigzag irrigation furrows, provide more uniform soil moisture in sloped areas and reduce erosion. It remains to test other technologies employed in other arid regions of the world, such as field and contour bunding or vegetative barriers, and ridging with micro-catchments.

Rangeland Management. Several actions are required to improve this critical component of pastoral and many farm systems. These include the following:

- Improvement of the monitoring of rangeland resources (possibly through the introduction of NDVI technologies);
- Improved herd management and mobility to reduce overgrazing near settlements (see below);
- Management of grazing rotations and animal rest periods to favor forages that remain nutritious and palatable to animals during drought;
- Inter-seeding rangeland with drought-resistant forages, such as grasses (sorghum, sudangrass, crested wheatgrass, barnyard millet) and legumes (especially alfalfa);
- Planting range stripes of beneficial bushes, such as White Saxaul (*Haloxylon Persicum*) and Black Saxaul (*Haloxylon Aphyllum*); and
- Establishment of nurseries for future range rehabilitation.

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[101] ICARDA, 2004, *Inception Workshop and First Steering Committee Meeting of the Asian development Bak regional project (RETA 6136) on Improving Livelihoods through Efficient On-Farm Water and Soil Fertility Management, 19029 February, 2004*; MMD Ak Altin Report.

ICARDA successfully tested methods of rehabilitating degraded rangelands under drought conditions in Turkmenistan, Kazakhstan and Uzbekistan. It remains to expand these efforts over wider areas.

Mobility is key to rangeland management. However, subsidized transportation to distant pastures is no longer available to herders, as during the Soviet period. It remains to explore market-oriented mechanisms to facilitate access during drought to distant pastures that have recovered (and during snowstorms to moving herds away from threatened areas).

On-Farm Water Management. Research on demonstration fields in Central Asia has identified several ways to make on-farm irrigation more efficient and suitable to the smaller farms that have replaced most large kolkhozy and sovkhozy. A number of possibilities have been explored and found successful:

- Inexpensive technologies such as siphons and portables chutes can increase water productivity between 50 and 100%. Although much more expensive, drip irrigation provides significant water saving for vineyards and vegetable production. Sprinkler irrigation may also be suitable in some areas.[102]
- ICARDA's experiments with alternate furrow irrigation resulted in 30% reduction of water use and a 40% decline in drainage water discharge.
- Tensiometers to check soil moisture are simple to utilize. Their introduction should be explored to improve irrigation scheduling.
- Use of wastewater for fodder, industrial, and tree crops achieved positive results in Tajikistan and Kazakhstan. Low saline drainage water could be better utilized, especially in upstream countries such as Tajikistan.
- Improved salinity management would greatly reduce the volume of water required for leaching salt from fields (as much as 30-40% of total demand in some areas). A USAID on-farm demonstration in Uzbekistan has shown that by leveling fields and introducing siphon irrigation and proper scheduling, yields can be increased as much as threefold on severely salinized land, while nearly eliminating leaching in wintertime.[103] The use of lysimeters to detect salt-water balance is another option that may be explored.
- Rainwater, snow, and flood harvesting can be utilized to either retain the bulk of water in the field or to divert excess water to a reservoir.

Pastoral Water Management. Operations and maintenance of boreholes and pasture irrigation structures is in dire need of improvement. Rights to use wells should be clarified and mechanisms for conflict resolution introduced. There is need to rehabilitate and in many instances cap and pipe boreholes. Contingency boreholes would provide a ready reserve in times of drought, which would reduce distance traveled for water and physical stress on herds and households (especially women who must draw water). Water and snow harvesting would make more water available in times of scarcity. If less saline water sources exist in range areas, they should be developed (as young animals have a low tolerance to salt).

Input Supply and Services. Farmer and herder access to inputs declined in many countries during the 1990s. The assurance of a more stable supply through private sector, including supply cooperatives, would reduce shortages of seed and other critical input during times of drought. In highly exposed and vulnerable areas, it is advisable to establish strategic reserves of key inputs for distribution during times of agricultural drought.

Fodder supply typically falls during a drought (and is a day-to-day concern for herders in Central Asia). When herders and farmers cannot adequately feed and fatten their animals during summer drought months, they are much less able to withstand cold winter conditions and sudden blizzards in steppe areas (*zud*) that

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[102] PA Consulting, 2004, *On Farm Water Management Pilot Program: Status Repot for the period from Inception to February29, 2004, Central Asia Natural Resources Management Program*; ACDI/OVA Caucasus farmer-To-Farmer Project, 2002, *Final Report for Drip Irrigation.*

[103] Field trip by author, March 2004.

often kill large numbers of livestock. A number of measures could be implemented to prepare fodder supplies for the onset of drought:

- Improved haymaking techniques and increased local fodder storage are required for individual households that are out of the delivery range of central storage reserves (if these exist) during both drought and snow periods.
- Sowing feed mixtures as intermediate winter crops and the use of marginal water to grow fodder crops has been tested in the Kazakhstan, the Kyrgyz Republic, Turkmenistan, and Uzbekistan. The adoption of new and more diverse sources of feed (such as feed blocks) should also be explored.
- In some areas, the creation of strategic fodder reserves at the district or province level would mitigate the impacts of drought. However, they need to be regularly replenished and suitably equipped in order to distribute fodder effectively in emergency situations.

Strengthening veterinary services, which have been scaled back significantly, would enhance disease prevention and allow animals to withstand droughts better. Veterinary service should target identified disease risks reduce the survival capacity of stock.

Crop Management. Cropping systems can be optimized for drought tolerance in Tajikistan, Azerbaijan, and Uzbekistan ICARDA and CIMMYT set up on-farm trials and seed multiplication activities for drought-tolerant varieties of wheat barley, chickpea, lentil, and grasspea.[104] Non poisonous grasspea developed by scientists, a legume crop that is extremely resistant to drought, cold, water-logging and pest attack, is being increasingly adopted by farmers in Central Asia. ICARDA's experiments with crop diversification in Kazakhstan and Turkmenistan have resulted in high, more reliable yields and improved soil fertility.

Planting and cultivation can be significantly improved for drought mitigation. Rates of seeding are exorbitant in Central Asia and the Caucasus, with farmers sowing 200 kg/ha or more of wheat and 120 kg/ha cotton, when 120 to 150 kg/ha of wheat or 40 kg of cotton seed is actually required (such practices may be related to the poor quality of available seeds). The timing of sowing is critical (and largely reliant upon Gidromet forecasts) and is the subject of research by CIMMYT, which is also studying "raised bed" planting techniques. Limiting weed competition, through adoption of efficient planting methods and land management in the early stages of plant growth is also essential for better moisture conservation and its use for making crops healthy enough to withstand water stress.

Herd Management. Stocking rates should be balanced with rangeland capabilities and animal characteristics. Higher productivity of animals and smaller flocks would permit more fodder for the remaining animals and maintain productivity a bit better; in extreme cases, more productive animals have a much better survival rate and recover more easily after the drought. Drought-resistant mixes of grazing species, as well as optimized rotation lengths and rest times, should be determined for various ecosystems and production systems. ICARDA has researched ways to optimize sheep herds, including early weaning, early lambing, and lamb fattening at appropriate periods.

Research has only begun into livestock breeding for better survival and resistance to drought. Typically, it is the slow growing breeds can provide dependable growth using poor quality and dry forages. Herders should select breeds that consume less water (e.g. British breeds of sheep consume 20% more water in hot weather than Merino sheep). Efficient monitoring of endemic areas for diseases and management of livestock with appropriate prophylactic vaccinations against possible outbreak of epidemics during drought also saves the emaciation and loss of valuable herds.

Socioeconomic Inquiry. Socioeconomic inquiry must accompany research into agro-technical measures for drought management and mitigation. ICARDA and other institutions are presently exploring the

[104] Similarly, an ongoing agro-biodiversity project sponsored by the International Plant Genetic Resources Institute is studying local crop varieties that are more drought resistant than the available improved (imported) varieties.

socioeconomic impact of various agro-technical measures. Environmental impacts should also be included into this research.

Agricultural Research and Dissemination Systems. Agricultural research and dissemination systems are required to adapt and make the drought mitigation options described above available to farmers and herders. The ICARDA center in Tashkent and regional CGIAR Central Asia and Caucasus initiatives have strengthened the capacity of the National Agricultural Research Services through involvement in participatory on-farm research, training courses, regional and international conferences, and the establishment of regional networks for research into various crops. Information dissemination and sharing systems can be improved to more widely disseminate the results of ongoing research efforts.

Advisory Services and Training. Most agriculturalists lack knowledge of risk management for drought mitigation, as no framework existed on collective and state farms to teach them these skills. Efforts to establish and develop advisory services in drought prone areas should include diffusion of knowledge and training of farmers and herders (as well as local officials) in drought management and mitigation skills.

Annex 8:
VULNERABILITY AND CAPACITY ASSESSMENT DATA

Meteorological Drought

- Time series of climatic indicators influencing drought: precipitation, temperature, humidity, potential evapotranspiration (all countries, by province)
- Frequency of drought years
- Predicted frequency of drought years under various climate change scenarios
- Number and condition of meteorological stations, 1991-2000
- Early warning data collection and transmission, information flows within government, databases, and information products for the public
- Early warning institutions: structure of services, operations budget, qualifications and accountability of staff, relationships with other agencies, and participation of end users

Hydrological Drought

- Time series of data on surface water area and volume, runoff, streamflow, groundwater resources, infiltration, and water table fluctuations
- Time series of water balance: planned allocations and actual withdrawals of water among various sectors; percent of GDP and employment generated by various sectors
- Time series (disaggregated by oblast or rayon) of irrigated and non-irrigated area (planned and actual), water withdrawals for these areas, and channel losses on main canals and in the off-farm and on-farm irrigation networks
- Frequency of hydrological drought (of various degrees) in various areas over the past 30 years
- Number and condition of flow and snowpack monitoring stations, 1991 to present
- Early warning data collection and transmission, information flows within government, databases, and information products for the public
- Early warning institutions: structure of services, operations budget, qualifications and accountability of staff, relationships with other agencies, and participation of end users
- Water management measures taken during 2000-01 at the interstate and local levels (negotiations, regulation of reservoirs, reduced limits, water use plans, “abran/navbat” rotations, etc.)
- Minimum/maximum hydro-power flow requirement and availability of water resources during 2000-01; percentage of electricity generated by hydropower
- Maximum/minimum water requirement for fisheries and availability of water resources during 2000-01; estimated losses
- Maximum/minimum water requirement for wetlands and ecological equilibrium of rivers and availability of water resources during 2000-01
- Desertification impacts of hydrological drought, 2000-01 and earlier
- Vulnerability to and frequency of fires, 1991 to present

Agricultural Drought

- Number and condition of agrometeorological stations, 1991 to present

- Early warning data collection and transmission, information flows within government, databases, and information products for the public
- Early warning institutions: structure of services, operations budget, qualifications and accountability of staff, relationships with other agencies, and participation of end users
- Crop-weather relation (irrigated and non-irrigated land, pasture)
- Soil qualities in primary agro-ecological zones: classification of texture, humus content, moisture retention, and ball bonitet
- Percent of a GDP irrigated and non-irrigated cropland, livestock, other.
- Diversity of production (crops, livestock, agro-forestry, mardikarlik, etc.)
- Percent of cropland, orchards, and pasture irrigated
- Sown irrigated and non-irrigated area, 1991 to present (disaggregated by rayon, if possible)
- Percent salinized land in various categories
- Yield response to salinity of water and/or soil (various crops)
- Carrying capacity of pasture: percent of pasture degraded, maximum animals per hectare in various areas
- Cropping patterns and estimated crop water requirements, 1991 to present
- On-farm agro-technical measures taken during and after the drought
- Crop yields, 1991 to present (disaggregated by rayon, if possible)
- Cost of losses to crops, livestock and fisheries resulting from the drought
- Impact assessment: objectives, data availability, methodology, timeliness of analysis, criteria for triggering drought response
- Targeting methodologies
- Relief measures: readiness, implementation, and cost

Socioeconomic Drought

- Population (age pyramid, growth rate, stage of demographic transition)
- Percent with in-house plumbing, access to centralized standpipe, well, canals, etc.
- Impact of drought upon drinking water quality (turbidity, salinity, chemical composition) and quantity (LPCD drinking water, rural/urban and by province and/or district)
- Frequency of water-borne and/or drought-related diseases and maladies
- Household income, food consumption and storage, and nutrition, 1991 to present
- Impact o the drought upon rates of migration
- Early warning data collection and transmission, information flows within government, databases, and information products for the public
- Early warning institutions: structure of services, operations budget, qualifications and accountability of staff, relationships with other agencies, and participation of end users
- Impact assessment: objectives, data availability, methodology, timeliness of analysis, criteria for triggering drought response
- Targeting methodologies
- Structure of relief institutions: formal (coordinating commissions, MES, IFRC) and informal, qualifications and accountability of staff, linkages with other institutions, participation of NGOs and communities
- Logistical readiness of relief effort in 2000-01: location, condition, and capacity of warehouses, transportation fleet and road access, communications system (coverage, capabilities, condition)
- Measures employed in relief: food relief, agriculture, other sectors, debt forgiveness, social services, balance of payments, budgetary support
- Relief measures: readiness, implementation, and cost

Drought Management and Mitigation Plans

- Officially recognized definition of drought (different among various ministries?)
- Definition of "drought" by various water users
- Triggering mechanisms for response before and after 2000-01
- Procedures and laws for response to drought in 2000-01;
- Drought management plans or projects adopted by the Government and/or donor agencies since 2000-01
- Education programs in place before and after 2000-01
- Capabilities for updating and evaluating a drought management and mitigation plan