23658

ARMENIA

TOWARDS INTEGRATED WATER RESOURCES MANAGEMENT

Final
November 2001
World Bank Technical Paper
Environmentally and Socially Sustainable Department
Europe and Central Region

CURRENCY AND EQUIVALENT UNITS

Currency Unit = Armenian Drams (Dram)

	1998	1999	2000
Dram/US$	500	536	540

WEIGHTS AND MEASURES

Metric System

BCM	billion cubic meter
g	gram
g/l	gram per liter
GWh	gigawatt hour
ha	hectare
km^2	square kilometer
KWh	kilowatt hour
l	liter
lcd	liters per capita per day
m	meter
m^3	cubic meter
m^3/sec	cubic meter per second
m^3/capita/year	cubic meter per capita per year
masl	meters above sea level
MCM	million cubic meters
Mill m^3/yr	million cubic metes per year
mm	millimeter
MW	megawatt

ACRONYMS AND ABBREVIATIONS

AWSE	Armenia Water Supply Enterprise
BOD_5	Biological Oxygen Demand
CAS	Country Assistance Strategy
DRAM	Armenian Dram
DSP	Dam Safety Project
ECA	Europe and Central Asia Region (World Bank)
ECSEI	ECA Energy and Infrastructure Unit (World Bank)
ECSSD	ECA Environmentally and Socially Sustainable Development Unit (World Bank)
EMC	Environmental Monitoring Center (MoNP)
EU	European Union
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GIS	Geographic Information System
GNP	Gross National Product
GoA	Government of Armenia
HPP	Hydro Power Plant
IDA	International Development Association
IDP	Irrigation Development Project
IFAD	International Fund for Agriculture Development
IMC	Inter-Ministerial Committee
IRP	Irrigation Rehabilitation Program
IWRM	Integrated Water Resources Management
IWRMP	Integrated Water Resources Management Planning
LSAP	Lake Sevan Action Program
MoA	Ministry of Agriculture
MoE	Ministry of Energy
MoH	Ministry of Health
MoNP	Ministry of Nature Protection
MoUD	Ministry of Urban Development
NEAP	National Environmental Action Program
NGOs	Non-Government Organizations
NPV	Net Present Value
O&M	Operation and Maintenance
PRSP	Poverty Reduction Strategy Program
RoA	Republic of Armenia
SCWE	State Committee of Water Economy
SIF	Social Investment Fund
TAB	Technical Advisory Board
UFW	Unaccounted-for water
UNDP	United Nations Development Program
US$	United States Dollars ($)
USAID	United States Agency for International Development
USSR	Union of Soviet Socialist Republics
WBI	World Bank Institute
WDI	Water Development Institute
WRC	Water Resources Council
WRMB	Water Resources Management Board
WS&S	Water Supply and Sanitation
WUCCs	Water User Consumer Cooperatives
WUFs	Water Users Federations
WWTP	Waste Water Treatment Plant
YWSE	Yerevan Water Supply Enterprise

PREFACE AND ACKNOWLEDGMENTS

A joint ECSSD/ECSEI team including Rita Cestti, Adriana Damianova, Arusyak Alaverdyan, Mark Lundell, Giuseppe Fantozzi, Brian Smith, and Salman Zaheer contributed to the preparation of this report, which summarizes the state of Armenia's water resources, analyses strengths and weaknesses of the current institutional framework, identifies policy and institutional options as well as the potential role of the Bank Group to address current and emerging water-related problems and promote sustainable development and management of the resource base. The report was completed under the guidance of Ms. Marjory-Anne Bromhead, Mr. Joseph Goldberg and Mr. Owaise Saadat. Peer reviewers of the report were Messrs. Ariel Dinar and Douglas Olson.

The report builds on the findings and recommendations of the Integrated Water Resources Management Planning (IWRMP) Study supported by the Bank Group between 1999-2001, and funded by the Government of the Netherlands. The report also borrows from the draft Water Supply and Sanitation Strategy, the Lake Sevan Action Program, the National Environmental Action Program and several other documents and reports prepared under the framework of the following water-related projects in Armenia (under implementation and under preparation): Municipal Water Supply Project, Water Supply and Sanitation Project, Irrigation Rehabilitation Project, Irrigation Development Project, Dam Safety Project, and Natural Resources Management and Poverty Alleviation Project.

The report benefited greatly from detailed comments and suggestions received at different stages from colleagues within the Bank, Armenian Government officials, international and Armenian experts, and participants at the June 15, 2001 stakeholder meeting, in particular, Messrs./Mmes. Vladimir Movsisyan, Gagik Martirossyan, Yuri Javadyan, Genadi Kojoyan, Nune Bakunts, Barbara Britton, Benoit Laplante, Marie Bourbigot, Anders Bond, Rafael Hovhannissyan, Mesropyan Eduard, and Kamo Aghababyan.

The team would like to express its sincere thanks to the staff of the Bank Country Office in Yerevan, the IWRMP team, the Project Implementation Unit of the Irrigation Rehabilitation Project, the members of the Technical Advisory Board of the IWRMP, and the United States Agency for International Development (USAID) Mission in Yerevan for their valuable contribution and support in the preparation of this report. Their cooperation made this report possible. In particular, special thanks are due to Messrs./Mmes. Tigran Yeghyan, Hosnik Kirakosyan, Gevorg Sargsyan, Alexander Astvatsatryan, Gayane Minasyan, Diana Hakobyan, Ruzanna Gevorgyan, Anahit Maranyan, and Era Buniatyan.

CONTENTS

TABLES

FIGURES

BOXES

VOLUME II

MAPS

EXECUTIVE SUMMARY

Background and Objectives of the Study

i. Armenia is a small, mountainous, semi-arid country. About 75 percent of the land area of 29,800 square kilometers (km^2) is above 1500 meters (m); 60 percent of the territory receives less than 600 millimeters (mm) of rain and 20 percent less than 400 mm. These basic parameters shape water resource use. Irrigation is the main water user. Armenia has an official population of 3.8 million and agriculture accounts for 33 percent of Gross Domestic Product (GDP). About 31 percent of the population lives in rural areas but even town dwellers have small farms to supplement their incomes.

ii. Armenia's income fell rapidly after independence in 1990, followed by the conflict over Nagorno Karabakh and the trade blockage imposed by Turkey and Azerbaijan. The economy has grown steadily over the last six years, but despite quite a good record of economic reforms, the Gross National Product (GNP) per capita is still less than US$500. There is limited private sector investment, a shortage of management skills resulting from geo-political isolation, and governance problems linked in part to very low public sector salaries. The population has had to rely increasingly on natural resources, water in particular, for both agriculture and electricity generation. There are close synergies between environmentally sustainable growth, which has been accorded high priority in the Poverty Reduction Strategy Program (PRSP) process, and the current Country Assistance Strategy (CAS) priorities of improving the business environment, governance and public sector services, and re-building human capital.

iii. Water resources play a key role in Armenia's economic development. Eighty percent of the country's value crops are irrigated, and hydropower accounts for 23-25 percent of total energy production. The country's largest body of freshwater, Lake Sevan, has been declared an environmental disaster because of the huge water withdrawals that took place between 1947 and 1967 and then again between 1992 and 1995. In 1999, the Government of Armenia (GoA) acknowledged that only integrated management of the country's water resources would ensure environmentally and economically sustainable use of its water resources, and launched the preparation of an Integrated Water Resources Management Planning (IWRMP) Study, aiming to develop a comprehensive policy framework to ensure the sustainable management and use of water resources and development of the water using sectors, taking into account economic, financial, environmental, social and institutional considerations.

iv. The objective of this paper is to examine the challenges in the water sector faced by Armenia today, and outline options for management and allocation of its water resources in the future, considering the need for a stable, transparent public sector management framework and sustainable resource use for long-term private investment and job creation, and for appropriate balances among water uses for domestic, industrial, agriculture, electricity generation, watershed protection and ecological purposes. The report builds on the recommendations of the IWRMP Study, which was supported by the Bank, financed by the Government of the Netherlands, and completed in 2001. The options presented in the IWRMP Study were developed with the participation of Armenian Government agencies, research institutions and local experts and serve as a framework for Armenian policy makers. The report also builds on experience with project implementation to date in water-related sectors.

Water Resources

v. Available water resources in Armenia are about 3,000 cubic meters per capita per year (m^3/capita/year). Although Armenia is not "water-stressed" overall,[1] there are regional imbalances and available per capita water resources are less than those of neighboring Georgia and Azerbaijan (11,600 and 3,800 m^3/capita/year, respectively). Water resources are scarce in particular in the densely populated Hrazdan Basin in the center of Armenia, where Yerevan is situated, and in the south and northwest of the country. There is significant seasonal and annual variability in river run-off, including frequent droughts with low overall river flow, and risk of flooding in the spring, when about 55 percent of total annual run-off occurs. There has been extensive development of dams to address this variability; 79 dams have a storage capacity of 1.1 billion cubic meter (BCM). Groundwater, generally of good quality, accounts for a substantial share of water use and is the source of 96 percent of drinking water. Lake Sevan, "The Heart of Armenia," with a surface area of approximately 1,250 km^2, a volume of approximately 32 BCM, and an average annual volume of water for utilization of over 525 million cubic meter (MCM), has a central hydrological role in the country. Apart from providing regulated outflow and additional strategic storage, Lake Sevan offers a number of direct and indirect benefits. Its waters provide a significant amount of hydropower and irrigation to croplands in the Ararat Valley. The lake is an important recreational, natural habitat and cultural heritage site, and a motivating feature of Armenia's history, poetry and music. In addition, the lake is very sensitive to changes in climate. Over the past 40 years, Lake Sevan's level has dropped 19 m and its volume by almost 44 percent, due partly to average temperature rises and partly to excessive withdrawals for irrigation and electricity generation. While river water quality is generally good, Lake Sevan has suffered from increasing pollution over the last 30 years.

Water Uses

vi. Total water use in Armenia was estimated at 3.9 BCM in 1988, with irrigation accounting for 70 percent. Following land privatization and the breakup of collective farms, there was widespread deterioration in irrigation infrastructure and potentially irrigated area declined from 330,00-340,000 ha to about 275,000 ha between 1988 and 1998. Area actually irrigated only accounted for 187,000 ha in 1998. Irrigation still accounts for 70 percent of total water use, with domestic and industrial use accounting for the remainder. In the past, irrigation was heavily dependent on electricity for pumping to lift water to higher systems that could not be reached by gravity conveyance systems. About 42 percent of the total equipped irrigation area depends on pumping. To lower the cost of operating the irrigation system energy, a program for pump-to-gravity irrigation conversion has been developed, where such conversion is feasible and economic. Its implementation is in an early stage. So far, no realistic estimates have been made of the area that could economically be irrigated.

vii. Surveys indicate that the areas where irrigation has declined the most have also been those where poverty incidence has increased the most rapidly. The increased yields which irrigation provides bring both subsistence and cash incomes. For a land-scarce, relatively labor-abundant country like Armenia (arable land is only 0.13 ha per capita) irrigation provides an opportunity for higher returns; 1998 average returns per hectare were estimated at US$370 with

[1] Countries with less than 1,000 m^3 per capita are considered water stressed.

irrigation and US$40 without. Recently, much higher returns for irrigation have been registered – about US$550 per hectare. However, drainage problems have developed particularly in the Ararat plain where water tables are high. Irrigation water costs vary by region but farmers pay on average US$0.008 per cubic meter, or 30 percent of operation and maintenance costs. Because of the lack of clarity in the allocation of responsibilities for the management of the irrigation system, the irrigation sector is characterized by wasteful practices and a high rate of water losses at the level of conveyance infrastructure. Plans are underway to substantially improve the mechanisms for funding of operation and maintenance activities and to create a full set of enabling conditions for effective participatory irrigation management.

viii. Municipal water use has also decreased since independence, as industrial and commercial activity has declined and infrastructure has deteriorated. Recent surveys indicate that poor households are the most affected by poor drinking water supply services. Utility water prices for domestic consumers increased by about 100 percent in real terms between 1994 and 1999, and households presently pay on average US$0.08/$m^3$, which represents a fraction of the operation and maintenance costs. Because of the lack of metering, tariffs are calculated on the basis of standard per capita daily consumption of 250 lcd in Yerevan and 200 lcd in other urban areas – even though the volume actually consumed by the population is a fraction of this. Water tariffs are significant higher in urban areas, especially in Yerevan, where the tariff is US$0.84 per capita per month. If tariffs were fully enforced, they could represent approximately US$2.6 per month per household or 5 percent of current average monthly expenditure. Present revenues from water supply services are insufficient to maintain the systems adequately, but household incomes are too low for significant across-the-border increases to be affordable. There is however substantial room for improving collection, operational efficiencies, and tariff structure. A management contract has recently been awarded for the management of the Yerevan Water Supply Company, and plans are under way to involve other forms of private sector participation in areas outside Yerevan. The participation of the private sector in the provision of water supply and sewerage services will bring improvements in efficiency – global experience shows that the private sector generally makes better use of existing assets by emphasizing preventive maintenance and rehabilitation; and of investment resources by maximizing operational efficiencies. About 71 percent of households have indoor taps, 45 percent in rural areas and 87 percent in urban areas, but supply is intermittent; this has contributed to contamination and an increase in intestinal infections. Most towns have sewerage systems but they do not operate adequately, and water is generally discharged untreated into rivers. Industrial water accounts for a small proportion of water use but effluent discharges also contribute to pollution.

ix. Hydropower accounts for about 23-25 percent of electricity generation in Armenia, with most hydropower plants installed along two cascades, the Vorotan and Hrazdan. Electricity generation from Hrazdan is tied to irrigation releases from Lake Sevan, so is generated mostly in the summer (when electricity requirements are less). There has been a deterioration of many of the dams since 1990 and several are now unsafe. A dam rehabilitation program is ongoing with support from the International Development Association (IDA).

x. Lake Sevan is regarded as a national treasure, but is also the major natural multi-purpose reservoir of the country. As part of a plan to restore the ecology of Lake Sevan and its capacity as a strategic water reserve for multi-purpose use, a 48 km tunnel was built to divert 250-300 MCM of water annually from the Arpa River to the lake. A similar investment, to divert 165

MCM of water annually from the Vorotan River through a 22 km tunnel, which is in an advanced stage of construction, has not been completed. A major water resource development decision for Armenia, which needs to be made on technical, economic and environmental grounds, is whether this tunnel should be completed.

xi. Adequate watershed management contributes to flood protection and soil conservation but there has been overgrazing and deforestation over the last ten years, as people have turned to fuelwood for heat and to farming for subsistence. A further key environmental issue is wetlands restoration and management, both around Lake Sevan and in the Ararat Valley. Again, there are issues of balance between water and land use for recreation or irrigated agriculture and wetland conservation. Armenia has adopted Soviet guidelines for maintenance of environmental flows in rivers and for stream-bed protection, which need to be revised and more importantly enforced.

xii. Until now, the Ministry of Nature Protection has had overall responsibility for water resources management. Plans are under way to create an independent body for the overall planning and management of the water resource base in the country. The newly established State Committee of Water Economy is in the process of taking over the responsibilities for the financial and operational tasks related to provision of commercially-oriented water services (water supply and sanitation, irrigation and drainage, and bulk water supply) previously assigned to the Ministries of Agriculture and Urban Development. Currently, the Ministry of Agriculture develops irrigation and drainage policies, defines irrigation norms for crops, undertakes research and monitoring, and maintains an inventory of irrigated lands. The Ministry of Energy implements water releases from Lake Sevan. The Ministry of Health develops quality standards for drinking water and coordinates all health related issues. The Ministry of Urban Development is responsible for water supply and wastewater policies and design standards, while the municipalities are in theory responsible for water management and planning (though in practice this is done by the municipal water and irrigation enterprises). The Ministry of Economy and Finance is responsible for tariffs and public finance matters related to publicly owned companies and public services. Institutional responsibilities have been established to promote private sector participation in the operation of the various water use services.

xiii. The 1992 Water Code provides guidelines for water management, but it requires updating. A permitting system exists to regulate water withdrawals and a water cadaster (also in need of updating) is maintained by the Ministry of Nature Protection. A pollution discharge permit system also exists but is not widely used at present. There is a quite a comprehensive network of water measurement stations but monitoring and data collection has been limited since 1990; assessment methods are thorough but separate accounting of groundwater and surface water has led to some double counting. Water allocation is presently undertaken only for releases from Lake Sevan, and only for irrigation since no special releases are done for hydropower production.

Water Management and Allocation Options

xiv. The IWRMP study included an assessment of available water resources and a projection of likely demands up to 2020. Its objective was to generate information illustrating the implications of different water management decisions and investments, and so help decision-makers in Armenia make choices regarding water allocation, water policy and investments. Four

alternative investment scenarios were presented, each with differing results in terms of water scarcity, balance of water use between summer irrigation and winter electricity generation country-wide, recovery in the level of Lake Sevan, and differing improvements in municipal and irrigation water efficiency. These improvements require both continued increase in prices, to cover operation and maintenance costs (to US$0.14-0.20/$m^3$ for municipal and US$0.020-0.026/$m^3$ for irrigation water), and investments in system rehabilitation and hydropower generation.

xv. While the modeling exercise needs further refinement to make very specific policy recommendations, it is possible to conclude that an investment and policy reform program—which includes system rehabilitation, improvements in irrigation practices, an active role for water pricing in irrigation and water supply, and transfer of additional water from the Vorotan Basin, a water-abundant region, to the Hrazdan/Sevan Basins, a water-scarce region, even though it would reduce hydropower generation during the winter season below present levels—would increase irrigation water availability in the densely populated Hrazdan Basin, and permit an increase of Lake Sevan by 4 to 6 meters by 2020. The projections illustrate that important trade-offs will have to be made in the choice of policies and investments between uses of water for drinking, irrigation, hydropower and environment. Although drinking water has the highest priority for water use for social reasons, this water use also faces challenges in terms of trade-offs, particularly in situations where water is wasted by users and/or water utilities.

Water Policy and Institutional Responsibilities

xvi. Armenia has recently developed a draft Water Policy and is currently undertaking key institutional reforms in water management. Its Water Policy Statement, developed over the 2000-2001 period and still being finalized, recognizes that water is a finite and vulnerable resource, with an economic as well as a social and environmental value, and that sustainable management in the interests of society requires a balance between present and future users. It recognizes the priority of water requirements for basic human needs, the inter-sectoral nature of water, the role of the state in water resources management, and the importance of stakeholder participation, the role of the private sector and cost recovery in efficient water use. Finally, it recognizes transboundary issues, and the unique importance of Lake Sevan. Institutional responsibilities for water are evolving to take account of these overriding water policy principles and promote integrated water resources management. In May 2001, the Government of Armenia adopted a comprehensive reform program to improve the financial sustainability of the companies responsible for the provision of drinking water supply/wastewater and irrigation/drainage services, and charged its implementation to a newly established State Committee of Water Economy (Government Decree No. 440, May 17, 2001). The State Committee of Water Economy is responsible for the financial and operational regulatory tasks related to provision of commercially-oriented water services. Plans are under way to establish an independent water body -- the Water Resources Management Board -- to take overall responsibility for planning and management of the resources base. The need for (and scope) of an independent “economic” regulation of water services remains unclear.

Future Water Management Decisions

xvii. Armenia has undertaken key policy and institutional reforms in water management over the last five years, and has begun development of analytical tools to evaluate future options. The analysis so far suggests that a water management strategy that focuses on rehabilitation and reduction of water losses, and balances demands for drinking, irrigation, hydropower and environmental use is likely to have the highest welfare gains. Further, a strategy that uses economic instruments to manage demand, and increases private sector participation and local stakeholder responsibility for system operation, with the public sector maintaining a key role in overall water resources management, will help improve the efficiency of water use. Armenia needs to further develop and adopt such a strategy.

xviii. The next priorities are to consolidate changes of functions among ministries and agencies as well as the building of capacity and new skills among water institutions to implement the Water Policy effectively, and, within resources constraints, to reach consensus regarding options laid out for management of Armenia's water resources over the longer term.

I. INTRODUCTION

o Water resources play a key role in the socio-economic development of Armenia. Agriculture, which depends on irrigation for about 80 percent of overall production, contributes about 30 percent of the Gross Domestic Product (GDP), and provides opportunities for subsistence and employment to a large percentage of the economically active population displaced by a drastic decline in the industrial sector. Hydropower generation accounts for about 23-25 percent of the electricity generation in the country.

o Lake Sevan, the largest high altitude freshwater reservoir in the Transcaucasus region and the country's largest body of freshwater, is considered by the majority of the population as a cultural and spiritual symbol. Lake Sevan suffered excessive withdrawal of water between 1947-1967 and 1992-1995. Its water level has decreased by 19 m and has almost reached the threshold level of the Hrazdan River's outlet; its volume has decreased by 44 percent as compared to its natural conditions in the 1930s. As a result, the lake has almost lost its capacity as a strategic water reserve for multi-purpose use.[2] Lake Sevan has been declared an environmental disaster and is high on the list of public environmental and socio-economic concerns.

o The Government of Armenia (GoA) has acknowledged that only integrated management of the country's water resources will ensure their environmentally and economically sustainable use, and in 1999 it embarked on preparation of an Integrated Water Resources Management Planning (IWRMP) Study with the participation of a broad range of stakeholders and decision-makers, including Non-Governmental Organizations (NGOs) and water users.

o This report is organized in five sections. Section II provides a diagnostic of water resources management challenges and opportunities in Armenia, and identifies cross-cutting issues that need to be addressed with urgency. Section III presents the findings and conclusions of the IWRMP Study to address these issues and outlines recommendations for a water resources management strategy. Section IV looks at the institutional implications of the strategy and proposes some recommendations for establishing a modern institutional framework for integrated water resources management. Section V concludes with some recommendations for further action. Several annexes are included in Volume II.

[2] In the 1930s, a series of decisions caused the destablization of Lake Sevan's hydrology and ecology. Water was taken from the lake for irrigation at rates substantially greater than the natural inflow, causing a lowering of the water level by 19 m over a period of 40 years. The decrease of the water level, together with increased external pollution loads from point and non-point sources, greatly altered the lake's ecological conditions. Recreation and tourism were negatively affected and significant declines in the trout harvest, which used to comprise about 60 percent of the official catch, were observed. The lake's capacity to provide reserve for hydropower production and irrigation, as well as possible drinking water, was seriously threatened. (Lake Sevan Action Program (LSAP), page x).

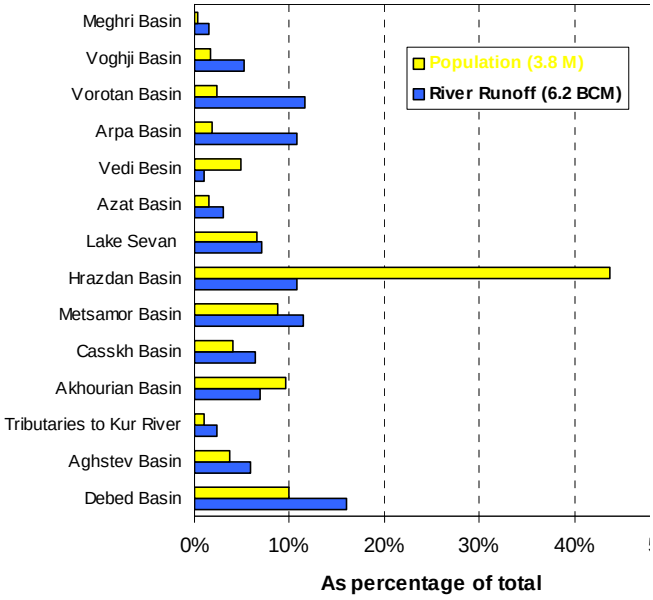
II. DIAGNOSTIC OF WATER RESOURCES MANAGEMENT

o Armenia is a small, landlocked country located in the southern Caucasus region. It counts Georgia, Azerbaijan, Iran and Turkey as its neighbors. The official population is estimated at 3.8 million inhabitants and its 1999 Gross National Product (GNP) per capita was measured at US$490. It is a mountainous country, rising from 375 meters above sea level (masl) along the Deved River Basin in the south-west to a maximum of 4,095 masl at Mount Aragatz. About 75 percent of the country is more than 1,500 masl. Its total area is 29,740 square kilometer (km^2), including the major inland water body Lake Sevan, which covers 1,246 km^2 at an elevation of 1,897 m. Armenia is characterized by its semi-arid and arid climate. Average annual precipitation varies from 1,000 millimeters (mm) in the mountains to 300 mm in the Ararat Valley, with a countrywide average of 570 mm. About 60 percent of the territory receives less than 600 mm of rainfall, 20 percent receives less than 400 mm and the closed basins only 200 mm to 300 mm.

A. Assessment of the Water Resources Base

o On average, Armenia is relatively well-endowed with water resources. If all water resources are considered, Armenia has about 3,000 cubic meters per capita per year (m^3/capita/year), which drops to to 2,700 m^3/capita/year if only internally renewable water resources are considered. The limit beyond which water is considered scarce is 1,000 m^3/capita/year. Nonetheless, the country faces a spatial and temporal imbalance of its water resource base. The uneven spatial distribution of surface water can be seen in Figure 1.

Figure 1: Spatial Distribution of River Runoff



Source: IWRMP Study, Stage IA Report.

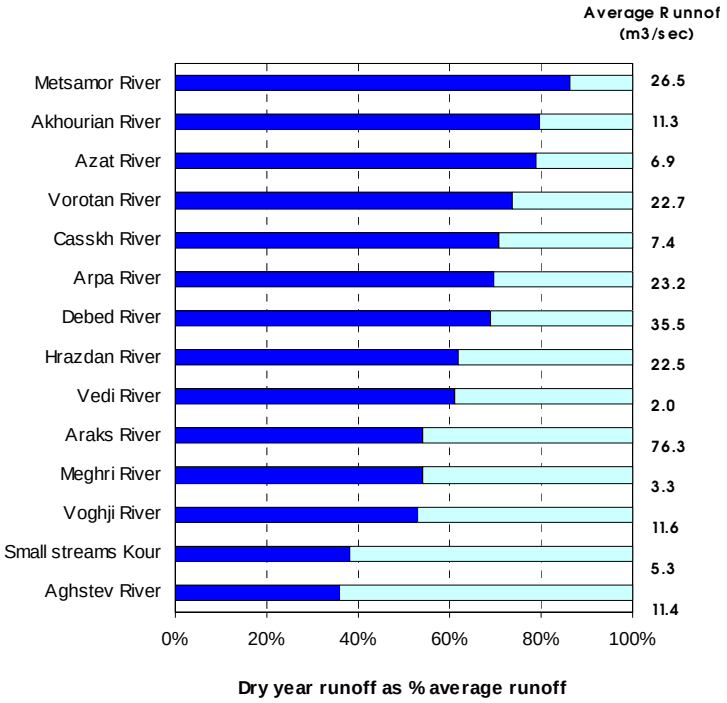
Surface Water Quantity and Quality

o Based on the most recent estimate of the hydrological cycle for the country, more than 17.6 billion cubic meters (BCM) of water are added each year as precipitation, and about 11.5 BCM are lost by evapo-transpiration. Two additional transboundary water sources add to the country's water balance: 0.94 BCM from the Araks River, and about 1.19 BCM of deep groundwater inflow from Turkey to the Ararat artesian basin.

o Most rivers in Armenia are small, rapid and fed by melting snow, springs and groundwater drainage. River flows tend to be highest in spring when the mountain snows melt. The overall river flow has been estimated at 7.15 BCM, out of which about 6.25 BCM originate within the country. Springs contribute 1.60 BCM, and drainage groundwater 1.43 BCM.

o There is a significant annual and seasonal variability in river runoff. As illustrated in Figure 2, about 50 percent of the total river flow volume is subject to high annual variability, e.g., the "dry" year flow volume represents less than 65 percent of the "average" year flow. Thus, a series of dry years may lead to severe drought conditions such as those that were experienced during the period 1999-2000. Similarly, the monthly volume of stream flows tends to fluctuate widely. Within a normal year, the ratio between maximum and minimum flow may be 10 to 1. Figure 3 shows that about 55 percent of river flows occurs during the spring months.

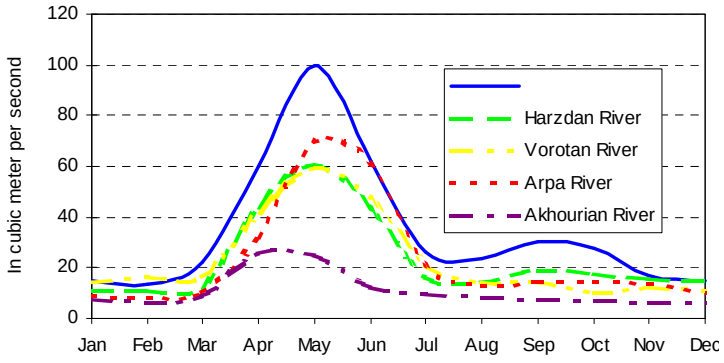
Figure 2: Variability of River Runoff



Source: IWRMP Study, Stage IA Report

o In order to address seasonal variations of river runoff, the country has built 79 dams with a total capacity of 1.1 BCM. Most of these dams are single purpose, e.g., 70 reservoirs are used for irrigation and 6 for hydropower purpose, and only 3 are for dual purpose, e.g., irrigation and domestic water supply. Three additional dams are under construction. Lake Sevan, which has a regulated surface outflow at the Hrazdan River, also acts as an important multi-purpose water reservoir for irrigation, hydropower, fishery and recreational uses. The annual amount of lake water used in an average year is about 525 million cubic meter (MCM), including the natural inflow and outflow, and the water diversion from the Arpa Basin. The water balance of Lake Sevan in an average year is presented in Table 1.

Figure 3: Seasonal Distribution of River Runoff



Source: IWRMP Study, Stage IA Report

o The overall natural water balance of Lake Sevan is very sensitive to changes in meteorological conditions[3]. During dry years, the water balance may be negative, causing a drop

[3] The lake's high altitude and the relatively high incoming radiation cause the yearly evaporation to exceed yearly precipitation. In the 1930s, the Soviet Government adopted a plan to decrease the lake's surface area in order

in the level of the lake[4]. The First National Communication of the Republic of Armenia on Climate Change reveals that a negative natural balance of Lake Sevan can be expected in the case of a rise in air temperature by 2 degree centigrade.

Table 1: Overall Annual Water Balance of Lake Sevan
(including inflow from Arpa River)

	Mike Basin	Basic Data	LSAP
Natural Inflow and Transfer (MCM)			
Precipitation	463	468	494
River inflow	753	763	729
Arpa Tunnel	251	233	250
Groundwater	82	94	70
Total Inflow	1,549	1,558	1,543
Natural Outflow (MCM)			
Evaporation	1,024	1,002	1,012
Groundwater	0	14	14
Total outflow	1,024	1,016	1,032
Net Available Volume for Use	525	542	512

Notes: Mike Basin estimates are over a random time period of 21 years. Basic data estimates are over the period 1927-1997. LSAP refers to estimates made under the Lake Sevan Action Program.
Source: IWRMP Study, Stage II Report

o The break-up of the Former Soviet Union resulted in a serious budget reduction, which led to deterioration of the man-made dams and related safety problems. In 1994, about 4 percent of these dams experienced some sort of failure, and a number of accidents have been reported at dam sites in recent periods. In 2000, the country embarked in a dam safety program to rehabilitate 20 primary irrigation dams and address their safety conditions. Safety investigations are also underway for all remaining dams in Armenia. In addition, a dam safety emergency fund has been established to improve the safety condition of other dams found to pose an imminent threat to human life.

o Pollution of Armenia's rivers was extensive during the Soviet period, resulting in poor water quality. The current extent of pollution of Armenian's surface sources is not known with certainty. The major impediment to making a comprehensive assessment of surface water body quality is the lack of reliable data and the inadequacy of the existing monitoring program. An analysis of available data does show that river water quality conditions have improved over recent years compared to international standards, as a result of the closure of several industrial enterprises and the decline in irrigated-agriculture and industrial production. Today, surface water quality of Armenia is generally considered good except immediately downstream of Yerevan and other main cities where organic pollution either consumes the oxygen in the water or hinders the self-purification capacity of the rivers. Without proper attention to water pollution in the future, the water quality may easily deteriorate again once economic activity increases[5].

o Over the years, the quality of the country's largest water reservoir has deteriorated. Lake Sevan is experiencing a disruption of its ecological balance due to threats of eutrophication as a

---

to reduce loss of water from evaporation. The implementation of this plan marked the beginning of the destabilization of Lake Sevan's hydrology and ecology.

4 According to Hydromet, the net natural balance of Lake Sevan (including the current water transfer via Arpa Tunnel) varies between +800 MCM (wet years) to –400 MCM (dry years).

5 The results of a surface water quality monitoring crash program conducted between April 2000 and March 2001 under the framework of the IWRMP Study reveal that in general concentrations of chemical parameters are below standards, with the exception of ammonia and heavy metals downstream main cities.

result of increased human activity in the Sevan watershed, higher inputs of nitrogen and phosphorus, and the lowering of its level. These events combined have led to a sharp change in the chemical and physical conditions of the lake, undesirable changes in the nutrient cycles of phosphorus and nitrogen, and a rapid decline in fishery yields.

Groundwater Quantity and Quality

o Armenia also has considerable renewable groundwater resources. They play a very important role in the overall water balance. About 96 percent of the water used for drinking purposes and a substantial share of the water used in the country (about 40 percent) comes from groundwater.

o The total renewable groundwater resources in Armenia have been estimated at 4.1 BCM per year, out of which about 1.6 BCM re-appears within the country as springs and 1.4 BCM drains into rivers and lakes. Deep groundwater originating within Armenia accounts for about 1.0 BCM. Important deep groundwater sources are found in the Ararat artesian basin. Artesian wells produce from 5-100 liter per second without pumping. From Turkey on the western border, about 1.2 BCM of deep groundwater flows into the Ararat artesian basin on a yearly basis. In the south, around 0.77 BCM of groundwater flows out of the Ararat basin back into Turkey, Nakhichevan and Iran, and about 0.19BCM flows to the Araks Basin. In the north, about 0.1 BCM outflows to the Kura Basin.

o Approved groundwater resources amount to 2.4 BCM, out of which 66 percent are located in the Ararat artesian basin. So far, overdrafting of groundwater has not been registered in Armenia. The artesian basin features three hydraulically interdependent aquifers: the upper aquifer (down to 20 m), a sub-pressure intermediate aquifer (between 30 m and 70 m), and the deep pressure aquifer (below 70 m). Because of the artesian nature of the aquifers, groundwater in the Ararat Valley tends to naturally come back to the surface. As a result, the top groundwater layers are often saturated with water, which has adverse consequences for the population and agriculture production.

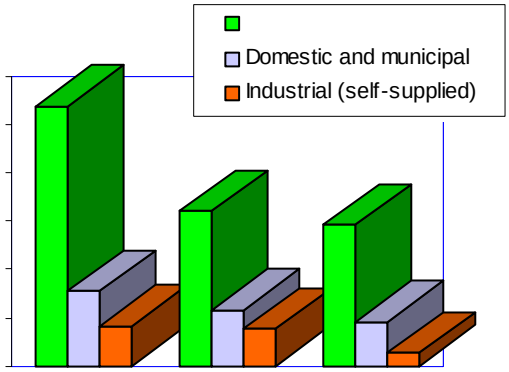
o Although recent data on groundwater quality is scare, it is possible to conclude that in general, quality of raw groundwater sources is very good. In many parts of Armenia, spring water can be used as drinking water without any further treatment. Some sources however do not meet chemical and biological standards, and cannot be used for drinking purpose. About 25 percent of the spring sources have experienced high concentrations of nitrates, nitrites, and fluoride. In order to prevent further pollution, existing sanitary zones around groundwater sources should be reinforced. Similarly, a few wells in the Ararat artesian basin experience high mineral content (0.5 to 2.0 gram/liter) exceeding acceptable health standards, which makes the water unsuitable for drinking purposes.

B. Past and Present Trends in Water Use and Management by Sector

o Water uses in Armenia consist of: (i) intake uses including irrigation, domestic, commercial, institutional and industrial purposes, and power plants; (ii) in-stream uses including hydropower plants, fishery, waste dilution and recreational purposes; and (iii) onsite uses including wetlands, unirrigated crops, and evapotranspiration from crops and evaporation.

Historical trends of water withdrawals for the main intake uses are presented in Figure 4. The figure shows a steady decline in total water withdrawals for all intake uses. Between 1989 and 1998, water withdrawal experienced a sharp decline from 3.9 BCM to 2.0 BCM. Industry and irrigation water uses experienced the most pronounced decline, 67 percent and 46 percent respectively[6].

Figure 4: Historical Trends of Water Withdrawal

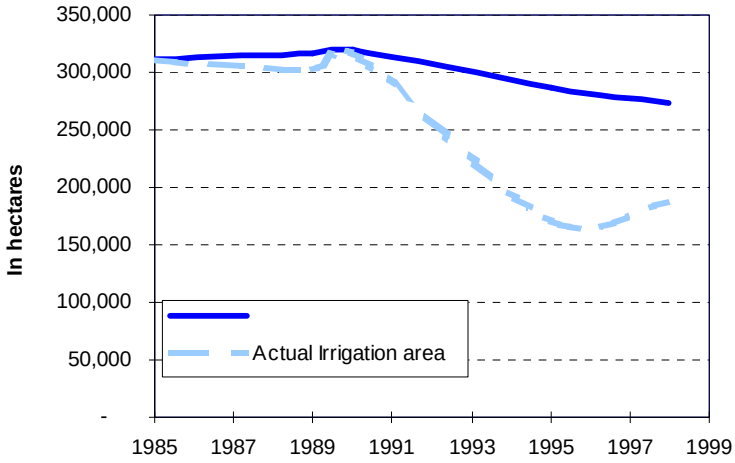


Source: IWRMP Study, Stage IA Report.
Note: The historical trends maintained by the Ministry of Agriculture differ from the ones presented in this report.

Irrigation

o Irrigation is the largest water user. Most of the cropped area in Armenia depends on water from irrigation schemes, and nearly 80 percent of total crop production is produced with irrigation. According to the inventory undertaken by the Ministry of Agriculture, arable land that could technically be brought under irrigation amounts to 0.94 million ha or 67 percent of total agricultural land. The total area with irrigation infrastructure increased from 60,000 ha in 1920 to 330,000-340,000 ha in 1987; by 1998 the area declined to 274,000 ha as nearly 65,000 ha were taken out of production. The cropped irrigated area decreased from 314,000 ha to 188,000 ha between 1987 and 1998 – a reduction of almost 40 percent. In 1998, the utilization ratio was around 70 percent - about 90,000 ha were not irrigated because of a combination of factors: failure of pumping and conveyance systems, costly and unreliable pump irrigation, inability of the on-farm irrigation system designed to service large farms to adjust to the new post-socialist realities of small private farms, and poor condition of the drainage system and/or lack of flushing. Figure 5 shows the 1986-1998 trend in irrigation.

Figure 5: 1985-1998 Irrigation Trends



Source: IWRM Study, Stage IA Report.

o In the past, irrigation was heavily dependent on electricity for pumping to lift water to higher systems that could not be reached by gravity conveyance systems. Irrigation schemes that depend on pumping account for about 42 percent of the total equipped area. The high cost of

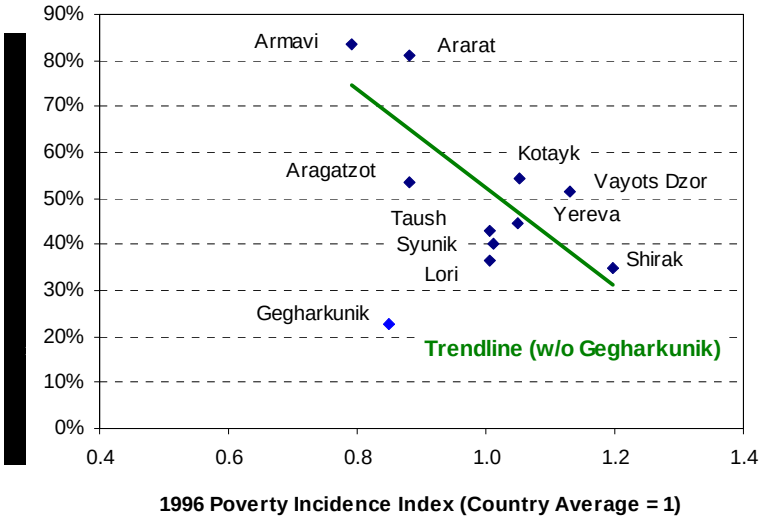
6 The sharp decline in irrigation and industrial water use can be explained by the decline in agriculture and industrial output. During the period 1987-97, industry production experienced a yearly decline of 21 percent, while agriculture output declined at a rate of 5 percent.

pumping makes about 10-15 percent of the total area economically unviable[7]. Other uneconomic areas have already gone out of irrigated production as shown in Figure 5. As a result, irrigation water volume has reduced from 2.7 BCM in 1988 to about 1.5 BCM in 1998.

o It is expected that the decline in irrigation is having some impacts on poverty. The causal relationship has not been assessed yet, but it is clear from Figure 6 that those Marzes which have experienced a severe decline in irrigation between 1990-1995 (with the exception of Gegharkunik), are also the ones which score the highest in terms of poverty. The methodology to determine poverty scores follows the one used under the Social Investment Fund II Project[8].

o In order to lower the cost of operating the irrigation system through decreased reliance on electric energy, a program for pump-to-gravity irrigation conversion has been developed where such conversion is feasible and economic. Unit conversion costs range from US$1,700 to US$2,200 per hectare, while the energy savings average 0.72 KWh per cubic meter or US$115 per hectare (assuming an opportunity cost of electricity during the summer equal to US$0.02/KWh and 8,000 m^3/ha of water requirement). No decision has been made yet on what to do with those schemes where such conversion is found to be infeasible and/or uneconomic.

Figure 6: Irrigation Decline and Poverty Incidence



Source: Prepared on the basis of information contained in the IWRMP Study, Stage IA Report.

o The current average overall irrigation efficiency from the source to field countrywide is about 48 percent, 6 points higher than the level registered in 1995, but in some areas efficiency is down to 38 percent. The high rate of water losses is due to the deterioration of the water conveyance infrastructure. Some improvements in irrigation efficiency have been achieved as a result of a program to rehabilitate the water conveyance infrastructure, but more needs to be done in this area. The average efficiency of a few rehabilitated schemes, mostly primary and secondary canals covering a fraction of the irrigated area, has increased from 60 percent to 80

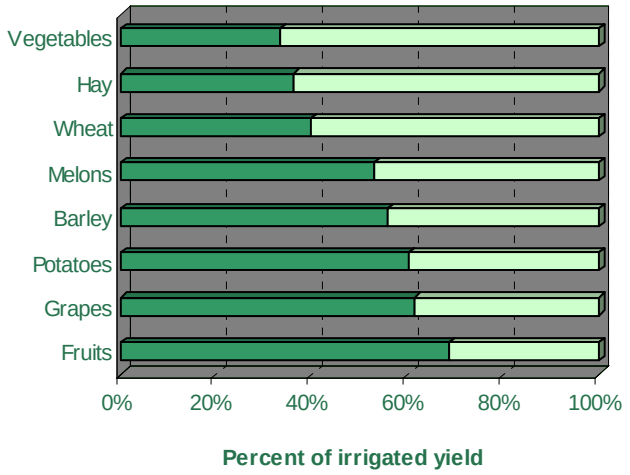
---

7 Lifting water above 100 m. for irrigation requires on average 8,000 KWh per ha (i.e., 8,000 m^3/ha water requirement at the field at 50 percent efficiency at 0.5 KWh/m^3). At a financial cost of electricity of US$0.038/KWh, average annual pumping costs can represent up to US$300 per ha or 50 percent of the gross financial return.

8 These scores are computed from three poverty indicators for 1996/1997: poverty incidence or proportion of population below national poverty line, the severity poverty index representing the intensity of poverty, and unemployment rate representing the poor's opportunity to secure means of sustainable livelihoods; and two regional factors representing border and earthquake zones.

percent through the repairs of critical sections of the canals. Irrigation could be more efficient still if system losses were further reduced and farmers were provided with incentives to move to improved technologies, management and cropping patterns. Volumetric water pricing and on-farm improvements through agriculture extension services can contribute to make irrigation more efficient.

Figure 7: Crop Yields on Un-irrigated Land
(As percentage of irrigated land yields)



Source: 1998 Survey of Family Farms.

o The benefits of irrigation are clearly observed in the financial performance of farms. The 1998 Survey of Family Farms reveals that farms with irrigation generated net returns of about US$370 per ha compared[9] to US$40 for farms without irrigation[10]. This is explained by the substantial higher crop yields achieved under irrigation. Figure 7 summarizes the findings from the survey regarding the yields on irrigated and unirrigated lands.

o The current weighted average return to water in the irrigation sector has been estimated at about 11 US cents per cubic meter of water at the farm gate. Table 2 summarizes estimates of return to irrigation water per crop in each agro-economic zone as well as the weighted averages for each zone. Returns for individual crops to water were estimated using the residual method including investment costs without correcting for "non-contractual costs" and without assigning an economic value to own family labor[11]. Weighted averages were calculated on the basis of water volumes (taking

Table 2: Return to Irrigation Water at the Farm Gate
(US cents per cubic meter)

Crop	Ararat Plain Area	Hilly Area	Mountainous Area	Subtropical Area	Weighted
Wheat	10	4	9	11	8
Vegetables	25	15	20	16	21
Potatoes	35	25	30	34	31
Alfalfa	4	3	2	3	3
Fruits	8	6	8	12	8
Grapes	10	7	--	10	9
Weighted Average	13	8	11	12	11

Source: Prepared on the basis of information provided by the Project Implementation Unit of the Irrigation Rehabilitation Project. Details for estimating returns to irrigation water in the Ararat Plain are provided in Annex I.

9 Irrigated farms were able to irrigate only half of their land and the other half was under rain fed agriculture.

10 In 1998, the difference in productivity between irrigated and rain fed agriculture was about US$330 per hectare. The difference in productivity has almost doubled during the past few years as a result of higher yields obtained in vegetables and fruits, and a slightly higher preference for these and potatoes. More recent field surveys reveal a higher net return to irrigation – about US$550 per hectare.

11 It assumes that family labor in the short and medium term has limited alternative use.

into account cropping patterns, crop water requirements, and irrigated area). The Ararat Valley is the most productive zone per unit of irrigation water.

Table 3: Distribution of Land According to Groundwater Level

Groundwater Table	Total Irrigated Area		Ararat Plain	
	Hectares	Percent	Hectares	Percent
< 1.0 m	4,230	2 percent	2,380	3 percent
1.0 m – 2.0 m	34,125	13 percent	19,230	24 percent
2.0 m – 3.0 m	30,145	11 percent	8,878	11 percent
> 3.0 m	196,380	74 percent	50,430	62 percent
Total	264,880	100 percent	80,918	100 percent

Source : IWRMP (Stage IA Report).

o About 15 percent of the total irrigated land, most of which is located in the Ararat Valley, requires drainage systems in order to reduce the impacts of waterlogging and high groundwater levels[12]. In the Ararat Valley, as much as 27 percent of the total irrigated area appears to be within 2 m of the water table. The countrywide and region wide distribution of groundwater levels in irrigated areas is provided in Table 3.

o Part of the area that has high groundwater levels has been provided with underground ceramic drains to lower groundwater to levels that allow crop production, particularly in those areas that include saline and alkaline soils. Due to a lack of funds for several years, no replacement or proper maintenance and cleaning of the drainage system has taken place, and as a result the drainage conditions in the Ararat plain have deteriorated rapidly, causing waterlogging and higher water table levels, which have led to secondary salinization and alkalization of the soil. This has negatively impacted agricultural production and public health - malaria has re-emerged over the past few years. Table 4 shows the impacts of several levels of groundwater and the secondary salinization of soils on crop yields, crop choices, and gross farmer's income (without including family labor cost and pumping cost).

Table 4: Impacts of Groundwater Table and Salinization on Crop Yield and Gross Farmers' Income

Crops	Yield (kg/ha)			Gross Farmers Income (US$/ha)		
	Very High (< 1.0 m)	High (1-2 m)	Low (> 2.0 m)	Very High (< 1.0 m)	High (1- 2 m)	Low (> 2.0 m)
Wheat	1,550	2,550	2,840	139	301	327
Tomato	--	16,500	22,000	--	1,465	2,012
Potato	--	14,000	14,000	--	2,164	2,164
Alfalfa	6,000	9,000	11,000	138	249	314
Fruits	--	--	5,800	--	--	651
Grape	--	--	7,500	--	--	1,492

Source: Environmental Assessment Report of the Irrigation Development Project (Draft).

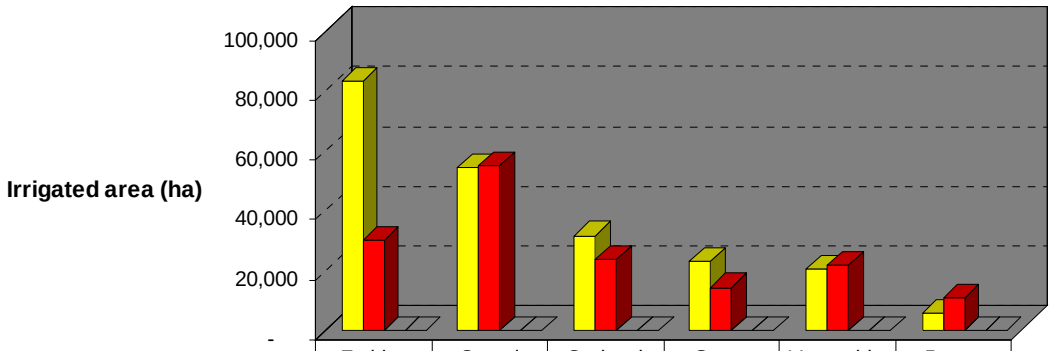
o Depending on its quality, drainage water is often diverted back into the irrigation supply system and re-used for restricted irrigation purposes. Drainage reuse is restricted by the quality of the soil, the irrigation season and the type of crop. Drainage water is unsuitable for irrigation purposes[13] unless it can be mixed with freshwater to lower the mineral content. When the

12 Irrigation networks built in the 1940s-1950s, i.e., Artashat canal, Lower Hrazdan canal, Hoktemberien canal, led to the rise of the groundwater table in the Ararat Valley. To lower the groundwater table, open and closed drainage systems were built starting from the 1950s-1960s.

13 Both water quantity and quality of the drainage collectors are monitored during the irrigation season. The results of the 1999 monitoring survey show that: (i) in the Metsamor-Kassakh system the flow rates range up to 7 m3/sec, with a mineral content generally below 1.0 g/l and only occasionally up to 1.4 g/l; (ii) in the Hrazdan River

mineral content of the drainage water exceeds 1.0 g/l and an alternative water source is not available for dilution, chemicals may be added to the drainage water to lower the pH levels, and the soil is leached to avoid secondary salinization and alkalinization. The operation of drainage systems is essential to avoid salinization and/or re-salinization of some of the reclaimed land. The degree of soil salinity is an important factor in crop production. During the past 10-13 years, significant changes in salinity levels and crop production have been observed in the Ararat plain, particularly in the communities of Hayanist and Darbnik.

Figure 8: Trend in the Distribution of Cropping Patterns in Irrigated Land, 1992-1999



	Fodder	Cereal	Orchard	Grape	Vegetable	Potato
1992 Irrigates Area (ha)	82,940	54,340	31,460	22,880	20,020	5,720
1999 Irrigated Area (ha)	30,140	54,926	23,407	14,160	21,248	10,918
Increase/decrease	-64%	1%	-26%	-38%	6%	91%
Economic return of water (US cent/m3)	3	8	8	9	21	31

Sources: Project Appraisal Document of the Irrigation Rehabilitation Project; IWRMP Study (Stage IA Report); and Project Implementation Unit of the IDA-funded Irrigation Rehabilitation Project (IRP).

o The cropping mix in the main irrigated areas is changing rapidly, as is the overall demand on water and the return per cubic meter of water. Figure 8 illustrates the trend from 1994 to 1999 in the distribution of cropping patterns in irrigated areas. It is clear from the figure that low value water uses (i.e., fodder) are declining, and high value uses (vegetable and potato) are increasing.

o Despite the spatial and temporal variations in the availability and use of water of various quantities and qualities in the Ararat Valley, i.e., irrigation supply, drainage water, and groundwater, no integrated water management is practiced yet, particularly conjunctive use of surface, groundwater and drainage water.

Municipal and Drinking Water Supply and Wastewater Services

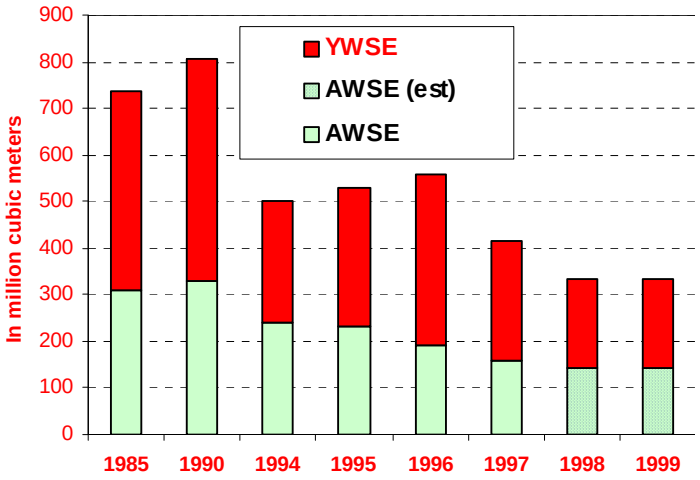
o The water supply and sanitation sector is organized as follows. According to the law on local self-government, communities are responsible for drinking water and wastewater services within their geographic boundaries. A large number of urban and semi-urban communities and villages have delegated operational management of the services to two public operators: Yerevan

---

Bank system, the flow rates range up to 9 m3/sec, and the mineral content is below 1.0 g/l; (iii) in the Hrazdan Left Bank system, the recorded flow is 11 m3/sec and the mineral content exceeds 1.0 g/l and in some cases reaches 1.5 g/l; and (iv) in the Hrazdan-Araks collector, the flow rate is 1.5 m3/sec and has a high mineral content of 1.5 g/l.

Water Supply Enterprise (YWSE) for Yerevan and surrounding communities, serving about 1 million inhabitants, and Armenia Water Supply Enterprise (AWSE) elsewhere, serving about 43 cities and 290 villages totaling about 1.4 million. Four cities and about 600 villages, totaling about 0.6 million inhabitants, directly operate their water systems. AWSE also supplies bulk water to about 100 of the above mentioned villages. A third operator, Nor Akunq has recently been established to operate in 12 cities and villages with a total population of 100,000 in Armavir Marz.

Figure 9: Trends in Municipal Water Use



Source: IWRMP Study, Stage IA Report

o The municipal sector is the second largest water user after irrigation. Most of the municipal water supply comes from relatively unpolluted groundwater sources, particularly springs and deep groundwater. Only 5 percent of the water is supplied from surface sources. Municipal supply covers household, institutional (hospitals, schools, public buildings, etc), commercial (hotels, restaurants, shops, etc.) and in some cases industrial demands. In general, water used for municipal purposes has decreased since independence from 0.8 BCM in 1990 to about 0.4 BCM in 1999[14]. This trend can be partially explained by the fact that the industrial share in overall municipal water use has experienced a decline from 41 percent in 1985 to 14 percent in 1998, by the inability to provide 24-hour service to consumers, and by the decline in population[15]. Figure 9 shows the trend of water supplied by the two major public water operators.

o Although most municipal water demand is met from groundwater sources, there are some areas where no groundwater is available and surface sources have to be used (e.g., Vadnazor, Kapan, Dilijan and Talin). There are also some areas where the capacity of the springs to meet current demands is limited, and may not be sufficient to meet future demands (e.g., Martouni, Sisian, Spitak and Vanadzor).

o Since water flow metering is nearly non-existent, average production and consumption levels are not known with accuracy. Recent estimates suggest that the volume of water used by consumers, net of leakages prior to delivery, reaches about 250 lcd[16]. This represents less than half the amount of water produced, about 560 lcd. Thus, unaccounted-for water (UFW) could

14 Water supply trends in communities and villages not supplied by AWSE and YWSE are not available. Given that overall population is 500,000 inhabitants, the estimated water demand is 30 MCM per year.

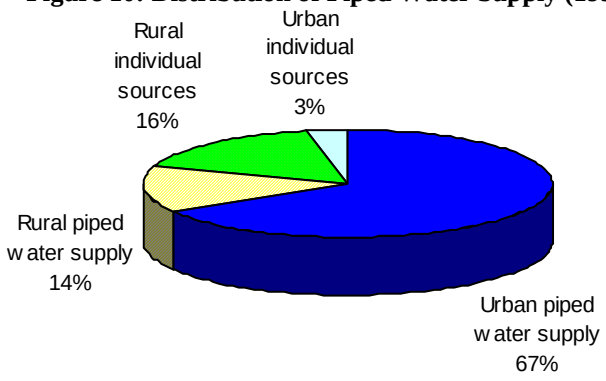
15 Although the official population is 3.8 million inhabitants, this statistic seems to be inflated and a more realistic value is 3.2 million. The upcoming national census, scheduled for November, will clarify this issue.

16 Evidence indicates that water consumption is much lower than estimates. Water consumption in the city of Vanadzor, where 20 percent of the customers are equipped with water meters, is only 130 lcd.

represent between 55-65 percent of the total water supplied, and in the earthquake zone, the UFW exceeds 65 percent. Water losses exist in all stage of the hydrological cycle and their high levels are explained by the age of the infrastructure, the quality of construction materials, the conditions of installation, and the service pressure as a result of the mountainous topography. Network losses have been estimated at 61 percent in Yerevan, 71 percent in Gyumri, and 75 percent in Vanadzor. Undergroundwater leakage is causing subsidence of buildings. Unmetered household water use is wasteful, as a result of intermittent supply and zero marginal cost.

o According to recent statistics, about 81 percent of the total population has access to piped water supply networks, while the rest get their water from an irrigation company or from local, and often unprotected, water sources (i.e., private or public wells, springs, open sources). In most cases, individual systems are by gravity and often without any treatment. Trends in coverage of piped water supply and non-piped water supply by urban and rural population are shown in Figure 10. Communities who manage their own systems, about 19 percent of the population, seem to be facing a high risk of distributing contaminated water.

Figure 10: Distribution of Piped Water Supply (1999)



Source: IWRMP Study, Stage 1A Report.

o Indoor water taps are available to 71 percent of the population, with a marked difference between urban and rural populations. While the vast majority of urban households (about 87 percent) have tap water at home, only 45 percent of the rural population has access to home taps. The quality of water services is deficient on several counts. Drinking water supply is supplied for a few hours a day, and due to damaged pumps, some communities and inhabitants of high-rise apartment buildings go without water for days at a time. The urban population with indoor water taps receives water 8 hours per day on average, while the number of daily hours of services for the rural population is 14. Only 50 percent of the population received water every day during the past year, while the other 50 percent experienced long waiting periods without water in their taps – on average 40 days out of the year. When there is no indoor water tap, the urban population spends 29 minutes per day collecting and bringing water to the house. Box 1 describes the alternative coping mechanisms to address poor water services, and reveals that the economic costs of deficient water supply can be enormous.

o All Armenian towns, where about 67 percent of the population live, and some 250 villages have sewerage coverage. Sewerage systems remove on average 60-80 percent of the volume of wastewater generated in towns, while in rural areas the figure is about 50 percent. The sewerage networks in Armenia are also in disarray because of their age and the lack of rehabilitation and renewal. About 70 percent of the volume of wastewater collected is supposed to be treated in the 19 wastewater treatment plans located across the country. At present,

however, the treatment plans are not operating properly, and as a result most of the untreated wastewater is discharged into rivers in most places.

- Although access to water sources is not a constraint at present, the quality of the water supplied does not meet hygienic standards. In 1993, out of the 1,141 water supply systems that were inspected, 39 percent were found to be hygienically inadequate, and 13 percent of the 8,900 tested samples taken did not meet microbiological standards. The situation has deteriorated during recent years. In 1998, 52 percent of the 1,133 water supply systems did not meet sanitary requirements and 17 percent of the 21,700 tested samples did not meet microbiological standards[17]. The main reason for this further deterioration is the unsatisfactory condition of the water supply network. Contamination occurs beyond the water sources as a result of intrusion of different kinds of pollution (including untreated wastewater) into the pipelines.

- Conditions of the water supply systems managed by local communities also are unsatisfactory. About 60 percent of the 883 rural systems do not have any disinfecting equipment. The poor quality of water supply is linked to the high level of water-borne diseases. Figure 11 shows trends in waterborne diseases in four Marzes with a high percent of water supply systems without disinfection facilities.

- The state of the water supply system has deteriorated in recent years due to decreases in budget allocations, and payment for water consumed by the population does not cover operation and maintenance. The poor performance of water supply services organizations is closely related to their financial unsustainability.

[17] Armenian standards for potable drinking water, based on Soviet Quality Norms, comply with EU guidelines and WHO standards.

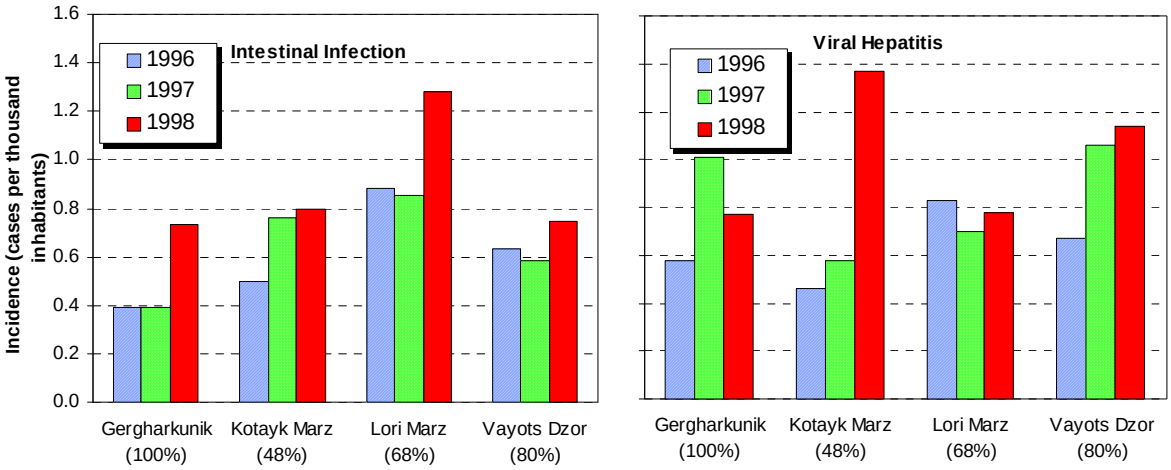
Box 1: Water Supply Coping Strategies of Armenian Households

The 1999 household survey conducted under the framework of "Utility Pricing and the Poor: Lessons from Armenia" study reveals that households in Armenia use a variety of mechanisms to cope with deficient water supply services:

- *Storage*. As hours of service decrease households with private taps are more likely to store water. In urban areas, where water is available for only about 8 hours a day, 80 percent of households store water. In rural areas, where water is typically available for 14 hours a day, only 50 percent of households store water. Generally households store an average of 20 lcd, about 80 percent of daily reported consumption. About 8 percent of households invested in storage systems in the last two years with a median investment equivalent to 13-31 percent of the average monthly income of non-poor and poor households, respectively.
- *Pumping.* About 20 percent of urban and 7 percent of rural households use motorized pumps to address problems with pressure. Over 40 percent of households report using a pump in mountainous Gegharkunik. Fewer poor than non-poor report using pumps. About 14 percent of households using pumps report paying a fee of about 0.5-1.2 percent of their average monthly income for its operation, without including the cost of electricity.
- *Alternative sources.* When storage or pumping is not adequate to handle supply problems, households are forced to use alternative sources of water—such as street taps or natural sources. About 50 percent of residents using home taps needed to find alternative sources of supply in 1999. Urban households generally rely on street taps or neighbors. Rural households commonly rely on street taps, neighbors and natural sources. Households generally do not pay for water from these sources, except when using water vendors. The price of vended water ranges from US$0.02–0.05 per 10 liters. Vendors are very uncommon, however. Although the monetary cost of alternative sources is not high, the combination of finding, carrying and storing water can involve considerable time and effort – up to one hour per day can be spent in these tasks. This time could be spent on other important and productive tasks.
- *Treatment.* About 26 percent of households in urban areas and 18 percent in rural areas treat their water before drinking it. Of those treating their water, 63 percent use boiling as their primary treatment method, 33 percent allow particles to settle out and 4 percent use filtering.

Source: Lampietti, Julian (2001). Utility Pricing and the Poor: Lessons from Armenia (forthcoming)

Figure 11: Trends in Water-Related Diseases in Rural Areas



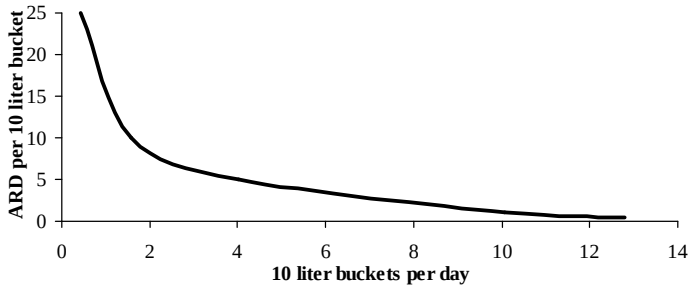
Note: Numbers in parenthesis indicate percentage of systems without desinfection facilities.
Source: IWRMP, Stage IA Report.

o Although water for municipal use, including drinking water, receives the highest priority, the value people attach to water for domestic use is relatively low. Recent estimated values per unit of water used by domestic consumers range from US$0.11 to US$0.95 for consumers using 130 lcd and 37 lcd, respectively. As shown in Box 2, these estimates are based on the household demand curve for improved water services prepared with the 1999 household survey data. The low value may reflect the low affordability level of the Armenian population combined with the abundant supply of water provided in the past – about 500 lcd.

Box 2: Valuing Water for Domestic Users

Under the "Utility Pricing and the Poor" study, a multivariate response model was developed to predict household responses to changes in price if the improved system were in place. The model suggests that at 1 ARD per 10 liters, a 10 percent increase in price to 1.10 ARD per 10 liters, would lead to about a 2.4 percent reduction in consumption for all households. Meanwhile at 5 ARD per 10 liters, a 10 percent increase to 5.5 ARD per 10 liters would lead to a 11.6 percent reduction in consumption. Using these predictors and the water demand curve shown below, it is possible to estimate the value of water demanded for households at different points in the demand curve.

Household Water Demand for Improved System



Source: Lampietti, Julian (2001). Utility Pricing and the Poor: Lessons from Armenia (forthcoming)

Industrial Uses

o As noted above, part of the industrial water demand is met by the municipal supply, but most of the largest industries in Armenia have their own water supply systems. Industrial demands have declined considerably due to the closing down of many enterprises after the break-up of the Soviet Union. In the case of self-supplied industries, their water demand has declined from 208 MCM in 1988 to 54 MCM in 1998. Industries use both surface and groundwater sources. Since few industries have water meters, the above figures are only an estimate of what the enterprises report to the central authorities as their level of water consumption. Most industries are concentrated in the Yerevan Marze, and they represent about 40 percent of the total number of water-using industries in Armenia. The largest industrial water user is the nuclear power plant.

o Although industrial demand represents a small percentage of total water use, the major concerns of this sector relate to effluent discharge, often contaminated with a large number of pollutants. Only a few of the wastewater treatment facilities built during the Soviet times are reported as being operational. No new facilities have been built since 1990. Therefore, it is expected that most industries discharge their wastewater without any pre-treatment to the municipal sewers or directly to the receiving water body – either rivers or reservoirs.

Hydro Power

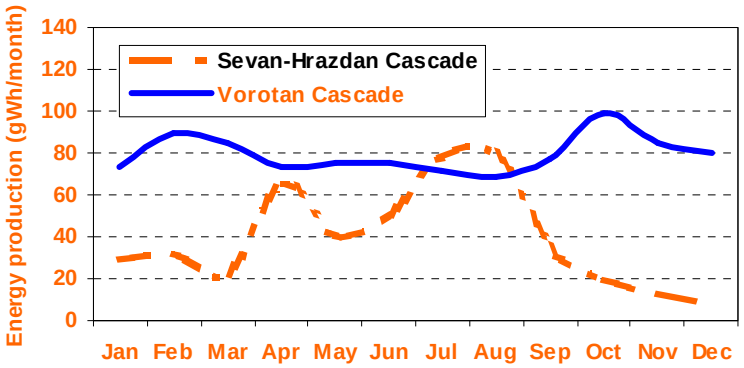
o The total installed hydropower generating capacity of Armenia is about 1,020, MW out of which about 800 MW currently is operational. Out of 35 hydro power plants (HPPs), 9 are

part of two important hydropower cascades, the Vorotan Cascade and Hrazdan Cascade, which together represent 92 percent of the total installed hydropower capacity in the country and generate 23 percent of total electric energy. The Hrazdan Cascade produces on average about 570 GWh, while the Vorotan Cascade produces 1,100 GWh per year. Overall hydropower production, in general, is subject to fluctuations in the hydrological regime and the need to undertake repairs and rehabilitation work of the infrastructure.

o In the Vorotan Cascade, the hydropower stations are largely independent from other water uses and are operated more in accordance with power needs, using the available storage of the reservoirs in the Vorotan Basin. Most of the energy in this cascade is generated to meet daily peak demand, which is particularly severe during the winter months. This is of considerable value for the proper functioning and stability of the power system in the whole country.

o In the case of the Hrazdan Cascade, at present no special releases from Lake Sevan are made for electricity generation. The HPP stations generate electricity only from the water that is released from Lake Sevan for irrigation purposes. This cascade therefore cannot play the same role as the Vorotan Cascade. During the winter, when there is no need of irrigation but when electricity is in high demand, a small amount of energy is generated mainly from the water coming from the tributaries. During the summer period when irrigation releases from Lake Sevan are available for power generation, the releases can, to some extent, be tuned to peak requirements by means of re-regulating storage ponds. Figure 12 shows the energy produced per month in each of the two cascades in 1998, and confirms that water releases through the Hrazdan Cascade are concentrated in the summer months, while the releases of the Vorotan Cascade are more evenly distributed through the year and are slightly higher in the non-irrigation period from October through March.

Figure 12: Energy Production Patterns of Vorotan and Hrazdan Cascades (Data for 1998)



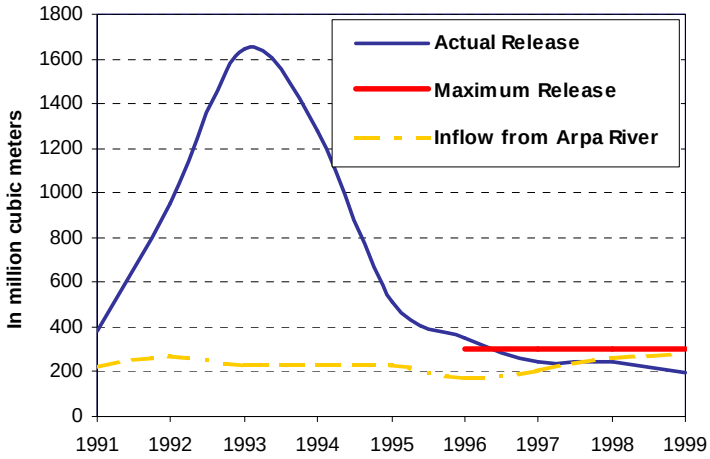
Source: IWRMP Study, Stage IA Report.

o Apart from the fact that the total heads of the Vorotan and Hrazdan Cascades are 1,119 m and 833 m, respectively, which implies that the amount of energy generated in the Hrazdan Cascade by water from the Vorotan Basin will be substantially less than what could be generated in the Vorotan Cascade itself, the KWh of electricity produced in each cascade does not have the same value. On the basis of available information, it is possible to infer on the one hand that the value of electricity in the summer months is low, around US cents 2.0/KWh. On the other hand, the value of electricity production in winter is considerably higher, around US cents 3.5/KWh, and will become even higher when the nuclear power plant is shut down. These seasonal values of the cost of electricity together with the specifics of the two basins have to be taken into

account when estimating the value of water in hydropower generation in the Vorotan Basin and the Hrazdan Basin.

o One of the ongoing reforms in the energy sector is to promote private sector participation in the management and operation of HPPs. At present 13 out of the 25 small hydropower plants have been privatized, while the others are in the process of being privatized. So far, no major concerns in the area of water resources management have been identified that could have a negative impact on the participation of the private sector, since most of the small size HPPs are of the run-of-river type and do not affect irrigation release patterns. Concerns however are expected to rise when the private sector participates in the development of new HPPs or in the management of the larger HPPs.

Figure 13: Releases to/from Lake Sevan During the 1990's



Source: IWRMP Study, Stage IA Report.

C. Other Important Water Management Issues

Strategic and Multi-purpose Reserve

o Lake Sevan, apart from being an important environmental, social, energy and irrigation resource for Armenia and the region, also represents a cultural treasure for the Armenian population and has inspired the history, poetry and music of the country over many centuries. Due to excessive water utilization, the original level of Lake Sevan decreased by 19 meters between 1934 and 1995, and its volume decreased by 41 percent as compared to its natural conditions in 1930s. Much of the drop in the lake's level occurred prior to the early 1960s when some management measures were introduced. As a result of the energy crises of the 1990s, the level of the lake dropped again by several meters. The storage capacity of the lake as the country's main strategic reserve for multi-purpose use has been practically depleted.

o In the 1960s, a plan to increase the inflow to the lake was undertaken, which included the diversion of water from the Arpa River to Lake Sevan through the Arpa-Sevan tunnel. At present, the Arpa-Sevan diversion transports 250-265 MCM of water per year from the Arpa and Yeghegis Rivers to Lake Sevan via a 48.3 kilometer two-segment tunnel built between 1963 and 1982.

o In 1978, the Government decided that a second diversion scheme was needed to raise the level of the lake, and in 1982 a plan to divert an average of 165 MCM of water per year from the upper Vorotan River was approved. The Vorotan-Arpa diversion is still under construction. Construction of the 21.6 km tunnel was slowed in 1989 as a result of the economic collapse

following the breakdown of the Soviet Union. Of the entire length of tunnel, all but about 550 m are excavated.

o Between 1995 and 1998, the Government of Armenia with the support of the Bank Group prepared the Lake Sevan Action Program for the recovery of Lake Sevan and its surroundings. The program proposes activities on several fronts: legal and regulatory changes, institutional adjustments, and capital investments. Apart from the restrictions on water releases from Lake Sevan to 200-300 MCM per year[18], as shown in Figure 13, limited progress has been made in the implementation of the program.

In-Stream Water Use and Functions

o The water related biodiversity and ecosystem functions in Armenia are of high quality, but certain problems are evident and need serious attention. The rapid agricultural and industrial development in the past led to heavy pollution and significant reduction of the water flow of some rivers, reducing their biodiversity and fish production and decreasing their capacity to buffer floods and retain loads of organic materials and nutrients. While agricultural and industrial pollution has declined considerably during the past ten years, much of this decline has been the result of the contraction of GDP, including agriculture and industrial output.

o Two of the most serious issues that deserve immediate attention are the degradation of Lake Sevan and the protection of wetlands, particularly those in the Ararat Valley and around Lake Sevan. Protection of Lake Sevan will contribute to protection of biodiversity and nature values, sustainable economic utilization of the water resources, fish production and tourist potential of the Lake, and restoration of the biggest strategic water reservoir in the country. Raising the level of water in Lake Sevan would help to arrest severe perturbations to the ecology of the lake as a result of the extended drawdown (e.g., extinction of four subspecies of the endemic Sevan trout, which used to live in Lake Sevan; threats to more than 150 out of an estimated 1,500 species of flower and seed producing plants, decline of the diversity of bird species; decline of recreational activities and tourism affected by the constantly receding shoreline and deteriorating aesthetic value of the shoreline area). Maintaining and improving the quality of existing wetlands is an important objective by itself because the wetlands provide valuable services to the whole society, functioning as habitats for breeding and migratory waterfowl, buffering flood events and retaining nutrients.

o A challenge for decision-makers is whether or not to maintain the wetlands and marshes in the Ararat Valley, as some of these have reverted back to their natural state and formed habitats for some species as a result of the poor drainage systems. There is not an easy answer to this. It requires achieving the right balance between public and private interests, and between social benefits (public health impacts associated with the potential re-emergence of malaria and losses of employment opportunities in the agricultural sector) and environmental benefits (ecological value of wetlands) when making decisions regarding areas to bring back under cultivation. As shown earlier, farmers in flooded areas do not benefit economically from the services of the wetlands – moreover, as a result of high water level, profits from their lands have been reduced drastically.

---

18 Despite these limits, the level of Lake Sevan has not increased – suggesting illegal withdrawals of water.

Minimum Flows

o There is an established system for calculating minimum flow requirements in rivers. Armenian regulations call for maintaining a minimum flow ("sanitary flow") in rivers to maintain multiple functions including, aesthetics, fish production; protection of human health and an overall healthy water ecosystem. Although the regulations do not specify the methods to estimate sanitary flows, Armenian institutions generally use the "Guidelines for Regulating Minimal Water Flow in Rivers for Nature Protection." The guidelines make reference to the average monthly flows, based on historical flows recorded by the nearest monitoring stations. The guidelines suggest setting the minimum flow level equal to 75 percent of the 95th percentile of previously recorded monthly water flow levels. That is, the minimum sanitary flow is set equal to 0.75 times the minimum flow of 95 percent probability of historically observed data[19].

Table 5: Selected Minimum Environmental or Sanitary Flows
(in cubic meter per second)

River	Monitoring Point	Minimum flow	Average flow 50 percent probability
Akhurian	Tallin region	1.43	9.75
Hrazdan	Masi spot	2.00	23.09
Azat	Zovashen spot	1.00	7.07
Vedi	Karabakhlaz	0.30	2.43
Sev Jur	Ranchpar	2.00	33.20
Vorotan	Vorotan	2.01	22.42
Vokhchi	Kapan	1.06	7.14
Agstev	Krivoy most	0.42	11.05
Debet	Akhtala	2.38	34.40

Source: Institute of Water Problems, MoA. It should be noted that average flow data used by the MoA differs from that maintained by Hydromet by +/- 10 percent.

o As shown in Table 5, proposed minimum environmental or sanitary flows for some river sections seem reasonable compared to what is used in other countries as compensation flow in cases where the river is heavily regulated or transferred. These thresholds, however, are not optimal when seen from an environmental perspective. These requirements are given in one point only along each river, far downstream in the basin, with no regards to the flow in the rivers upstream of the point of reference. In addition, in years of good water availability the environmental functions should receive more than the minimum flow volumes.

o There is an old requirement for "sanitary zones" along rivers and other water bodies (i.e. keeping a buffer zone of natural vegetation along the watercourses), which unfortunately is no longer enforced. Experience has shown that this is one of the most efficient measures for reducing the runoff of pollutants from agricultural lands. In addition, this practice has a very positive impact on the biodiversity in and around the watercourses.

Floods

o During the spring period, river floods in general cause damage to infrastructure and personal property and sometimes casualties. In the Kura River Basin, the cause of the floods is

[19] Although a methodology has been adopted based on Soviet norms, it is not clear why different institutions derive different sets of minimum flows for the same point of the river – sometimes the ratio of minimum flows derived is 1:4. Either different databases are used or the methodology leaves some ambiguity in its application. A range of approaches has been adopted worldwide to define minimum flows. A common approach used in international best practice is to define a minimum flow equivalent as the lowest average seven or ten day period of daily flow during a 10 year return period drought (often referred to as 7Q10 and 10Q10).

generally rainfall and in the Araks River Basin it is snowmelt. In particular, when sudden high temperatures and relatively warm rain trigger high runoff, floods can be devastating and ruin bridges, riverbank protections, and cultivated fields. In parts of the country with steep slopes and weathered loose surface material, high rainfall and related runoff often cause mudflows, which tend to be more damaging than runoff with low concentrations of solids. They also tend to be more local and more difficult to prevent with water management related measures. Because of their relatively severe impact, the emphasis in Armenia has been to prevent mudflows.

o In general, the irrigation reservoirs in Armenia are not designed to act as flood storage reservoirs. However, most of the existing reservoirs are able to mitigate (part of) the effects of otherwise devastating floods. They act as flood storage reservoirs whenever they have ample (dynamic) storage volume in comparison with the spring runoff volume of that particular river.

o Apart from inundation of infrastructure and cultivated fields, the erosive forces of river floods tend to cause damage to riverbanks. These effects may be mitigated by the construction of groynes or other bank protection measures. Such measures have been designed and constructed along various rivers. The most extensive works exist along the Araks River, where along one stretch of 150 km (on each riverbank) high flood embankments as well as gabion-type protection works have been constructed to prevent inundation of homesteads and arable land.

Drought

o As mentioned above, Armenia is very prone to droughts. Last year a severe drought affected the northern region of the country, with devastating impacts on the agricultural sector. As a result of the drought, water flows in rivers decreased by 40-50 percent. Available water for irrigation was 31 percent less than the previous year, causing severe damage to crops. The impacts of the drought were exacerbated by the disrepair of the infrastructure and the high level of water losses; the poor condition of reservoirs, which prevents collection of spring flood flows to be used in periods of shortage; the poorly regulated contractual agreements between water companies and water-consumers groups; and the lack of mechanisms for monitoring drought conditions and impacts, and communicating them early on to decision-makers and water users[20].

D. Institutional Framework for Water Resources Management

o This section describes the current organizational/institutional arrangement for water resources management, the decision-making process for water allocation, and the monitoring system.

Institutional Arrangements and Legal Foundation[21]

o At present the Ministry of Nature Protection (MoNP) is formally charged with the overall management responsibility for water resources. Development, planning and management responsibilities are shared with other Ministries, namely the recently established State

20 UNDP Report of the Study of the Communities Most affected by the Drought. August-September 2000.

21 The assessment was completed at the end of June 2001. Subsequent changes have not been reflected here.

Committee of Water Economy[22] responsible for water-related operational functions (development, operation and use of water resources and related infrastructure for irrigation, water supply and sanitation, and hydropower); the Ministry of Agriculture responsible for the development of the policies for irrigation and drainage; the Ministry of Health, responsible for monitoring of water quality and quantity in relation to public health; the Ministry of Urban Development, responsible for the development of policies for the supply of potable water and sewerage services to the population; the Ministry of Energy, responsible for policies and programs for energy including hydropower; and the Ministry of Finance, responsible for water tariffs and financial matters[23]. Coordination among the various actors is weak. Annex II shows the tasks and responsibilities of the various entities involved in the management of water resources.

o A recent analysis of the institutional framework reveals that the formulation of a coherent and integrated long-term policy for water resources management has not been a priority issue during the transition period. However, several important laws and regulations have been established, including the Water Code of 1992 and Ministerial Decisions on a number of water-related issues. Box 3 provides additional details on the Water Code. Water quality standards exist for raw water and effluent discharge. Design standards or norms for water consumption for different sectors exist but are in general considered too high. In the past, certain "functional uses" were assigned to (parts of) rivers and lakes. This classification of rivers has not been updated. In general, the current legal framework provides the basis for water resources management, but it will need to be updated and made more specific, particularly with regard to formulation of water resources policies, definition of functions that need to be carried out in water resources management, and the assignment of the role and responsibilities of the government and the different users.

[22] The establishment of the State Committee of Water Economy was motivated by the need to restructure the water service agencies (i.e., irrigation, drainage, bulk suppliers or reservoirs, water supply and sanitation) to make them commercially-oriented, to devolve responsibilities for service delivery to irrigation user groups, and to consolidate bulk water supplies. It is expected that this new body will foster integrated planning to maximize the use of the resources at the macro (national perspective) and micro (sectoral perspective) levels.

[23] Given the desire of the Government to promote private sector participation in the provision of water services, a study is underway to assess the need to establish a single regulator to regulate the monopoly aspects of water services, including tariff determination.

Box 3: The 1992 Water Code of Armenia

The main water-related legal document in Armenia is the 1992 Water Code. The Water Code regulates the state's management and control of water use, water consumer rights and duties, water protection, and prevention of water deterioration. The Code provides for permits to use water and discharge pollution. Water user fees are charged to water utilities, industry, agriculture and irrigation water users. Pollution fees are to be paid by industries and wastewater facilities.

The Code contains guidelines in the following important areas:

- Water source management (i.e., classification of sources, who is allowed to use the water, who has rights to use water).
- Classification of water consumers (i.e., domestic, industry, irrigation, etc.).
- Pollution prevention measures (e.g. penalty regulations).
- Assessment and planning of water resources and the need to establish water balances at the basin level.
- International issues related to water.

The Code states that water used for drinking water purposes has priority over other uses, and relies on a series of regulations that define specific procedures and norms and thereby govern operations in the sector. The Code highlights a number of important sector issues (the creation of a National State Register of water resources and uses, as well as a State Water Fund), and introduces the concept of water extraction fees, and development of water markets.

Although the Water Code appears to be rather comprehensive, there is a need to review it so as to take full account of the good practices and principles in water management issues which have emerged since 1992; and to update it since other laws and decrees issues after 1992 have superceded the Code. The Water Code also lacks a general description of the main functions of integrated water resources management and guidance for institutional arrangements. Efforts to amend/update the Water Code are currently underway.
Sources: IWRMP Study, Stage I Report, Part D, and Ministry of Agriculture.

Water Use Permit and Discharge Permit Systems

o Armenia has adopted the water use permit system as a means to regulate water withdrawals, which applies to both surface water and groundwater sources. In the case of surface water, the approach followed for the issuing of the permit is that first minimum flows are established at different reaches of the rivers, and then the remaining river flows are allocated for productive purposes. The water permits however are silent in terms of consumptive use and return flows, which limit the capacity of the system to be used as a tool to make decisions on water allocation. Before issuing the water use permit, consistency with water quality norms and with the "assigned" functions of rivers and lakes must be ensured. The duration of the permit is on average 5 years, and compliance with its requirements is to be monitored by the State Environmental Inspectorate. At present, water use permits are not transferable.

o The aggregate information provided by the water use permits is registered in the Water Cadaster, currently maintained by the Ministry of Nature Protection. A complete and updated Cadaster could indeed be an excellent tool to administer use of water resources. Unfortunately, this is not currently available. The Water Resources Protection Department of the MoNP does not have sufficient personnel to administer the water use permit system – the annual budget of this 6-staff unit is $3,200 per year. At present, the Water Cadaster is incomplete and fragmented,

and as a result, administration of water resources is not proceeding on a knowledgeable basis. It is particular important to update the Water Cadaster and to expand its scope to include secondary users. During the water permit application process, the information provided by the Cadaster should be supplemented with information on water sources (such as runoff and streamflow data of surface water sources, as well as data on storage, recharge and depth of groundwater).

o A system of pollution discharge permits, or ecological passports, is also in place to manage any kind of municipal or industrial point-source discharge in Armenia. In principle, the pollution discharge system should form an integral part of the Water Cadaster. At present, this is not the case. Because of their poor financial situation, only 25 percent of industrial enterprises have discharge permits. The Environmental Inspectorate charges fines for non-compliance with permits but due to the bad economic situation, only a small part of this is paid and enforcement mechanisms are not operational.

Water Planning and Allocation

o Most of the planning and allocation of water resources has been done on the basis of norms. The system of norms is obsolete and in many cases has little connection with reality. There is an urgent need to improve the current system so proper and informed decisions on water allocation can be made.

o During the last 10 years, apart from the IWRMP Study, no other comprehensive and systematic efforts have been made to carry out water resources planning. Only for the allocation of water from Lake Sevan are annual forecasts for hydropower and irrigation prepared by the Ministries of Agriculture and Energy, and evaluated by the Ministry of Nature Protection, in consultation with the concerned regional authorities. The jointly prepared annual water allocation plan for Lake Sevan is subsequently approved by the Cabinet.

o Allocation of water from existing reservoirs is based on irrigation and drinking norms set by the Ministry of Agriculture. Stakeholders are not consulted in the allocation process. Only in cases where actual water permits are requested, are the Ministry of Agriculture, the Ministry of Urban Development and the Ministry of Health consulted.

o Comprehensive planning and management of water resources in Armenia is currently constrained by the deficiencies of data gathering networks, monitoring stations and water quality laboratories. The system is characterized by the lack and unreliability of information and the outdated data processing and analytical methods[24].

Monitoring of Water Resources

[24] Current analytical methods to assess water resources are based on thorough scientific analysis inherited from the Soviet era, which if used correctly, could produce reliable data. Surface and groundwater are linked and interact in a complicated matter. Because these two resources have always been investigated and monitored by two separate institutions, water investigations have sometimes resulted in the double counting of the resource.

o The Hydro-meteorological Institute produces quantitative data on the flow of rivers and level of reservoirs and lakes. The country has an extensive network of around 130 monitoring stations of surface water. But the implementation of water resources monitoring and control programs has been hampered by low salaries and low operational budgets. During the past decade, very limited monitoring has taken place. As a result, the quality and availability of data is rather poor. Since 1988, measurement of river flows and levels of lakes and reservoirs has been very limited, especially with regard to frequency. Groundwater monitoring is also limited. Monitoring of water quality is even poorer. Reliable data on water quality is nearly unavailable. Data on water quality collected by the Environmental Monitoring Center are very limited. The water quality laboratory structure is fragmented and ill-equipped, and coordination between several actors does not exist. Table 6 presents an overview of the current status of water resources monitoring activities.

Table 6: Assessment of Ongoing Water Resources Monitoring Activities

Subject	Organization	Processing	Dissemination	Availability
Discharge of rivers	Armhydromet	Manual	Books and reports	Incomplete
Level of reservoirs	Jrambar SCISC Armhydromet	Manual	Books and reports	Incomplete
Surface water quality	Monitoring Center	Manual	Books and reports	Poor
Groundwater quantity	Geological Administration	Manual	Books and reports	Poor
Groundwater quality	Geological Administration	Manual	Books and reports	Poor
Meteorological data	Armhydromet	Manual/ Computerized	Books, reports, and internet	Good

Source: IWRMP(Stage IA Report)

Financing and Operational Management

o Since 1998, consumptive commercial water users are supposed to pay an extraction fee (or water resources tax) equivalent to US cents 0.2 per cubic meter for the use of surface or groundwater for any commercial purpose (i.e., irrigation, energy and fish production) and a special fee for the use of Lake Sevan's waters. In addition, water users have to pay a fee for the discharge of wastewater. At present, agricultural water users are exempted from the water extraction fee until end of 2001, unless they use water from Lake Sevan, in which case they have to pay a fee of US cents 0.3 per cubic meter. In 1998, less than 1 percent of anticipated revenues was actually collected. Given the poor financial status of irrigation enterprises, a proposal is under consideration to extend the moratorium until 2006, and to expand the scope of the exception to all water users. The current system does not provide incentives for metering water consumption, and is not considered an active instrument to encourage demand management. So far, the main objective of the system has been to generate revenues for the central budget, instead of reinvesting the collected funds into the sector, by providing soft financing to water users for water projects.

o Although self-financing of irrigation and water supply and sanitation services is a stated priority for the Government, limited progress has been made so far in this direction. Urban water supply tariffs in Armenia experienced a real increase of about 100 percent between 1994 and 1999. The average water tariff today is about US cents 8 per cubic meter, which should be enough to cover a large fraction of the operation and maintenance cost of the water utility -

O&M costs range from US cents 14-20 per cubic meter[25]. However, only a few households pay the water bill. Consumers are reluctant to pay water tariffs calculated on the basis of normative per capita consumption, particularly when the services provided are of poor quality[26]. Efforts are underway to introduce block metering and to improve water services. In the case of irrigation, there is a policy in place to ensure full recovery of operation and maintenance costs of irrigation services by 2007. On average, farmers pay US cent 0.8 per cubic meter, which covers 30 percent of the operation and maintenance costs of supplying the irrigation water. Although a uniform irrigation water tariff system is currently in place, the Government is considering introduction of a differentiated tariff system after 2003, and is trying to de-politicize the setting of water tariffs.

Management of Water Services

- Efforts are underway to introduce some reforms in both the irrigation and water supply/sanitation sectors[27]. In the water supply sector, emphasis is being placed on promoting private sector participation and putting the sector on a commercial and financially sustainable basis. A water operator has recently been contracted by the Municipality of Yerevan to manage the Yerevan Water Supply and Sanitation Company. It is expected that the water operator will introduce modern utility management practices and improve water services to adequate levels at a lower cost. The Government seems committed also to transforming the 46 branches of the Armenian Water Supply Company into separate companies that could be "privatized" individually or in groups, and to promoting private sector involvement through management contract, lease or concession arrangements.

- In the case of the irrigation sector, since 1996 the Government has tried to promote the adoption of a participatory approach to irrigation management in order to enhance accountability and reliability of services. Water User Consumer Cooperatives (WUCC), a form of Water User Groups, have been established along hydrological boundaries and on a village basis. They are supposed to operate and maintain lower level irrigation channels and to collect irrigation service fees for operation and maintenance (O&M) of both lower level and higher level system facilities. The experience to date with WUCCs has been mixed and has demonstrated the need for a critical mass of users to take over O&M responsibility for the entire irrigation system servicing them. A proposal has been prepared to develop Water Users Federations (WUFs) in order to give users greater responsibility in the management of the irrigation system below the primary outlet and to progressively commercialize the sector. It is expected that the WUFs will be independent, self-managed and eventually self-financed. The Government is also interested in seeing the WUFs take responsibility over time for the operation and maintenance of the main and secondary levels of the irrigation system, while the water intakes would remain in state hands.

---

25 They include depreciation of assets and provision for debts.

26 Recent surveys indicate that in general households are willing to pay higher prices for improved quality of water services.

27 Details about the ongoing sectoral reforms are provided in Decision 92, dated February 9, 2001, on "Reforms in Water Economy Management System," and the Government Decree 440, dated May 17, 2001, on "2001-2005 Program of Financial Flows and their Implementation Measures Targeted at the Improvements of Activities and Management of the Republic of Armenia State Committee of Water Economy and its Companies."

International Waters[28]

o A number of bilateral treaties bind Armenia with respect to the development and use of international waters. Armenia has an agreement with Turkey on the use of the Araks and Akhurian Rivers. The treaty shares the use of both transboundary rivers in equal proportions. There is another agreement with Turkey on the joint exploitation of a dam and reservoir in the Akhurian River. An agreement also exists between Armenia and Iran on the joint utilization of the border areas of the Araks River for irrigation, power generation and domestic use. The treaty shares the border areas of the river in equal proportions (50 percent). Whilst these treaties were concluded by the USSR, Armenia considers itself to be a successor state of the USSR and is thus bound by them.

o Before the break-up, water issues within the Soviet Union were addressed centrally. Management issues among the Soviet Republics were dealt with by the Council of Ministers of the USSR through decisions or agreements adopted among Ministers of the Soviet Republics. Decisions and agreements were made between Armenia and Georgia on the use of the Debet River; and, between Armenia and Azerbaijan on the use of the Arpa, Vorotan, Agstev and Tavoush Rivers. These decisions and agreements have generally been accepted by Former Soviet States and honored in practice, and would be very difficult to replace.

E. An Assessment of Water Related Activities Supported by the World Bank and Donor Community

World Bank Role

o World Bank water-related activities undertaken in recent years include the following:

- Irrigation Rehabilitation Project (ongoing): Help to reduce further deterioration and collapse of critical irrigation infrastructure and address ineffective water management in the irrigation sector by the formation of WUCs;

- Dam Safety Project (ongoing): Protect rural inhabitants and livelihoods from dam accidents;

- Irrigation Development Project (ongoing): Support the rehabilitation and restructuring of the irrigation and drainage system and initiate an appropriate countrywide approach to participatory management of the irrigation system;

- Municipal Development Project (ongoing), Social Investment Fund Project (ongoing), and the Municipal Water Supply and Sanitation Project (currently under preparation): Improve public health conditions in urban and rural areas by improving water and wastewater services in Yerevan and areas outside the capital city, and promoting the participation of the private sector and community-user groups;

[28] For additional details on transboundary arrangements refer to the report on "International Waters" prepared by Ms. Laurence Boisson de Chazournes, Professor at the University of Geneva (Switzerland).

- National Environmental Action Plan, the Lake Sevan Action Program and the Integrated Water Resources Management Planning Study: Identify environmental priority actions to address environmental challenges including the deterioration of Lake Sevan, strengthen environmental institutions and seek cross-sectoral alliances;

- Natural Resources Management and Poverty Reduction Project (currently under preparation): Improve watershed management; and

- Restructure the energy sector.

o In general, the results achieved so far on the ongoing and completed water-related activities have been positive. Section V presents some recommendations for future World Bank assistance in the water sector.

Role of Other Donors

o There are several donors active in the water sector. Until very recently, the donor community has supported activities in irrigation and water supply. IFAD, for example, supported the establishment of water user groups in the form of WUCCs, as well as the development of institutional capabilities to allow WUCCs to operate as independent, self-managing tertiary-level management entities, capable of maintaining the tertiary system and, eventually, participating in the management of higher-level sections of the irrigation conveyance system. The Government of Germany, through KfW, has supported the establishment of a water utility in Armavir that is run like a business. During the past two years, support from the donor community in the water resources management sector has increased. A large number of proposals, particularly for strengthening and building capacity to manage transboundary waters, have been developed. A brief inventory of the water-related activities supported (or to be supported) by the donor community is provided below.

③ The sustainable water resources management project for enhanced environmental quality in Armenia supported by USAID, which started in April 2001, will last until December 2002. The project will focus on the following areas: (i) improve the national framework for integrated water resources management; (ii) increase capacity for water resources monitoring to support integrated water resources management; and (iii) increase local participation in integrated water resources management.

③ At the regional level, there are several donors supporting in one way or another water management in the South Caucasus region: (i) USAID'S Strengthening Water Management in the South Caucasus program will support data collection and monitoring, geographic information systems, data exchange, capacity building for sub-basin management, and capacity building for an improved legal framework; (ii) the European Union (EU) is supporting the Joint River Management Program on Monitoring and Assessment of Water Quality on Transboundary Rivers, which includes the Kura Basin; (iii) UNDP is proposing a GEF program to promote increased national and regional capacity to address

transboundary water problems in the Kura-Araks Basin, which will include Turkey and Iran in addition to Armenia, Azerbaijan and Georgia; and (iv) NATO under its program "Science for Peace" is supporting a project to address monitoring of water quality in the Kura-Araks Basin.

- Other donors who have expressed interest in supporting water resources management in Armenia are the Government of Denmark (through DANIDA) and the Government of Japan (through JICA).

- It is obvious that some sort of coordination is needed between the various donors with an interest in the regional dimension of water resources management, particularly in the monitoring of water quality and quantity of transboundary water flows. Country-based and regional forums for dialogue among the donors and between the countries and the donors are needed to avoid duplication of effort.

F. Identified Cross-Cutting Water Resources Management Issues

- This section has identified the following cross-cutting issues that need to be addressed in the water sector in Armenia:

  - Determining trade-offs between energy generation, irrigated agriculture and environmental demands for water, including water quality management and freshwater reserve storage capacity in Lake Sevan;

  - Balancing supply and demand management, particularly in water deficit areas;

  - Satisfying environmental demands for water, including protection of surface and groundwater quality, mitigation of salinity, protection of wetlands, maintenance of minimum environmental flows, and protection of Lake Sevan and its strategic freshwater reserve;

  - Resolving policy and institutional issues, particularly developing water allocation mechanisms for an efficient system of water rights[29], and establishment of an effective legal, regulatory and administrative framework for water resources management; and

  - Improving the role of economic incentives to reduce demand, promote wise water use, and enable cost recovery to rehabilitate distribution networks to improve efficiency and reliability of water services, and reduce operation and maintenance costs.

[29] The introduction of a WUF's water rights system will be piloted under the proposed IDA funded Irrigation Development Project.

III. DEFINING A WATER RESOURCES MANAGEMENT STRATEGY

o The previous section highlights not only important issues in each water using sector, but also the extent to which water use in each sector has important effects on the environment and water quality, water availability in each sector, and the overall socio-economic development of the country. Addressing these important cross-sectoral issues requires an integrated water policy and management framework that balances demands and impacts in each sector including the environment, and seeks to optimally achieve the country's objectives of sustainable socio-economic development.

o This section briefly reviews the findings of the IWRMP Study to address the cross-cutting issues that have been identified. It first presents alternative future water supply and demand scenarios looking at year 2020, then discusses the wide ranges of policy choices and trade-offs available to Armenian decision-makers, and finally outlines strategic guidelines for developing a water resources management strategy.

A. Alternative Future Scenarios for Water Supply and Demand

o Under the IWRMP study, an assessment was made as to whether available resources are sufficient to meet the development goals of the various water using sectors as well as the international commitments on water sharing with riparian countries. In brief, the sectoral development plans analyzed were: (i) irrigation - expansion of irrigated agriculture to 386,000 ha by 2020[30] and improvements in irrigation efficiency;[31] (ii) municipal and rural water supply - provision of 24-hour water services to all consumers; (iii) hydropower generation - continuation of current patterns in hydropower production, i.e., following irrigation releases; (iv) environment - raising of Lake Sevan by 6 meters by 2020[32] and meeting minimum flows in rivers; and (v) industry – increasing industrial production at an annual rate of 3 percent.[33]

---

30 This level of irrigation expansion is not fully justified in economic terms, given current cropping patterns and yields. This conclusion is drawn by comparing the average net return per cubic meter of water (at the farm gate) in irrigation, estimated at about US$0.11, with the average O&M costs per unit of water, estimated at about US$0.026, and the average annualized capital cost of developing a new water source (e.g., Yeghvard Reservoir) and new irrigation land (e.g. at a cost of US$2,500 per hectare) estimated at about US$0.14 per unit of water. Unless cheaper water sources are developed first (reduction of losses), it is difficult to justify horizontal expansion of irrigation on economic grounds. The capital costs of such expansion also exceed all foreseeable sources of finance. A reasonable range of estimates for maximum irrigation expansion is 260,000–270,000 ha, including 40,000-50,000 ha irrigated with groundwater sources.

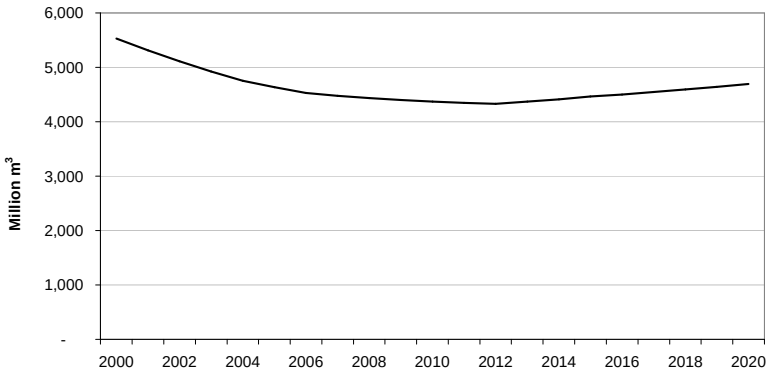
31 The irrigation efficiency is defined here as irrigation system efficiency. This is composed of conveyance and distribution efficiencies in the primary and secondary canals and on farm efficiencies. The figures used in the study are based on IDP targets and comparable international experience. The forecast estimates take into account the IDP targets for primary and secondary canals as well as estimations of field efficiency.

32 A 6-meter increase in the level of the Lake Sevan over a period of 20 years, as modeled by the IWRMP study, is regarded by some as incorrect and not feasible. The level of accuracy of the estimation performed under the IWRMP study has not been assessed, and the reliability of the data used to assess the following factors is questionable -- evapo-transpiration, groundwater recharge, and ecological demands.

33 For more details on the water balance model, the reader is referred to the IWRMP Stage II Report, available at the Ministry of Environment or the World Bank.

o In order to estimate water demands by 2020, the influence of a number of variables have been taken into account, including population growth (population in 2000 was assumed at 3.0 million, with annual growth rates of 0.3 percent in villages, 0.6 percent in towns and 0.5-1.0 percent in Yerevan), domestic water consumption (assumed at 135 lcd in villages, including livestock, 185 lcd in towns and 270 lcd in Yerevan), national income and industrial production growth rates, household income growth rate (assumed at 2 percent per year), the price of water, the rate of rehabilitation of existing irrigation schemes, crop mix, and programs to reduce losses in the piped water supply and irrigation systems.[34]. Rather than trying to assign a value to the various variables that influence water demand, alternative future projections of water use were made. Water withdrawals in 2020 were estimated to range from 4.7 BCM to 5.0 BCM per year. Figure 14 shows an aggregate water utilization forecast for the period 2000-2020 if current demand-side measures and programs continue into the future, namely, reduction of losses in municipal water systems and irrigation systems, introduction of meters, and increase in water prices. An alternative projection was used to illustrate the effects of an alternative course of actions on the demand side, i.e., 50 percent of projected irrigation area expansion and 50 percent of planned efficiency gains in irrigation, and the interaction between demand and supply management options[35].

Figure 14: Aggregated Water Utilization Forecast
(on the basis of current Government sectoral plans)



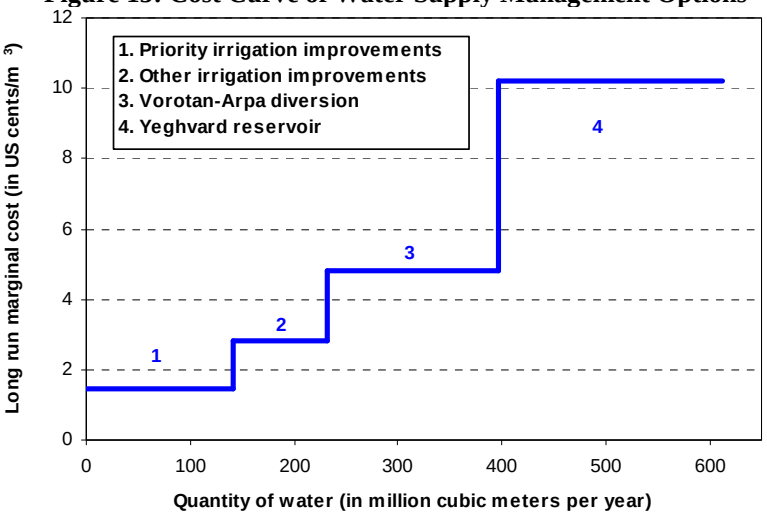
Source: IWRMP Study, Stage II Report.

[34] A water forecasting model was developed under the IWMRP study to assess future water demands. The impacts of existing and proposed demand side measures were also examined using the forecasting model.

[35] Supply is defined by synthesized river flows, releases from Lake Sevan, reservoirs, groundwater sources, recycling of return water, and trans-basin transfers via the Arpa-Sevan and Vorotan-Arpa diversion schemes. In the case of river flows, since historical flow data were incomplete, a random sequence of monthly time series flows was generated for five hydrological conditions: very dry year (95 percent) - annual natural flow is less than this flow once every 20 years, dry year (75 percent) - annual natural flow is less once every 4 years, average year (50 percent) - annual average natural flow, wet year (25 percent) - annual natural flow is higher once every 4 years, and very wet year (5 percent) - annual natural flow is higher once every 20 years.

o The four alternative scenarios considered in the assessment were the following: (i) Scenario 1, projected sectoral demands with programs to improve efficiency in irrigation and municipal systems and existing hydraulic infrastructure; (ii) Scenario 2, same as scenario 1 plus the completion of the Vorotan-Arpa diversion scheme, which would transfer water from the Vorotan Basin, a water-surplus region, to the Hrazdan/Sevan Basins, a water-shortage region; (iii) Scenario 3, half of expected irrigation area expansion with limited improvements in irrigation efficiency plus the completion of the Vorotan-Arpa diversion scheme; and (iv) Scenario 4, same as Scenario 1 plus completion of Vorotan-Arpa scheme and construction of Yeghvard Reservoir. The range of discounted costs per unit of water of the various water supply management (or enhancement) options available for Armenia is presented in Figure 15. The cost curve shows cumulative water volume developed or saved versus the unit cost of developed or saved water. The water supply cost curve shown here only includes capital and operation and maintenance costs (and the net value of the forgone energy production in the case of the completion of the Vorotan Basin diversion). Potential environmental and social costs of any of the options have not been factored in the cost.

Figure 15: Cost Curve of Water Supply Management Options



Note: A discount rate of 10 percent is used to estimate marginal cost.
Sources: IDP project files, IWRMP Study, LSAP.

o The conclusions of the water supply and demand assessment were as follows[36]:

③ Future water demands can be met if attention is given to both supply and demand management options.

③ Deficiencies, however, will arise in some localized areas, but in general, the expansion of the irrigation sector is not limited by water availability.

③ Under Scenario 1, the majority of the irrigation demand can be met, but considerable problems will be encountered in the Akhurian Basin and along tributaries to the Kura River. Reduction in upstream water use in the Hrazdan Basin as a result of improvements in irrigation efficiency could decrease irrigation deficits towards the end of the analyzed period. Some problems will be encountered in meeting municipal and large industrial demands. Hydropower generation averages 850 GWh/yr in the Vorotan cascade, and 310 GWh/yr in the Hrazdan cascade. The necessary increase in the level of Lake Sevan (5.4 m) could

36 The water balance model developed under the IWRMP Study only evaluates water quantity relationships. Water quality relationships were not included because of the lack of reliable data to calibrate the model.

be obtained by 2020 only at the expense of severe deficits in Hrazdan Basin irrigation schemes.

- Under Scenario 2, deficits in irrigation still occur, but are less severe than those under Scenario 1. The major beneficiaries are the irrigation schemes in the Hrazdan Basin. Hydropower generation averages 550 GWh/yr in the Vorotan cascade, and 500 GWh/yr in the Hrazdan cascade. The increase in the level of Lake Sevan by the end of 2020 could equal 5.7 m.

- Under Scenario 3, deficits in irrigation are more severe than those under Scenarios 1 and 2, as a result of higher water losses. Hydropower generation averages 550 GWh/yr in the Vorotan cascade, and 480 GWh/yr in the Hrazdan cascade. The increase in the level of Lake Sevan by the end of 2020 could reach 5.7 m.

- Under Scenario 4, deficits in irrigation in the Hrazdan Basin are eliminated. Hydropower generation averages 550 GWh/yr in the Vorotan cascade, and 410 GWh/yr in the Hrazdan cascade. The increase in the level of Lake Sevan by the end of 2020 could equal 5.7 m.

- The above scenarios indicate that in future, important trade-offs will have to be made with regard to the choice of policies and investments, particularly in the use of water for irrigation, environment and hydropower and in the allocation of investment funds. An attempt to evaluate these trade-offs is presented next.[37]

B. Evaluating Trade-offs in Water Allocation

- The main water allocation trade-offs in Armenia are those between the irrigation, environment and energy sectors. In the Sevan-Hrazdan Basin, allocation trade-offs are the subject of Government deliberations during determination of annual releases from Lake Sevan. While a variety of possible trade-offs could be discussed, those presented in this report and earlier assessed by the IWRMP study are the trade-offs involved in the transfer of water from the Vorotan Basin (water-abundant region) to Lake Sevan and Hrazdan Basin (water-scarce region)[38].

- The analytical framework used in the analysis is described below:

[37] The analysis presented here aims to illustrate the methodology, and should not be seen as a full cost-benefit analysis of the Vorotan hydro-technical structure. The authors wish to acknowledge the analysis framework developed by IWACO/Norconsult and Jinj.

[38] Under the framework of the LSAP, a cost-benefit analysis was carried out for completion of the Vorotan Tunnel, which concluded that the only option with positive net present value (using a 10 percent discount rate) for raising the level of the lake was by limiting releases. The major assumption under this analysis was that for 37 years the 165 MCM of water from the Vorotan basin would be used only to raise the level of the lake, and that releases from Lake Sevan for economic activities would occur only after the lake had risen 6 meters.

Problem:	Need to improve the ecological balance of Lake Sevan and develop its strategic reserve for meeting growing water shortages in Hrazdan Basin.
Source sectors:	Hydropower, environment, irrigation and fishery sectors in the Vorotan Basin.
Receiving sectors:	Environment, hydropower, irrigation, tourism, and fishery in Sevan-Hrazdan Basins, and environmental improvements in Lake Sevan.
Strategy:	Complete the Vorotan-Arpa diversion scheme, rehabilitate the Arpa-Sevan diversion scheme, and transfer additional 165 MCM per year to Lake Sevan. Of this amount, 65 MCM would be retained in the lake and 100 MCM would be released into the Hrazdan River to facilitate conversion from pumping to gravity supplied irrigation schemes and produce energy in the Hrazdan Cascade.
Impacts and Costs	A breakdown of impacts and costs resulting from the transfer is shown in Tables 7 and 8, respectively.

Table 7: Trade-Off Analysis – Breakdown of Benefits and Foregone Benefits Involved in the Reallocation

(After the IWRMP Study – with revised figures on the opportunity cost of energy during summer and winter, revised estimates for energy savings, revised estimates for fishery benefits)

Impact	Economic Benefits in the Receiving Sector(s)	Foregone Benefits in the Source Sector(s)
Irrigation	Incremental agricultural production resulting from an additional 100 million m^3/yr release of water in the Hrazdan Basin - approx. US$6.1 million/yr - see note 1. Irrigation water will be more reliable. Cost of pumping avoided as additional water can substitute for pumped supplies and thereby save electricity costs – potential savings today are approx. US$1.4 million/yr - see notes 2 & 3. Expected irrigation benefits resulting from the rehabilitation of the Arpa-Sevan diversion are US$1.6 million/yr - see note 4. Neither indirect benefits from irrigation nor irrigation benefits resulting from the use of Lake Sevan during drought periods are included in the analysis.	It is assumed that the transfer of 165 million. m^3/yr. will not affect the irrigated area and hence agricultural output in the Vorotan Basin - see note 5.
Hydropower	Incremental production in the Hrazdan Cascade – estimated at 192 GWh equivalent to US$4.4-5.0 million/yr. Expected generation benefits resulting from the Arpa-Sevan diversion rehabilitation US$1.1-1.2 million/yr - see note 6.	Reduction in hydropower production in the Vorotan cascade – estimated at 264 GWh, represents an annual loss of US$8.1-10.8 million/yr (see note 7). It is also assumed that after Lake Sevan level rises 6 m, 100 MCM will be diverted outside the Vorotan Basin.
Environment	Improvements to the ecological and strategic value of Lake Sevan and increased flow in the Hrazdan River. The strategic value was not quantified in this analysis, but would be of great importance for future studies to attempt to provide such a measure.	Possible reduction in the environmental flows and dilution effects in the Vorotan Basin due to a reduction in river flows (not quantified in this analysis).
Fisheries	Improvements in habitat would lead to increased trout catch of about 55 tons as estimated under the LSAP- approx US$0.30 million /yr - see note 8.	Possible losses of fishery in the Vorotan Basin due to a reduction in river flows (not quantified in this analysis).
Public Health	Increased environmental flows and dilution effects in the Hrazdan Basin and associated reduction of water related diseases (not quantified in this analysis).	Reduced environmental flows and dilution effects in the Vorotan Basin possibly leading to an increased frequency of water related diseases (not quantified in this analysis).
Amenity / Tourism and Existing Value	Improvement in the amenity value of the lake because the raised level would lead to an increase in tourism and associated economic activity. The GoA has estimated that tourism revenues would increase to US$10 million/yr. This is very optimistic given the fact that overall tourism/recreational output in Armenia was US$2 million in 1999. Instead of using this estimate as a proxy for the economic benefit of tourism (recreational and amenity value), it has been assumed that each household is willing to pay about US$3 per year to increase the level of Lake Sevan (US$2.7 million/yr). This is about 70 percent of the value of drinking water supply – see note 9.	

Explanatory Notes to Table 7:

1. **Irrigation Benefits.** The strategy calls for the release of additional irrigation waters, some of which will generate incremental agricultural production. The economic benefits of these releases are based on the estimated economic value of irrigation water of US$0.09/$m^3$. While 100 MCM/yr is assumed to be released for irrigation, the quantity yielding economic returns will be less, as irrigation efficiencies are never more than 65 percent. Once these efficiencies have been accounted for, the volume that can be assumed to yield a return of US$0.09/$m^3$ is therefore 65 MCM/yr. The benefits could therefore be estimated as:65 MCM/yr x US$0.09/$m^3$ = US$6.1 million/yr

   This benefit stream represents the "with project" scenario. The "without" project scenario involves irrigation from the existing pumping stations. Because of the unreliability of the system, it is not expected farmers will go for high value crops. The reduced economic value of water used here is equivalent to US$0.05/$m^3$. The incremental benefit used in the analysis is the difference between the "with" and "without" scenarios. In the "without" project scenario the existing pumping stations have an operational life of a further 10 years (IDP), according to a linear declining schedule.

2. **Pumped Scheme Energy Savings.** The energy savings predicted as a result of the release of an additional 100 MCM/yr was 72 GWh. This is based on the operations of Mkhchyan and Ranchpar pumping stations, and provided the pumping stations continue working at the same capacity. Energy savings valued at the opportunity cost of generation means that this energy equates to 72 GWh x US$0.02/KWh or US$1.4 million. Expected savings at the time the conversion scheme is working will be less since the pumping stations are expected to deteriorate over the next 10 years.

3. **Irrigation Area.** The difficulty in calculating the benefits resulting from the additional irrigation releases is that the split between water that would go for energy savings on existing schemes, and water that would go to incremental production, is not known.

4. **Expected Irrigation Benefits of Arpa Rehabilitation.** The investment costs in the analysis include the cost of the Arpa-Sevan scheme rehabilitation – a necessary and “must” investment for the additional transfer of water to take place. One should note that our interest is to assess the trade-off of the reallocation, and not the prioritization of independent investments. The benefits above (note 1) relate to the incremental water that is supplied from the Vorotan Basin and do not address the use of the water presently flowing through from the Arpa Basin. This flow, approximately 265 MCM/yr, relates to around 20,000 ha of irrigation in the schemes below Lake Sevan. It is assumed that without the rehabilitation work the scheme may stop operating. The avoided loss of productivity has been assumed on the basis of a 10 percent chance that the scheme will cease operations without the investment; avoided losses (expected benefit) are therefore defined as follows:

Quantity transferred 265 MCM/yr	x	0.65 efficiency = 172 MCM/yr available
Water available 172 MCM/yr	x	US$0.09/$m^3$ = US$15.5 mill/yr gross benefit
Gross benefit US$15.5 million/yr	x	10 percent probability of failure = US$1.6 million/yr expected benefit

5. **Vorotan Basin Irrigation.** The reduction in the Vorotan River of 165 MCM/yr equates to approximately one quarter of the river flow in an average year. Irrigation in the Vorotan Basin requires about 75 MCM/yr. For the purposes of this analysis it is assumed that adequate water supplies for irrigation will be maintained within the continued releases.

6. **Expected Hydropower Benefits of Arpa Rehabilitation.** Following the same logic described above (note 4), expected benefits for hydropower resulting from investments in the Arpa-Sevan rehabilitation scheme can be defined. The 264 MCM/yr flowing through the scheme relate to an average annual generation of GWh 480/yr in the Sevan-Hrazdan Cascade stations. The rehabilitation work will reduce the risk of generation loss. The analysis assumes that there is only a 10 percent chance that the diversion scheme will stop operations so the avoided losses (expected benefit) for energy are therefore defined as follows:

Estimated generation 480 GWh/yr	x	US$0.023/KWh = US$11.0 million/yr gross benefit before 2007
Estimated generation 480 GWh/yr	x	US$0.026/KWh = US$12.5 million/yr gross benefit after 2007

Gross benefit US$11.0 million/yr	x	10 percent probability of failure = US$1.10 million/yr expected benefit before 2007
Gross benefit US$12.5 million/yr	x	10 percent probability of failure = US$1.25 million/yr expected benefit after 2007

The value of electricity in the Hrazdan cascade assumes the current production profile – 80 percent during the summer season, valued at US$0.02/KWh, and 20 percent during the winter season, valued at US$0.035/KWh before year 2007, and at US$0.05/kWh after 2007 (when the nuclear power plant is scheduled to stop operations).

7. **Energy Generation Losses.** Estimated at 264 GWh annually. This amount, valued at the equivalent value of electricity (US$0.031/KWh before year 2007 and US$0.041/kWh after year 2007), is equated to 264 GWh x US$0.031/KWh = US$8.1 million annually before 2007 and 264 GWh x US$0.041/KWh = US$10.8 million annually after 2007. This assumes the proposed schedule for diverting water from the Vorotan Basin (about 30 percent in the summer season and 70 percent in the winter season). After the lake level gains 4-6 meters, only 100 MCM will be diverted outside the Vorotan Basin, therefore generation losses will decrease to US$6.5 million/yr, 20 years after the scheme is under operation.
8. **Fisheries Benefits.** The improvement to Lake Sevan fisheries resulting from an increase in the lake level and investments for hatchery improvements would be shown principally in an increase in trout production. This is the conclusion from the Lake Sevan Action Plan Study. The figure included for this analysis is based on an incremental catch of 55 tons/year valued at US$5/kg or US$0.28 million/yr.
9. **Amenity, Tourism and Existing Benefits.** The analysis assumes that households value the increase in Lake Sevan level at 70 percent of their average value for good water supply services. A research study is underway to estimate the cultural heritage value of Lake Sevan as well as its touristic/amenity value directly associated with an improvement in both the quantity and quality of water of its water. Results are expected in Spring 2002.

Table 8: Trade-Off Analysis – Breakdown of Costs Involved in the Reallocation
(After the IWRMP Study – with revised estimates on irrigation investments, revised profile of relocation cost)

Component	Description
Conveyance, Distribution and Other Costs	
Investment costs of the completion/rehabilitation of the Vorotan Tunnel and upgrading of the Arpa Tunnel[39]	Various estimates: Ministry of Agriculture - US$7.8 million for Vorotan and US$8 million Arpa – Sevan Tunnel totaling US$15.8 million. Hagler Bailly Study - US$16–20 million for a comprehensive approach. This analysis assumes a comprehensive approach is necessary for the Arpa-Sevan and Vorotan-Arpa diversion scheme, and therefore assumes an investment cost of US$20 million.
Incremental O&M costs for the Vorotan and Arpa Tunnels	Various estimates: Ministry of Agriculture: US$140,000/yr. (Hagler Bailly 1999) Also quoted 1 percent-3 percent of investment costs (IWACO 1997). Tunneling experts suggested using a value of 1 percent of the investment costs, which is more in line with good international practices.
Relocation costs	Loss of Lake Sevan foreshore and infrastructure has been estimate by WDI at US$28 million in 1997 prices for a rise in the Lake to 1,904 masl. This analysis adopts this estimate over a 10-year period, starting in year 5, since no relocation is expected before the lake gains at least 3 m.
Pumped to Gravity Conversion costs	Costs required to convert and operate the targeted schemes. The analysis assumes a unit cost of US$2,000 per hectare for the 8,125 ha that could be converted from pumped to gravity irrigation as a result of the incremental 100 m^3/yr releases in the Hrazdan Basin. O&M costs were estimated at approximated at 1.0 percent of the gravity conversion cost.
Fishery infrastructure costs	Costs associated with the rehabilitation of two hatcheries at Lichk and Karchaghbiour, including operation and maintenance, are taken from LSEAP Working Group 5 Report.
Other costs	Environmental costs were not included in the analysis.
Transaction Costs (Information, Regulation and Enforcement)	
Recurrent costs	Costs incurred by the agencies associated with the provision of monitoring, regulation and enforcement services – e.g. Water Resources Board regulatory expenses (not included in the analysis).

39 The rehabilitation of the Arpa Tunnel is a pre-condition for the transfer of an additional volume of water from the Vorotan Basin to the Hrazdan Basin.

o To contribute towards the goal of welfare improvement, any reallocation for water must satisfy two conditions.

Condition I deals with the balance of benefits and costs for the respective sectors, i..e, benefits are greater than the costs plus the foregone benefits. It can be expressed as:

$$DB + IB > FDB + FIB + TC + CC$$

Where all benefit and cost expressions are in present value terms, and DB=direct economic benefit to receiving sectors, IB=economic benefit to indirectly affected sector(s), FDB=foregone direct benefit in source sectors, FIB= foregone indirect benefit in source sectors(s), TC=transaction costs, and CC=conveyance and storage costs.

Condition II stipulates that the water resulting from the reallocation is the least-cost source of water for the receiving sectors -- the sum of direct and indirect foregone economic benefits and the transaction and conveyance costs should be less than the cost of the next best alternative water source.

Welfare enhancement can be said to exist if the two conditions are met.

Evaluating Condition I

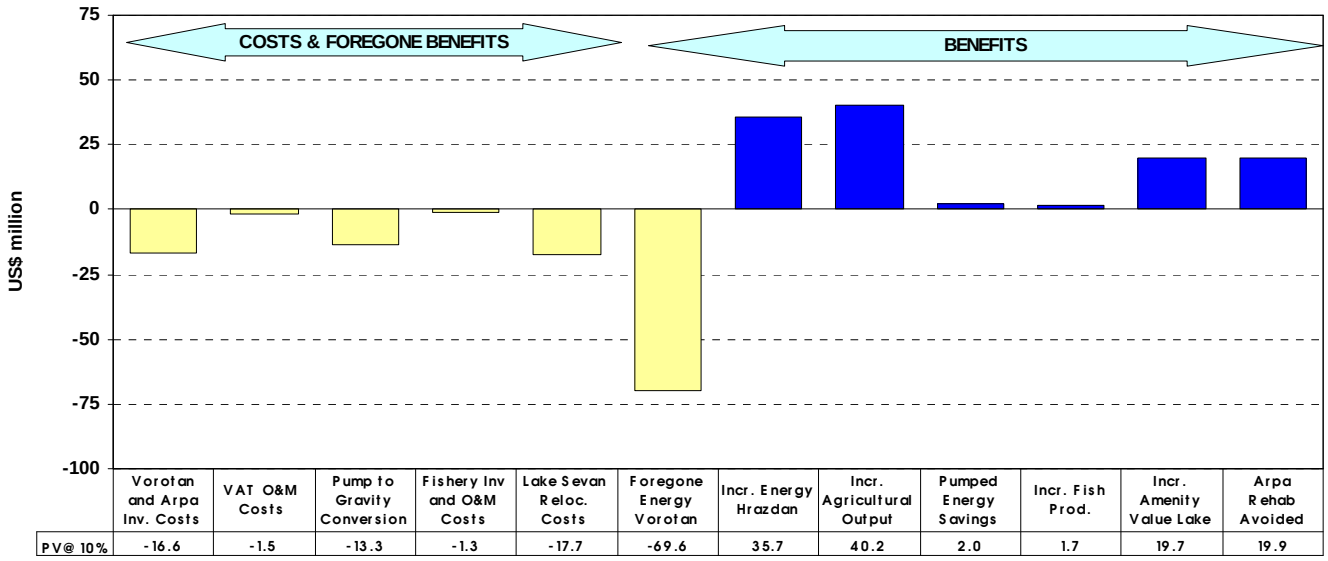
This calculation should take into consideration the timing of the costs and benefits, as well as the long-term benefits of the project. A cash flow analysis that sets out the costs and benefits is shown in Table 9. It must be noted, however, that two sets of benefits, expected to be high, have not been quantified in the analysis – environmental benefit associated with raising the level of Lake Sevan, and the benefit associated with the restoring of the strategic reserve in the Lake. This analysis uses a discount rate of 10 percent to express benefits and costs in present value terms, which can be considered a little high for this kind of investment – lump costs concentrated in early periods and flow of benefits realized over a long period of time. Nonetheless, this is the discount rate used to evaluate projects in Armenia. The asset lifetime has been assumed at 50 years, to account for the benefits occurring after Lake Sevan's level gains 6 meters. In order to ensure the benefits can be sustained for 50 years, the analysis assumes a reasonable level of operation and maintenance costs. The results of this cash flow are shown in Figure 16, in which the present value of the individual costs and benefits are illustrated. Condition I can be evaluated by looking at the present value of the benefits (US$119.1 million) and present value of costs and foregone benefits (US$110.5 million). Thus, on the basis of the current valuation assumptions, the reallocation from the water-abundant basin to the water-shortage basin meets Condition I[40].

[40] A risk-based sensitive analysis was performed to measure the variance associated with the benefit/cost ratio estimate. The risk variables selected were: the discount rate (ranging from 8 percent-12 percent), the operation and maintenance cost (ranging from 0.5 percent-1.5 percent), the value of energy during summer (US$0.015-0.025/KWh) and winter (US$0.02-0.05 before year 2007 and US$0.028-0.071/KWh after year 2007), the value of water in irrigation (US$0.07-0.11/$m^3$), the investment cost (US$16-24 million), and the willingness to pay for increasing the level of Lake Sevan (US$2-4/hh/year). The analysis revealed that there is a 84 percent confidence level that the reallocation will derive a benefit/cost ratio equal or greater than 1.0.

Evaluating Condition II

This condition states that the sum of direct and indirect foregone economic benefits and the costs associated with the reallocation are less than the cost of the next best alternative water source. On the basis of the water supply curve presented in Figure 15, which shows the discounted unit cost for alternative water sources, it is possible to conclude that Condition II is also met.[41]

Figure 16: Summary of Costs and Benefits



	Vorotan and Arpa Inv. Costs	VAT O&M Costs	Pump to Gravity Conversion	Fishery Inv and O&M Costs	Lake Sevan Reloc. Costs	Foregone Energy Vorotan	Incr. Energy Hrazdan	Incr. Agricultural Output	Pumped Energy Savings	Incr. Fish Prod.	Incr. Amenity Value Lake	Arpa Rehab Avoided
PV@ 10%	-16.6	-1.5	-13.3	-1.3	-17.7	-69.6	35.7	40.2	2.0	1.7	19.7	19.9

Summary

On the basis of the assumptions used in the evaluation (in particular, those related to the level and timing of investment costs, the value and timing of the energy and irrigation impacts, the exclusion of potential environmental impacts), it is possible to conclude that the reallocation of water from the water-abundant basin to the water-scarce one seems to be an economically viable water resources management option. This conclusion needs to be verified on the basis of detailed technical, economic and environmental studies. The conclusion will hold if there are not major detrimental environmental and social impacts associated with the reallocation and that negative impacts can be mitigated at a reasonable cost. It is possible that the overall economic justification of the reallocation could be higher since the analysis does not include the benefits associated with the use of Lake Sevan as a strategic reserve, or with its ecological restoration and preservation.[42]

---

41 In theory, one could say that improving irrigation efficiency in the Sevan Basin could achieve the same objective as the inter-basin transfer. In practice, the effectiveness of this option is low, since at current prices farmers in the Sevan watershed would like to use more water than what is currently available to them. At present, only half of the area equipped with irrigation systems can be irrigated because of the lack of water. Incentives to save water are already high, but the costs of doing so are likely higher and the means are not obvious. Provided vegetables and potatoes are grown, the use of water for irrigation in the Sevan Basin is economically justified, since the cost of irrigation water (i.e., cost of next best alternative source) is US$0.09 per cubic meter (at farm level assuming efficiency of 50 percent), compared to the economic return of US$0.20-0.30 per cubic meter.

42 Refer to the Lake Sevan Action Program for a list of measures that need to be implemented to "save" Lake Sevan.

Table 9: Stream of Costs and Benefits (Part 1 of 2)

Key Assumptions:

VAT Inv. Costs (USD mill):	20	VAT O&M costs (% of Inv. /yr):	1.0%
Irrigation conversiton Cost:	16.25	O&M cost (% of inv/year)	1.0%
Discount Rate:	10%		

COSTS AND FOREGONE BENEFITS

Year	Vorotan and Arpa Construction, Rehab. & Incr. O&M Costs			Irrigation Costs Pump to Gravity Conversion			Fishery: inv, and O&M costs	Lake Sevan Relocation Costs	Foregone Benefits: Vorotan energy lost	Total Costs & Foregone Benefits
	Inv. Cost	O&M	Sub-Total Tunnels	Inv. Cost	Incr. O&M	Sub-Total Conversion				
1	5.0		5.0	2.4		2.4	0.3			7.8
2	10.0		10.0	3.3		3.3	0.5			13.7
3	5.0		5.0	4.1		4.1	0.1			9.2
4		0.2	0.2	3.3	0.1	3.3	0.0		8.1	11.6
5		0.2	0.2	3.3	0.1	3.4	0.0		8.1	11.7
6		0.2	0.2		0.2	0.2	0.0		8.1	8.5
7		0.2	0.2		0.2	0.2	0.0		8.1	8.5
8		0.2	0.2		0.2	0.2	0.0		10.8	11.2
9		0.2	0.2		0.2	0.2	0.0	2.0	10.8	13.2
10		0.2	0.2		0.2	0.2	0.0	2.0	10.8	13.2
11		0.2	0.2		0.2	0.2	0.0	3.0	10.8	14.2
12		0.2	0.2		0.2	0.2	0.0	5.0	10.8	16.2
13		0.2	0.2		0.2	0.2	0.0	5.0	10.8	16.2
14		0.2	0.2		0.2	0.2	0.1	3.0	10.8	14.3
15		0.2	0.2		0.2	0.2	0.3	3.0	10.8	14.4
16		0.2	0.2		0.2	0.2	0.1	3.0	10.8	14.2
17		0.2	0.2		0.2	0.2	0.0	1.0	10.8	12.2
18		0.2	0.2		0.2	0.2	0.0	1.0	10.8	12.2
19		0.2	0.2		0.2	0.2	0.0		10.8	11.2
20		0.2	0.2		0.2	0.2	0.0		10.8	11.2
21		0.2	0.2		0.2	0.2	0.0		10.8	11.2
22		0.2	0.2		0.2	0.2	0.0		10.8	11.2
23		0.2	0.2		0.2	0.2	0.0		10.8	11.2
24		0.2	0.2		0.2	0.2	0.0		10.8	11.2
25		0.2	0.2		0.2	0.2	0.4		6.5	7.3
26		0.2	0.2		0.2	0.2	0.5		6.5	7.4
27		0.2	0.2		0.2	0.2	0.0		6.5	6.9
28		0.2	0.2		0.2	0.2	0.0		6.5	6.9
29		0.2	0.2		0.2	0.2	0.0		6.5	6.9
30		0.2	0.2		0.2	0.2	0.0		6.5	6.9
31		0.2	0.2		0.2	0.2	0.0		6.5	6.9
32		0.2	0.2		0.2	0.2	0.0		6.5	6.9
33		0.2	0.2		0.2	0.2	0.0		6.5	6.9
34		0.2	0.2		0.2	0.2	0.1		6.5	7.0
35		0.2	0.2		0.2	0.2	0.3		6.5	7.2
36		0.2	0.2		0.2	0.2	0.1		6.5	7.0
37		0.2	0.2		0.2	0.2	0.0		6.5	6.9
38		0.2	0.2		0.2	0.2	0.0		6.5	6.9
39		0.2	0.2		0.2	0.2	0.0		6.5	6.9
40		0.2	0.2		0.2	0.2	0.0		6.5	6.9
41		0.2	0.2		0.2	0.2	0.0		6.5	6.9
42		0.2	0.2		0.2	0.2	0.0		6.5	6.9
43		0.2	0.2		0.2	0.2	0.0		6.5	6.9
44		0.2	0.2		0.2	0.2	0.0		6.5	6.9
45		0.2	0.2		0.2	0.2	0.0		6.5	6.9
46		0.2	0.2		0.2	0.2	0.0		6.5	6.9
47		0.2	0.2		0.2	0.2	0.0		6.5	6.9
48		0.2	0.2		0.2	0.2	0.0		6.5	6.9
49		0.2	0.2		0.2	0.2	0.0		6.5	6.9
50		0.2	0.2		0.2	0.2	0.0		6.5	6.9
PV @ 10 %	16.6	1.5	18.1	12.2	1.5	13.3	1.3	17.7	69.6	110.5

Summary Indicators: **IRR = 12.4%** **NPV (USD million @ 10 %) = 8.6** **B/C Ratio = 1.08**

Table 9: Stream of Costs and Benefits (Part 2 of 2)

Discount Rate: 10%

Year	BENEFITS							NET BENEFITS
	Incr. Hydro Prod Hrazdan Cascade	Incr. Irrigation Output	Pumped Energy Savings	Incr. Fish Prod'n	Incr. Amenity Value Lake Sevan	Arpa Rehab Expected Avoided Losses	Total Benefits	
1	0.0							-7.8
2	0.0							-13.7
3	0.0							-9.2
4	4.4	3.5	1.0		2.7	2.4	13.9	2.3
5	4.4	4.0	0.8		2.7	2.4	14.3	2.6
6	4.4	4.5	0.6	0.3	2.7	2.5	14.9	6.5
7	4.4	4.9	0.5	0.3	2.7	2.5	15.3	6.8
8	5.0	5.4	0.3	0.3	2.7	2.7	16.4	5.2
9	5.0	5.9	0.2	0.3	2.7	2.8	16.7	3.5
10	5.0	6.1		0.3	2.7	2.8	16.8	3.6
11	5.0	6.1		0.3	2.7	2.8	16.8	2.6
12	5.0	6.1		0.3	2.7	2.8	16.8	0.6
13	5.0	6.1		0.3	2.7	2.8	16.8	0.6
14	5.0	6.1		0.3	2.7	2.8	16.8	2.5
15	5.0	6.1		0.3	2.7	2.8	16.8	2.4
16	5.0	6.1		0.3	2.7	2.8	16.8	2.6
17	5.0	6.1		0.3	2.7	2.8	16.8	4.6
18	5.0	6.1		0.3	2.7	2.8	16.8	4.6
19	5.0	6.1		0.3	2.7	2.8	16.8	5.6
20	5.0	6.1		0.3	2.7	2.8	16.8	5.6
21	5.0	6.1		0.3	2.7	2.8	16.8	5.6
22	5.0	6.1		0.3	2.7	2.8	16.8	5.6
23	5.0	6.1		0.3	2.7	2.8	16.8	5.6
24	5.0	6.1		0.3	2.7	2.8	16.8	5.6
25	5.0	6.1		0.3	2.7	2.8	16.8	9.5
26	5.0	6.1		0.3	2.7	2.8	16.8	9.4
27	5.0	6.1		0.3	2.7	2.8	16.8	9.9
28	5.0	6.1		0.3	2.7	2.8	16.8	9.9
29	5.0	6.1		0.3	2.7	2.8	16.8	9.9
30	5.0	6.1		0.3	2.7	2.8	16.8	9.9
31	5.0	6.1		0.3	2.7	2.8	16.8	9.9
32	5.0	6.1		0.3	2.7	2.8	16.8	9.9
33	5.0	6.1		0.3	2.7	2.8	16.8	9.9
34	5.0	6.1		0.3	2.7	2.8	16.8	9.8
35	5.0	6.1		0.3	2.7	2.8	16.8	9.6
36	5.0	6.1		0.3	2.7	2.8	16.8	9.8
37	5.0	6.1		0.3	2.7	2.8	16.8	9.9
38	5.0	6.1		0.3	2.7	2.8	16.8	9.9
39	5.0	6.1		0.3	2.7	2.8	16.8	9.9
40	5.0	6.1		0.3	2.7	2.8	16.8	9.9
41	5.0	6.1		0.3	2.7	2.8	16.8	9.9
42	5.0	6.1		0.3	2.7	2.8	16.8	9.9
43	5.0	6.1		0.3	2.7	2.8	16.8	9.9
44	5.0	6.1		0.3	2.7	2.8	16.8	9.9
45	5.0	6.1		0.3	2.7	2.8	16.8	9.9
46	5.0	6.1		0.3	2.7	2.8	16.8	9.9
47	5.0	6.1		0.3	2.7	2.8	16.8	9.9
48	5.0	6.1		0.3	2.7	2.8	16.8	9.9
49	5.0	6.1		0.3	2.7	2.8	16.8	9.9
50	5.0	6.1		0.3	2.7	2.8	16.8	9.9
PV @ 10 %	35.7	40.2	2.0	1.7	19.7	19.9	119.1	8.6

C. Strategic Guidelines for Meeting Current and Future Water Challenges

o The analysis presented earlier indicates that Armenia will need to make strategic choices to meet current and future challenges in the water sector. There seems to be a general consensus among stakeholders that the country needs to adopt some strategic guidelines in the formulation of its water resources management strategy if the objective of environmentally sustainable growth is to be achieved. Some of the key agreed guidelines are as follows:

- Adopt a water management approach that balances demands for drinking, irrigation, environmental and hydropower use;[43] combine supply and demand management options; and promote integrated water resources management;
- Accelerate sectoral reforms in irrigation/drainage and drinking water supply/ sanitation sectors as stated in the "Reforms in Water Economy Management Systems (Decision 92, dated February 9, 2001)," which are needed to ensure responsible use of water resources;
- Analyze trade-offs of alternative investments and policies and ensure efficiency in the use of scarce resources and in the selection of investments;
- Give priority to improving water use efficiency and reducing water losses in irrigation and drinking water supply systems;
- Introduce economic incentives and increase private sector and local stakeholder responsibility in system operation;
- Improve current water pricing systems/structures to balance economic efficiency, cost recovery, financial sustainability, and water conservation objectives;
- Maintain the role of overall water resources management within the public sector;
- Promote participatory water resources planning and management at the lowest possible level; and
- Involve stakeholders when developing the long-term vision, specific goals and objectives in the water sector.

o Adoption of the above mentioned strategic guidelines would allow Armenia to address inadequate water services and achieve sustainable management of its water resources. The next

[43] Allocating the highest priority to drinking water may provide a wrong signal to utilities and water users to continue with wasteful water use practices. Therefore, there is a need to provide incentives to promote levels and patterns of water use consistent with the principle of treating water as an economic good.

section discusses the changes needed in the institutional framework to make the most of the water resource base.

IV. TOWARDS A MODERN SYSTEM OF INTEGRATED WATER RESOURCES MANAGEMENT

o As stated in the previous sections, Armenia lacks a policy and institutional framework to promote integrated water resources management. During preparation of the IWRMP study, an institutional framework for water resources management was identified in close collaboration and consultation with stakeholders. The views expressed by a broad range of stakeholders were considered in formulating the institutional framework options. The design of the institutional framework has been based on widely accepted principles of integrated water resources management, and more importantly on the draft Water Policy Statement on IWRM embraced by the stakeholders,[44]. The statements include the following (See Annex III for a full description of the Draft Water Policy Statement):

- Water has an economic, social and environmental value, and attempts should be made consistently to optimize its allocation for achievement of equitable and sustainable economic and social development.

- Water needs to be managed in such a way that it provides reasonably equitable access to all users.

- The planning and implementation of actions in the water sector must be coordinated and integrated over all sectors.

- The use of water to meet basic human needs (drinking, sanitation, cooking, washing) will have overall priority over other uses.

- The value of water to the environment is thoroughly recognized, especially in the event of competing uses.

- The Government of Armenia must act as the custodian of the nation's water resources and has ultimate responsibility for and authority over water resources management, equitable allocation and use of water, and in international water matters.

- The Government of Armenia shall ensure that water resources management is carried out in a transparent way, in a manner that reflects its public trust obligations and the value of water to society.

[44] During the preparation of the IWRMP Study, consultations were held with stakeholders to start drafting a Water Policy. The final draft of the Water Policy, which has been accepted by the IMC and a broad range of stakeholders, is presented in Annex V.

- ③ Water resources management will be carried out in regional or water basin areas, which will coincide with natural river basins, groups of basins or areas with linked supply systems.

- ③ Water resources management at the operational level will be decentralized to the appropriate level, i.e. water basin or regional/municipal management authorities, to the extent feasible.

- ③ Any authorization to use water shall be given in a timely fashion and in a manner which is clear, transparent, secure and predictable.

- ③ Effective water resources management will be facilitated by participation of stakeholders (users, planners, regulators and policy makers) at relevant levels and stages of planning and implementation.

- ③ Stakeholder participation will be made possible through the dissemination and sharing of information on water resources and use, and public awareness and training activities.

- ③ The long term principle for the effective use of water will be to charge users for the costs of providing water, including costs for infrastructure and water management activities.

- ③ The disposal of wastewater will be made subject to pollution charges.

- ③ Water management shall include the use of economic incentives.

- ③ In the long term, many functions in provision of water could be undertaken by the private sector.

- ③ The special value of the water of Lake Sevan is recognized.

o Consistent with the Draft Water Policy Statement and taking into account the water resources problems faced by Armenia, the lessons learned on water resources management highlighted in Box 4, as well as the functions involved in water resources management and planning as identified in Annex IV, the following proposals for water resources management were agreed by the Government and stakeholders:

- ③ To establish a new and independent Water Resources Management Board (WRMB) as an independent State Government Body under the Government of Armenia (GoA), charged with the preparation of water resources policies, strategies and river basin plans.

Box 4: Institutional Arrangements for Water Resources Management -- Lessons Learned

The experiences of several countries on the managing of water resources were reviewed during preparation of the IWRMP. The key lessons that emerged from this review can be summarized as follows:

- The institutional arrangement for water resources management in each country is unique to that country.
- Setting of standards and regulations and operational functions should be separated into independent roles.
- Successful water resources management requires stakeholder participation in planning and decision making.
- It is essential that any country wishing to change its institutional structure should first define clearly what it wants to achieve by a restructuring.
- Extensive application of economic and financial instruments is essential to encourage efficient use of the resource, promote demand management, and meet capitalization requirements and operation and maintenance costs.
- River Basin Authorities (RBA) are not essential for effective water management. There are examples of very good RBAs as well as ineffective ones, and of good and bad water management without RBAs. They are instances, however, where RBAs have contributed to achieving integrated water resources management -- functions were carefully identified and authority added value and complemented tasks of other agencies.
- A strong data collection, processing, management and dissemination system is a pre-requisite for efficient water resources management.
- In countries where responsibility for water management rests with a number of different institutions and particularly when two or more ministries are involved, there will be powerful vested interests for and against change.
- Water quality objectives are the result of the simultaneous consideration of costs and benefits.
- Plans for restructuring need to address the identified objectives, but must also recognize political constraints on what is achievable.
- Successful reform requires either a strong and determined government or a consensus among the affected parties and a willingness to accept solutions.
- Giving a new function to an institution that historically had a different function is not usually successful, unless that institution itself is radically reformed.

③ To establish Local Water Authorities under the authority of the WRMB, charged with the operational management of primary water bodies[45].

③ To charge one organization, the Hydro-Meteorological Institute, with the task of monitoring all water resources (quality and quantity of surface water and groundwater sources).

③ To establish a National Water Resources Council, being an Advisory Group at the national level, and gradually establish Water User Groups at the water basin level for stakeholder participation[46].

45 In general, the authors of this report consider to premature to advise on the establishment of Local Water Authorities (LWAs). The functions of LWAs could be carried out initially by the WRMB until there is real demand for the establishment of local authorities. Instead, the formation of water users groups should be encouraged.

46 Implementation arrangements need to be defined for the proposed Water User Groups to avoid duplication of functions and responsibilities with existing and new irrigation institutions, namely, WUFs and WUCCs.

③ To keep the task of environmental protection and control with the MoNP and the Environmental Inspectorate.

o Clearly, one of the main challenges for achieving integrated water resources management in Armenia is to have an independent WRMB, under the authority of the GoA, with a focal point for coordination of the different functions in water resources management being either the Prime Minister, Ministry of Finance and Economy or another independent Ministry of the Cabinet which does not represent the interest of any of the most important water user groups. The detailed tasks and responsibilities of the proposed WRMB vis-à-vis the roles and functions of the other water related institutions are presented in Table 10.

Table 10: Proposed Institutional/Administrative Framework for Water Resources Management

TASKS AND RESPONSIBILITIES	GOA/ WRMC Policy-making and advisory body	WRMB/LWA Integrated water resources management and administration functions	"New" HydroMet Monitoring functions	MoNP Environmental functions	SCWE Financial and operational regulatory tasks related to provision of commercially-oriented water services (in the long term). Also, construction, operation and maintenance of irrigation and drinking systems (in the short and medium term)	Sectoral Ministries and Water Users Construction, operation and maintenance of water services (including all users)
Water Resources Policies and Legislation						
Formulation of IWRM policies and strategies		X	O	O	O	O
Classification of water bodies per function		X	O	O	O	
Formulation of laws and regulations		X	O	O	O	O
Preparation of sectoral water-related standards, norms, policies and strategies		O	O	X	X	X
Co-ordination of IWRM standards and norms		X	O	O	O	O
Approve IWRM policies and strategies	X					
Water Resources Planning and Allocation						
Inventory of surface and groundwater sources		X	O			
Projection of sectoral water demands		O		X	X	X
Establishment of environmental flows		C		X		
Strategic water planning (including preparation of (future) water balance statements, identification of problems and options, evaluation of options, setting priorities, preparation/ updating of water management plans)		X	O	O	O	O
Consultation with stakeholders		X		C	C	C
Approval of water resources management plans	X					
Water Allocation & Environmental Permits						
Reviewing and approval of sector allocations		X		C		
Issuing environmental permits		C		X	O	O
Issuing contracts (or permits) with users		X			C	C
Maintenance and completion of water cadaster to also include groundwater		X	O		O	
Reviewing/supervising implementation water-related international agreements		X	O	C	O	O

Table 10: Proposed Institutional Framework for Water Resources Management (continuation)

TASKS AND RESPONSIBILITIES	GOA/ WRMC	WRMB/LWA	"New" HydroMet	MoNP	SCWE	Sectoral Ministries and Water Users
Water Resources Monitoring						
Monitoring quantity of surface water and groundwater			X			C (MOH)
Monitoring of water quality			X			C (MOH)
Monitoring of climate and hydrometric conditions			X			
Develop, maintain and disseminate water resources database		X	O	O	O	O
Environmental Management						
Wetlands protection and management		O		X		
Protection of water sources (sanitary zones)				X	O	O
Watershed management and erosion control		O		C		X (MOA)
Land use planning		C		X		C(MOUD/MOA)
State Control and Enforcement						
State control of river basin management (surface water, groundwater)		X	O			
State control on water quality (wastewater)				X		
State control on drinking water quality						X(MOH)
Enforcement		X		X		X
Financial Management						
Developing financial policies for IWRM (water extraction fees)		X				
Developing financial policy for sector programs				X	X	X
Collection of water extraction fee and effluent discharge fee		X		X		
Supervision of water extraction fees and effluent discharge		X				
Operational Management						
Supervision of operational management of primary water bodies		X	O	C	C	C
Monitoring sectoral use of water				X	X	X
Monitoring of quality of wastewater discharge					X	X
Controlling water use monitoring and collect data		X	O	O	O	O
Implementing public information programs		X		X	X	X

Legend: X=Responsible party; O=Playing a supporting role; C=Participate in consultation; MOF=Ministry of Health; WRMC=Water Resources Management Council; WRMB=Water Resources Management Board; MoNP=Ministry of Nature Protection; SCWE=State Committee of Water Economy, MOA=Ministry of Agriculture MOUD=Ministry of Urban Development; LWA: Local Water Authorities.

Source: Revised version of the arrangement proposed under the IWRMP to reflect the functions of the SCWE.

o A very important element of the institutional framework and mechanisms for integrated water resources management is the establishment of water users groups initially at the system level and then at the basin or sub-basin level. These groups will have the task to support and advise the related government agencies in the preparation and implementation of water resources management plans for their respective area. Government agencies cannot manage water resources by themselves and are obliged to adequately involve and consult water users groups on all major water related issues, i.e., water resources planning and management of the river basin or catchment area concerned, operational management of the supply of water resources in the concerned area, and monitoring of water use by different user groups. The water users groups must play a principal role at the local level. The next section presents a few recommendations to move forward towards integrated water resources management.

V. RECOMMENDATIONS TO MOVE FORWARD TOWARDS IWRM

o Armenia faces several water resources management challenges: spatial and temporal imbalances of water resources, localized areas suffering severe water shortage, huge water losses in irrigation and water supply systems, inefficiency in the use of water resources because of lack of incentives, environmental degradation of Lake Sevan, source pollution, and increasing competition for water among irrigation, hydropower and environmental demands. The ongoing reforms in the management of water services are expected to improve efficiency. What is lacking is a reform agenda to address regulatory and resource management issues.

o This section presents some recommendations to move forward towards integrated water resources management. In line with the strategic guidelines outlined earlier, key actions should focus on:

- Implementing the institutional framework for integrated water resources management proposed under the IWRMP study, which aims to separate the functions of water resources management;
- Adapting and strengthening policy functions of new and existing public institutions;
- Improving and building capacity of existing and new bodies;
- Strengthening water resources monitoring and information systems, which are essential for making sound policy and investment decisions;
- Amending or harmonizing current legislation with the newly developed water management policy statement;
- Continuing process of developing a water resources management strategy and river basin management plans in a participatory setting;
- Promoting participation and institutional development at the lowest level by empowering water users to increase their influence in the decision-making process;

- ③ Strengthening and supporting the NGO community to play a more active role in water conservation and environmental awareness;

- ③ Continuing with ongoing efforts to improve efficiency in the irrigation and water supply sector[47]; and

- ③ Addressing deficiencies in the water licensing system and upgrading the Water Cadaster.

o The Bank Group can play a key role in helping Armenia to move forward towards IWRM. A few of the areas where the Bank can make a substantial contribution are:

- ③ Providing support in improving institutional and administrative arrangements and in building capacity in the intended Water Resources Management Board.

- ③ Implementing pilot projects in 2-3 key specific water resources management areas with serious problems (i.e., water scarcity, drainage, water pollution) to develop local programs for addressing these problems, with the participation of water users[48]. Local programs would include: (i) setting up a planning process to define activities, responsibilities and financing (including water balance and economic modeling); (ii) strengthening local institutional mechanisms; (iii) developing water allocation mechanisms and a new local water rights administrative system; (iv) strengthening local monitoring, measurement and control systems; (v) assessing mechanisms for adjusting the irrigation water regime in areas with small farm size; and (vi) assessing the potential of reusing drainage water for irrigation purposes in the Ararat Valley.

- ③ Building capacity in the areas of economic analysis of policy and investment alternatives, as well as reform options in various aspects of water resources management.

- ③ Identifying opportunities to address water resources concerns in Bank Group operations.

- ③ Safeguarding water resources management objectives in Bank Group operations in Armenia.

- ③ Expanding the Bank's partnerships with other donors with an interest in water resources management, and facilitating the flow of donor funds and resources to water resources management.

---

47 The State Committee of Water Economy has identified and approved a number of interventions in these two water-using sectors. As a next step, it is recommended to identify priorities and develop an investment plan and strategy to overcome the barriers to timely and cost-effective implementation of these priorities.

48 The proposed IDA-funded Irrigation Development Project has made provisions to implement these pilot projects on water resources management.

③ Facilitating some sort of country-based and regional forum for promoting dialogue among the donors and between countries and donors with interest in water resources management.

REFERENCE

Boisson de Chazournes, Laurence. 2000. *Report on "International Waters."* Commissioned by the World Bank under the framework of the IWRMP Study. Draft Version, July 2000.

ECODIT. 2000. *Environmental Assessment of Irrigation Development Project.* Draft Final EA Report Issued in January 2000.

ICEA and Cabinet Merlin. 2000. *Drinking Water and Wastewater National Sector Study.* Prepared under the framework of the Municipal Development Project – IDA Credit 3095-AM. Final Report, May 2000.

IWACO, JINJ and Norconsult. 2001. *Integrated Water Resources Management Planning Study.* Stage IA Final Technical Report, October 2000, and State II Final Technical Report, May 2001.

IWACO. 2001. *Crash Program for One Year of Surface Water Quality Monitoring.* Prepared under the framework of the Integrated Water Resources Management Study. Final Report.

Lampietti, Julian. 2000. *Utility Pricing and the Poor: Lessons from Armenia.* ECSSD Working Paper (forthcoming).

Ministry of Nature Protection of the Republic of Armenia. 1998. *Armenia Lake Sevan Action Program. Working Group 5 Report on Rehabilitation of Fisheries.*

Ministry of Nature Protection of the Republic of Armenia. 1998. *First National Communication of the Republic of Armenia Under the United Nations Framework Convention on Climate Change.* Prepared under the GEF project implemented by UNDP, October 1998.

Ministry of Nature Protection of the Republic of Armenia. 1999. *Armenia Lake Sevan Action Program. Main Report.*

Ministry of Nature Protection of the Republic of Armenia. 1999. *Armenia National Environmental Action Program. Main Report.*

United Nations Office in Armenia. 1999. *Poverty of Vulnerable Groups in Armenia.*

United Nations World Food Program. 2000. *Food Security and Nutritional Status Survey.* Draft Report, September 2000.

Young, Robert A. 1996. *Measuring Economic Benefits for Water Investments and Policies.* World Bank Technical Paper No. 338.

World Bank. 1994. *Armenia Irrigation Rehabilitation Project. Project Appraisal Document,* Report No. 12811-AM.

World Bank. 1995. *Armenia Agriculture and Food Sector Review.* Report No. 13034-AM.

World Bank. 1999. *Armenia Dam Safety Project. Project Appraisal Document.* Report No. 19362-AM.

World Bank. 1999. *Armenia's Private Agriculture: 1998 Survey of Family Farms.* ECSSD Working Paper No. 17.

World Bank. 2000. *Armenia Social Investment II Project. Project Appraisal Document.* Report No. 20326-AM. April 2000.

World Bank. 2001. *Armenia Irrigation Development Project. Project Appraisal Document.* Draft Version as of June 2001.

World Bank. 2001. *Armenia Municipal Water and Wastewater Project. Project Concept Document.* Draft Version as of May 2001.

ARMENIA

TOWARDS INTEGRATED WATER RESOURCES MANAGEMENT

VOLUME II

ANNEX I: CALCULATIONS TO ESTIMATE MARGINAL VALUE OF IRRIGATION WATER IN ZONE 1

(For more details refers to the Project Appraisal Document for the Irrigation Development Project.)

Table I.1: Financial and Economic Prices for Inputs and Outputs and Typical Cropping Patterns

Exchange Rate 500 Dram/US$ (1999)

Input Prices in 1999	Financial Price	Economic Price	Prices CB-Analysis
Seed (Drams/Kg)			
- Wheat	120	120	120
- Vegetables (per 1000 plants)	2000	2000	2000
- Fodder	1200	1200	1200
- Apricots (per tree)	400	400	400
- Grapes (per cutting)	400	400	400
- Potatoes	120	120	120
Fertilizers (Drams/ton)			
- Fertilizer 1	150	150	150
- Fertilizer 2	80	80	80
Pesticides (Drams/kg or Drams/l)			
- Pesticides 1	6000	6000	6000
- Pesticides 2	8000	8000	8000
Mechanized Work			
Transport (dram/ton/km)	400	400	400
Combine services (dram/hour)	2000	2000	2000
Tractor services (dram/hour)	1000	1000	1000
Energy			
- Fuel	200	200	200
- Electricity (Drams/Kwh) (Summer and winter)	22.3	10-17.5	10-17.5
Cost of water (Dramsm3)			
Average cost of water at farm gat	2.6	12.7	0
- Gravity (60%)		10.3	
- Pumping (40%)		16.3	
Cost of labor (dramday)			
- 1 worker-day	1500	1000	1000

Output Prices (dram)	Financial Price	Economic Price	Prices CB-Analysis
Wheat (per kg)	90	105.7	105.7
Vegetables/Tomatoes (per kg)	58.2/70	58.2/70	58.2/70
Potatoes (per kg)	123.4	123.4	123.4
Forage (per kg)	25	25	25
Apricots (kg)	82.8	82.8	82.8
Grapes (per kg)	124.2	124.2	124.2
Straw (per bundle)	200	200	200

Cropping Patterns and Water Requirements

Crops	Water Requirement (cubic meter/ha)	Cropping Pattern
Wheat	4000	33%
Tomato	8000	19%
Potatoes	5000	4%
Forage	8000	17%
Orchards	8000	14%
Vineyards	9000	13%

Table I.2: Crop Budgets for Wheat and Tomato

CROP Wheat	UNITS	WITHOUT			YEAR 1-2001			YEAR 2			YEAR 3			YEAR 4-20		
		Q.TY	PRICE	TOTAL	Q.TY	PRICE	TOTAL	Q.TY	PRICE	TOTAL	Q.TY	PRICE	TOTAL	Q.TY	PRICE	TOTAL
OUTPUT																
PRIM. PR.	kgs/ha	0	106	0	0	106	0	947	106	100,063	1,893	106	200,125	2,840	106	300,188
SEC. PR.	Tukes	0	200	0	0	200	0	83	200	16,667	167	200	33,333	250	200	50,000
TOTAL	Drams			0			0			116,729			233,459			350,188
INPUT																
SEEDS	kgs/ha	0	120	0	0	120	0	100	120	12,000	200	120	24,000	300	120	36,000
Pesticides	kgs/ha	0.0	6,000	0	0.0	6,000	0	0.5	6,000	3,000	0.5	6,000	3,000	0.5	6,000	3,000
N	kgs/ha	0	80	0	0	80	0	100	80	8,000	200	80	16,000	300	80	24,000
IRRIGATION	cu m/ha	0	0.0	0	0	0.0	0	4,000	0.0	0	4,000	0.0	0	4,000	0	0
TRANSPORT	Tonn/km	0	400	0	0	400	0	12	400	4,667	23	400	9,333	35	400	14,000
HARVEST SERV.	hours/ha	0	2,000	0	0	2,000	0	1.7	2,000	3,333	3.3	2,000	6,667	5	2,000	10,000
TRACTOR SERV.	hours/ha	0	1,000	0	0	1,000	0	8.7	1,000	8,667	17.3	1,000	17,333	26	1,000	26,000
LABOUR	Mandays	0	1,000	0	0	1,000	0	6.7	1,000	6,667	13.3	1,000	13,333	20	1,000	20,000
TOTAL	Drams			0			0			46,333			89,667			133,000
TOTAL	**Drams/ha**			**0**			**0**			**70,396**			**143,792**			**217,188**
Net return	**US$/m3**			**0.00**			**0.00**			**0.04**			**0.07**			**0.11**

CROP Tomato	UNITS	WITHOUT			YEAR 1-2001			YEAR 2			YEAR 3			YEAR 4-20		
		Q.TY	PRICE	TOTAL	Q.TY	PRICE	TOTAL	Q.TY	PRICE	TOTAL	Q.TY	PRICE	TOTAL	Q.TY	PRICE	TOTAL
OUTPUT																
PRIM. PR.	kgs/ha	0	70.0	0	0	70	0	8,000	70	560,000	16,000	70	1,120,000	24,000	70	1,680,000
TOTAL	Drams			0			0			560,000			1,120,000			1,680,000
INPUT																
SEEDS	1000 PCS	0	2,000.0	0	0	2,000	0	30	2,000	60,000	30	2,000	60,000	30	2,000	60,000
N	kgs/ha	0	80.0	0	0	80	0	117	80	9,333	233	80	18,667	350	80	28,000
PESTICIDES	kgs/ha	0	6,000.0	0	0	6,000	0	4	6,000	24,000	5	6,000	30,000	5	6,000	30,000
IRRIGATION	cu m/ha	0	0.0	0	0	0	0	8,000	0	0	8,000	0	0	8,000	0	0
TRANSPORT	Tonn/km	0	400.0	0	0	400	0	107	400	42,667	213	400	85,333	320	400	128,000
TRACTOR SERV.	hours/ha	0	1,000.0	0	0	1,000	0	25	1,000	25,000	25	1,000	25,000	25	1,000	25,000
LABOUR	Mandays	0	1,000.0	0	0	1,000	0	87	1,000	86,667	173	1,000	173,333	260	1,000	260,000
TOTAL	Drams			0			0			247,667			392,333			531,000
TOTAL	**Drams/ha**			**0**			**0**			**312,333**			**727,667**			**1,149,000**
Net return	**US$/m3**			**0.00**			**0.00**			**0.08**			**0.18**			**0.29**

Table I.3: Crop Budgets for Potatoes and Alfalfa

CROP Potato	UNITS	WITHOUT			YEAR 1-2001			YEAR 2			YEAR 3			YEAR 4-20		
		Q.TY	PRICE	TOTAL	Q.TY	PRICE	TOTAL	Q.TY	PRICE	TOTAL	Q.TY	PRICE	TOTAL	Q.TY	PRICE	TOTAL
OUTPUT																
PRIM. PR.	kgs/ha	0.0	123.4	0.0	0.0	123.4	0.0	8,500.0	123.4	1,048,900.0	10,200.0	123.4	1,258,680.0	14,000.0	123.4	1,727,600.0
TOTAL	Drams			0.0			0.0			1,048,900.0			1,258,680.0			1,727,600.0
INPUT																
SEEDS	kgs/ha	0.0	120.0	0.0	0.0	120.0	0.0	4,000.0	120.0	480,000.0	4,000.0	120.0	480,000.0	4,000.0	120.0	480,000.0
N	kgs/ha	0.0	150.0	0.0	0.0	150.0	0.0	116.7	150.0	17,500.0	233.3	150.0	35,000.0	350.0	150.0	52,500.0
PESTICIDES	kgs/ha	0.0	8,000.0	0.0	0.0	8,000.0	0.0	5.0	8,000.0	40,000.0	5.0	8,000.0	40,000.0	5.0	8,000.0	40,000.0
IRRIGATION	cu m/ha	0.0	0.0	0.0	0.0	0.0	0.0	5,000.0	0.0	0.0	5,000.0	0.0	0.0	5,000.0	0.0	0.0
TRANSPORT	Tonn/km	0.0	400.0	0.0	0.0	400.0	0.0	37.3	400.0	14,933.3	74.7	400.0	29,866.7	112.0	400.0	44,800.0
TRACTOR SERV.	hours/ha	0.0	1,000.0	0.0	0.0	1,000.0	0.0	28.0	1,000.0	28,000.0	28.0	1,000.0	28,000.0	28.0	1,000.0	28,000.0
LABOUR	Mandays	0.0	1,000.0	0.0	0.0	1,000.0	0.0	38.3	1,000.0	38,333.3	76.7	1,000.0	76,666.7	115.0	1,000.0	115,000.0
TOTAL	Drams			0			0			618,767			689,533			760,300
TOTAL	**Drams/ha**			**0**			**0**			**430,133**			**569,147**			**967,300**
Net return	**US$/m3**			**0.00**			**0.00**			**0.17**			**0.23**			**0.39**

CROP Alfalfa	UNITS	WITHOUT			YEAR 1-2001			YEAR 2			YEAR 3			YEAR 4-20		
		Q.TY	PRICE	TOTAL	Q.TY	PRICE	TOTAL	Q.TY	PRICE	TOTAL	Q.TY	PRICE	TOTAL	Q.TY	PRICE	TOTAL
OUTPUT																
PRIM. PR.	kgs/ha	0	25.0	0	0	25.0	0	5,850	25.0	146,250	8,100	25.0	202,500	9,900	25.0	247,500
TOTAL	Drams			0			0			146,250			202,500			247,500
INPUT																
SEEDS	kgs/ha	0.0	1,200.0	0	0.0	1,200.0	0	2.4	1,200.0	2,880	2.4	1,200.0	2,880	2.4	1,200.0	2,880
N	kgs/ha	0.0	80.0	0	0.0	80.0	0	33	80.0	2,667	67	80.0	5,333	100	80.0	8,000
IRRIGATION	cu m/ha	0.0	0.0	0	0.0	0.0	0	8,000	0.0	0	8,000	0.0	0	8,000	0.0	0
TRANSPORT	Tonn/km	0.0	400.0	0	0.0	400.0	0	29	400.0	11,733	59	400.0	23,467	88	400.0	35,200
TRACTOR SERV.	hours/ha	0.0	1,000.0	0	0.0	1,000.0	0	5.3	1,000.0	5,333	11	1,000.0	10,667	16.0	1,000.0	16,000
LABOUR	Mandays	0.0	1,000.0	0	0.0	1,000.0	0	4.3	1,000.0	4,333	8.7	1,000.0	8,667	13.0	1,000.0	13,000
TOTAL	Drams			0			0			26,947			51,013			75,080
TOTAL	**Drams/ha**			**0**			**0**			**119,303**			**151,487**			**172,420**
Net return	**US$/m3**			**0.00**			**0.00**			**0.03**			**0.04**			**0.04**

Table I.4: Crop Budget for Grapes and Alfalfa

CROP Grapes	UNITS	WITHOUT			YEAR 1-2001			YEAR 2			YEAR 3			YEAR 4		
		Q.TY	PRICE	TOTAL	Q.TY	PRICE	TOTAL	Q.TY	PRICE	TOTAL	Q.TY	PRICE	TOTAL	Q.TY	PRICE	TOTAL
OUTPUT																
PRIM. PR.	kgs/ha	0	124.2	0	0	124.2	0	0	124.2	0	0	124.2	0	1,000	124.2	124,200
OUTPUT ALFALFA	kgs/ha	0	25.0	0	0	25.0	0	1,000	25.0	25,000	4,000	25.0	100,000	6,000	25.0	150,000
TOTAL	Drams			0			0			25,000			100,000			274,200
INPUT																
NEW PLANTS			400.0		0	400.0		200	400.0	80,000		400.0			400.0	
SEEDS ALFALFA	kgs/ha	0	1,200.0	0	0	1,200.0	0	2.4	1,200.0	2,880	2.4	1,200.0	2,880	2.4	1,200.0	2,880
PESTICIDES	kgs/ha	0	8,000.0	0	0	8,000.0	0	0.5	8,000.0	4,000	0.5	8,000.0	4,000	0.5	8,000.0	4,000
N	kgs/ha	0	80.0	0	0	80.0	0	40	80.0	3,200	72	80.0	5,760	98	80.0	7,808
IRRIGATION	cu m/ha	0	0.0	0	0	0.0	0	4,000	0.0	0	4,833	0.0	0	5,667	0.0	0
TRANSPORT	Tonn/km	0	400.0	0	0	400.0	0	25	400.0	10,000	40	400.0	16,000	98	400.0	39,200
TRACTOR SERV.	hours/ha	0	1,000.0	0	0	1,000.0	0	16.0	1,000.0	16,000	0	1,000.0	0	24.0	1,000.0	24,000
LABOUR	Mandays	0	1,000.0	0	0	1,000.0	0	24.0	1,000.0	24,000	35.0	1,000.0	35,000	50.0	1,000.0	50,000
TOTAL	Drams			0			0			140,080			63,640			127,888
TOTAL	**Drams/ha**			**0**			**0**			**-115,080**			**36,360**			**146,312**
Net return	**US$/m3**			**0.00**			**0.00**			**-0.06**			**0.02**			**0.05**

CROP Grapes	UNITS	YEAR 5			YEAR 6			YEAR 7			YEAR 8-20		
		Q.TY	PRICE	TOTAL	Q.TY	PRICE	TOTAL	Q.TY	PRICE	TOTAL	Q.TY	PRICE	TOTAL
OUTPUT													
PRIM. PR.	kgs/ha	1,500	124.2	186,300	3,500	124.2	434,700	5,500	124.2	683,100	7,500	124.2	931,500
OUTPUT ALFALFA	kgs/ha	6,000	25.0	150,000	6,000	25.0	150,000	0	25.0	0	0	25.0	0
TOTAL	Drams			336,300			584,700			683,100			931,500
INPUT													
NEW PLANTS			400.0			400.0			400.0			400.0	
SEEDS ALFALFA	kgs/ha	2.4	1,200.0	2,880	2.4	1,200.0	2,880	0.0	1,200.0	0	0.0	1,200.0	0
PESTICIDES	kgs/ha	2.5	8,000.0	20,000	4.1	8,000.0	32,800	5.4	8,000.0	43,040	8.0	8,000.0	64,000
N	kgs/ha	118	80.0	9,446	134	80.0	10,757	148	80.0	11,806	200	80.0	16,000
IRRIGATION	cu m/ha	6,500	0.0	0	7,333	0.0	0	8,167	0.0	0	9,000	0.0	0
TRANSPORT	Tonn/km	102	400.0	40,800	132	400.0	52,800	55	400.0	22,000	75	400.0	30,000
TRACTOR SERV.	hours/ha	24.0	1,000.0	24,000	24.0	1,000.0	24,000	24.0	1,000.0	24,000	24.0	1,000.0	24,000
LABOUR	Mandays	65.0	1,000.0	65,000	115.0	1,000.0	115,000	155.0	1,000.0	155,000	184.0	1,000.0	184,000
TOTAL	Drams			162,126			238,237			255,846			318,000
TOTAL	**Drams/ha**			**174,174**			**346,463**			**427,254**			**613,500**
Net return	**US$/m3**			**0.05**			**0.09**			**0.10**			**0.14**

Table I.5: Crop Budget for Apricots and Alfalfa

CROP Apricot	UNITS	WITHOUT			YEAR 1-2001			YEAR 2			YEAR 3			YEAR 4		
		Q.TY	PRICE	TOTAL	Q.TY	PRICE	TOTAL	Q.TY	PRICE	TOTAL	Q.TY	PRICE	TOTAL	Q.TY	PRICE	TOTAL
OUTPUT																
PRIM. PR.	kgs/ha	0	82.8	0	0	82.8	0	0	82.8	0	0	82.8	0	0	82.8	0
OUTPUT ALFALFA	kgs/ha	0	25.0	0	0	25.0	0	1,000	25.0	25,000	4,000	25.0	100,000	6,000	25.0	150,000
TOTAL	Drams			0			0			25,000			100,000			150,000
INPUT																
NEW PLANTS			400.0			400.0		200	400.0	80,000		400.0			400.0	
SEEDS ALFALFA	kgs/ha	0	1,200.0	0	0	1,200.0	0	2.4	1,200.0	2,880	2.4	1,200.0	2,880	2.4	1,200.0	2,880
PESTICIDES	kgs/ha	0	8,000.0	0	0	8,000.0	0	0.5	8,000.0	4,000	0.5	8,000.0	4,000	0.5	8,000.0	4,000
N	kgs/ha	0	80.0	0	0	80.0	0	50	80.0	4,000	90	80.0	7,200	122	80.0	9,760
IRRIGATION	cu m/ha	0	0.0	0	0	0.0	0	4,000	0.0	0	4,667	0.0	0	5,333	0.0	0
TRANSPORT	Tonn/km	0	400.0	0	0	400.0	0	8	400.0	3,200	14	400.0	5,600	30	400.0	12,000
TRACTOR SERV.	hours/ha	0	1,000.0	0	0	1,000.0	0	16.0	1,000.0	16,000	0	1,000.0	0	24.0	1,000.0	24,000
LABOUR	Mandays	0	1,000.0	0	0	1,000.0	0	24.0	1,000.0	24,000	26.0	1,000.0	26,000	35.0	1,000.0	35,000
TOTAL	Drams			0			0			134,080			45,680			87,640
TOTAL	**Drams/ha**			**0**			**0**			**-109,080**			**54,320**			**62,360**
Net return	**US$/m3**			**0.00**			**0.00**			**-0.05**			**0.02**			**0.02**

CROP Apricot	UNITS	YEAR 5			YEAR 6			YEAR 7			YEAR 8-20		
		Q.TY	PRICE	TOTAL	Q.TY	PRICE	TOTAL	Q.TY	PRICE	TOTAL	Q.TY	PRICE	TOTAL
OUTPUT													
PRIM. PR.	kgs/ha	1,500	82.8	124,200	2,933	82.8	242,880	4,367	82.8	361,560	5,800	100.0	580,000
OUTPUT ALFALFA	kgs/ha	6,000	25.0	150,000	6,000	25.0	150,000	6,000	25.0	150,000	6,000	25.0	150,000
TOTAL	Drams			274,200			392,880			511,560			730,000
INPUT													
NEW PLANTS			400.0			400.0			400.0			400.0	
SEEDS ALFALFA	kgs/ha	2.4	1,200.0	2,880	2.4	1,200.0	2,880	2.4	1,200.0	2,880	2.4	1,200.0	2,880
PESTICIDES	kgs/ha	1.8	8,000.0	14,400	2.8	8,000.0	22,720	3.7	8,000.0	29,376	4.5	8,000.0	36,000
N	kgs/ha	148	80.0	11,808	168	80.0	13,446	184	80.0	14,757	250	80.0	20,000
IRRIGATION	cu m/ha	6,000	0.0	0	6,667	0.0	0	7,333	0.0	0	8,000	0.0	0
TRANSPORT	Tonn/km	36	400.0	14,400	69	400.0	27,467	90	400.0	36,178	134	400.0	53,600
TRACTOR SERV.	hours/ha	24.0	1,000.0	24,000	24.0	1,000.0	24,000	24.0	1,000.0	24,000	24.0	1,000.0	24,000
LABOUR	Mandays	65.0	1,000.0	65,000	95.0	1,000.0	95,000	123.0	1,000.0	123,000	108.0	1,000.0	108,000
TOTAL	Drams			132,488			185,513			230,191			244,480
TOTAL	**Drams/ha**			**141,712**			**207,367**			**281,369**			**485,520**
Net return	**US$/m3**			**0.05**			**0.06**			**0.08**			**0.12**

Table I.6: Marginal Return of Irrigation Water for Different Crops – Using Discounted Techniques

Irrigated year	Wheat	Water	Tomato	Water	Potatoes	Water	Alfalfa	Water	Apricots	Water	Grape	Water
0	0	0	0	0	0	0	0	0	0	0	0	0
1	70,396	4,000	312,333	8,000	430,133	5,000	119,303	8,000	(109,080)	4,000	(115,080)	4,000
2	143,792	4,000	727,667	8,000	569,147	5,000	151,487	8,000	54,320	4,667	36,360	4,833
3	217,188	4,000	1,149,000	8,000	967,300	5,000	172,420	8,000	62,360	5,333	146,312	5,667
4	217,188	4,000	1,149,000	8,000	967,300	5,000	172,420	8,000	141,712	6,000	174,174	6,500
5	217,188	4,000	1,149,000	8,000	967,300	5,000	172,420	8,000	207,367	6,667	346,463	7,333
6	217,188	4,000	1,149,000	8,000	967,300	5,000	172,420	8,000	281,369	7,333	427,254	8,167
7	217,188	4,000	1,149,000	8,000	967,300	5,000	172,420	8,000	485,520	8,000	613,500	9,000
8	217,188	4,000	1,149,000	8,000	967,300	5,000	172,420	8,000	485,520	8,000	613,500	9,000
9	217,188	4,000	1,149,000	8,000	967,300	5,000	172,420	8,000	485,520	8,000	613,500	9,000
10	217,188	4,000	1,149,000	8,000	967,300	5,000	172,420	8,000	485,520	8,000	613,500	9,000
11	217,188	4,000	1,149,000	8,000	967,300	5,000	172,420	8,000	485,520	8,000	613,500	9,000
12	217,188	4,000	1,149,000	8,000	967,300	5,000	172,420	8,000	485,520	8,000	613,500	9,000
13	217,188	4,000	1,149,000	8,000	967,300	5,000	172,420	8,000	485,520	8,000	613,500	9,000
14	217,188	4,000	1,149,000	8,000	967,300	5,000	172,420	8,000	485,520	8,000	613,500	9,000
15	217,188	4,000	1,149,000	8,000	967,300	5,000	172,420	8,000	485,520	8,000	613,500	9,000
16	217,188	4,000	1,149,000	8,000	967,300	5,000	172,420	8,000	485,520	8,000	613,500	9,000
17	217,188	4,000	1,149,000	8,000	967,300	5,000	172,420	8,000	485,520	8,000	613,500	9,000
18	217,188	4,000	1,149,000	8,000	967,300	5,000	172,420	8,000	485,520	8,000	613,500	9,000
19	217,188	4,000	1,149,000	8,000	967,300	5,000	172,420	8,000	485,520	8,000	613,500	9,000
20	217,188	4,000	1,149,000	8,000	967,300	5,000	172,420	8,000	485,520	8,000	613,500	9,000
NPV (at 10% discount rate)	1,654,939	34,054	8,673,269	68,109	7,417,785	42,568	1,402,321	68,109	2,395,895	57,144	3,161,740	62,916
Net Return (US$/m3)		0.10		0.25		0.35		0.04		0.08		0.10

ANNEX II: OVERVIEW OF CURRENT ORGANIZATIONAL ARRANGEMENT[49]

This Annex presents the current organizational arrangements for the planning, development and management aspects of water resources in Armenia.

Cabinet	• *Policy* - Responsible for overall water policy, including annual decision on cost recovery for irrigation. • *Allocation* - Responsible for deciding on Lake Sevan's water releases.
Ministry of Nature Protection (MoNP)	• *Policy* - Development of environmental policies including those related to water resources. • *Instruments* – Proposal of economic instruments (water extraction fees and pollution charges). • *Legal* - Drafting of relevant environmental legislation. • *Research* – Conduct of environmental research. • *Water use* - Maintaining the Water Cadaster and issuing Water Use Permits. • *Pollution control* - Participation in designing of quality standards; approval of enterprise projects for the least permissible discharges; elaboration of ecological passports; monitoring the state of the environment. • *Enforcement* - Management of the State Environmental Inspectorate and the Environmental Monitoring Centre. • *Public relations* – Promotion of public awareness. • *Monitoring* - Monitoring of water quantity, preparation of water balance statements, state registry of the run-off waters and maintenance of water cadaster (functions conducted by the Hydro-Meteorological Department), monitoring of wastewater discharges and enforcement of pollution control (State Ecological Inspectorate), monitoring of surface water quality of rivers and reservoirs (Environmental Pollution Monitoring Center).
State Committee of Water Economy (has assumed some of the functions previously assigned to the Ministry of Agriculture and Ministry of Urban Development)	• *Operational management* – Exercise state management authority over commercial use of all kinds of water resources (surface, groundwater and mineral), except those feeding Yerevan city. Responsible for sectoral, legal and economic monitoring of irrigation/drainage and dam enterprises, water supply and sewerage companies, inter-basin facilities, state hydropower facilities. In process of obtaining management authority over community owned water supply schemes. • *Allocation* - Participation in process of issuing water permits. • *Protection* – Responsible for sanitary zones around water sources.
Ministry of Agriculture (MoA)	• *Policy* – Development of irrigation and drainage policies. • *Allocation* – Definition of irrigation norms for crops.

49 The assessment reflects the situation until end June, 2001.

	• *Research* – Conduct of research on modern irrigation technologies. • *Monitoring* - Coordination of the institutions responsible for land use and protection. Together with the State Committee of Real Property Cadaster, recording of irrigation lands and inventory of irrigation systems. Monitoring and enforcement of regulations as regards land contamination.
Ministry of Economy and Finance	• *Finance* – Responsible for tariffs and public finance matters related to public services and the management of state-owned companies.
Ministry of Energy	• *Operational management* – Implementation of releases of water from Lake Sevan jointly with the Hydro Meteorological Institute.
Ministry of Health (MoH)	• *Pollution control* - Development of quality standards for drinking water. Coordination of all issues related to human health (for example sanitation issues). • *Allocation and use* – Provides agreement with issuing of water use permits and ecological passport. • *Enforcement* – Enforcement of quality standards (SanEpid).
Ministry of Urban Development (MoUD)	• *Policy* - Development and implementation of water supply and wastewater sector strategy. • *Implementation* - Development and approval of design, construction, operation standards.
Municipality of Yerevan	• *Management* – Overall management responsibility for water supply and purification services in Yerevan.
Regional Government at the Marz level	• *Planning and management* – In theory, responsible for overall planning and management/provision of services of water supply, drainage, irrigation and water treatment (in reality this is physically done by the water/irrigation enterprises). • *Implementation* - Organization of construction and maintenance of water reservoirs. • *Financing* - Tax collection for irrigation. • *Monitoring and enforcement* - Monitoring and enforcement of water (nature) resources use and protection.
Municipalities (hamaink)/local government	• *Management* – Management of district property and locally significant problem solving. • *Operation and maintenance* - Operation and maintenance of village water supply systems. • In reality, local level has little legal influence on the use of its own resources, but some hamainks are said to take a more active part on own initiative.
Ministry of Economy and Finance	• *Finance* – Responsible for tariffs and public finance matters related to public services and the management of state-owned companies.

Source: Modified/updated version of the overview presented in the IWRMP (Stage I and II Reports), as of June 30, 2001.
Note: Functions of some Ministries, e.g., Ministry of Agriculture, were modified after the assessment was completed.

ANNEX III: DRAFT ARMENIAN WATER POLICY STATEMENT[50]

We, the Government of the Republic of Armenia, appreciate that water is a finite and vulnerable resource, being scarce in some parts of Armenia. We realize that the overall objective of managing the nation's water resources is to achieve optimum, long-term, environmentally sustainable social and economic benefits for the society from their use, balancing the interests of both present and future users. We therefore recognize:

The Value of Water

- Water has an economic as well as a social and environmental value.[a] The water use allocation therefore must be optimal for the achievement of equitable and sustainable economic and social development.

The Importance of Basic Water Needs Provision

- The overall priority in water resources management is to meet basic human needs. All other needs have lower priority.

The Holistic Nature of the Resource

- Water resources shall in principle be developed, apportioned and managed in such a manner as to enable all user sectors to gain equitable and reliable access to the required quantity, quality of water.
- The planning and implementation of actions in the water sector must be coordinated and integrated over several sectors, as most of the actions are inter-related.
- Water quality and quantity are inter-dependent and shall be managed in an integrated manner, which is consistent with broader environmental management approaches.

The Environmental Value of the Resource

- The value and need of water, of the appropriate quality, for the ecosystems should be thoroughly recognized, especially in the event of eventually competing uses. This also includes water for wildlife, recreation and amenity.

Our Role as Custodian and Managers

- The Government of Armenia will act as the single custodian of the nation's water resources, and has ultimate responsibility for, and authority over, water resources management, the equitable allocation and usage of water and the transfer of water between water basins, and in international water matters.

---

[50] This annex presents the latest version of the Armenian Water Policy Statement, which was elaborated during the preparation of the Integrated Water Resources Management Planning Study and accepted by the various stakeholders, including the Technical Advisory Board and Inter-Ministerial Committee.

- The Government of Armenia shall ensure that the development, allocation, management and use of the water resources is carried out in a transparent way, using criteria of public interest, sustainability, equity and efficiency of use, in a manner which reflects its public trust obligations and the value of water to society.
- Water resources management at the operational level should to the extent possible be decentralized to appropriate local management authorities (water basin/regional/municipal).
- In the long term, management of water resources will be carried out in regional or water basin management areas (which will coincide either with areas linked with supply systems having common socio-economic interests; or with natural river basins, groups of basins, sub-basins, etc.).
- Any authorization to use water shall be given in a timely fashion and in a manner which is clear, secure and predictable in respect of the assurance of availability, extent and duration of use.
- Recognition of water rights.

Our Commitment to Stakeholder Participation

- Effective use of water resources, and the provision of appropriate service levels, is facilitated by the participation of stakeholders (users, planners and policymakers). This should occur at all the relevant levels, throughout the various stages of planning and implementation, as well as during operation and maintenance. One main objective is to provide services in accordance with the needs, desires and economic capacity of the water users and thus to improve the sustainability of the supply systems.
- A proper participatory approach will require appropriate dissemination and sharing of information on water resources, and will necessitate awareness raising and training activities among the stakeholders.

The Importance of Cost Recovery

- To promote an economically efficient use of water, the long-term principle will be to charge users for the costs of providing water, including operation and maintenance, infrastructure replacement and expansion.
- Development programs will be realistic and affordable and based on clear and consistent cost recovery principles.
- The use of rivers, reservoirs, lakes and underground resources to dispose of wastewater will also in principle be made subject to pollution charges.
- Water quality management options shall include the use of economic incentives and penalties to reduce pollution; and the possibility of irretrievable environmental degradation as a result of pollution shall be prevented.
- In a long-term perspective, many of the functions required for the provision of water and sanitation services could be fully or partly undertaken by the private sector.

Transboundary Impacts

- Transboundary water resources, specifically shared river systems, shall be managed in a manner that optimizes the benefits for all parties in a spirit of mutual cooperation. Allocations agreed for both upstream and downstream countries shall be respected.

The Importance of Lake Sevan

- Lake Sevan plays a significant role as a unique water resource of both regional and national strategic importance. It is also an important national symbol for the nation.

Note

a. The fact that water has an economic value implies that water can be managed by the introduction of incentives to improve efficiency in water use and allocation, and can be traded. This concept was introduced in the Civil Code.

ANNEX IV: TASKS AND RESPONSIBILITIES FOR INTEGRATED WATER RESOURCES MANAGEMENT[51]

This annex presents possible functions for a new entity in charge of integrated water resources management, i.e., the proposed Water Resources Management Board.

1. Formulation of Policies, Legislation and Standards

1.1 Formulation of national policies and objectives. Formulate national and regional policies and objectives, and identify which will have an impact on water resources management.

1.2 Formulation of water resources management (WRM) policies and objectives. National Policies and Objectives have to be "translated" into WRM policies and objectives.

1.3. Classification of water bodies per function. The translation of national policies and objectives into WRM policies and objectives requires the classification of water bodies per function.

1.4 Prepare WRM legislation. WRM policies should be supported by the necessary legislation and regulations.

1.5 Prepare WRM standards and norms. Prepare and update quality standards for raw water, for used water and for drinking water and develop standards for the design and use of water for different applications.

2. Water Resources Planning and Allocation

2.1 Inventory of water resources. Prepare an inventory of surface and groundwater resources for all major basins.

2.2 Projection of water demand per sector. Assess and update existing and future demand for water for each category of water users (agriculture, drinking water, energy, industry, etc.).

2.3 Revise minimum required environmental (or sanitary) flow. Establish the minimum environmental (or sanitary) flow in the water bodies needed to maintain water quality and to achieve major environmental objectives.

2.4 Prepare (future) water balance statements. Compare available and future water resources and water demand in order to define the water balance at strategic points in the water basin.

---

51 **Source:** Integrated Water Resources Management Planning Study (Stage I and Stage II Reports).

2.5 Identify water-related problems and issues.

2.6 Development of options. Development of scenarios and options on how to solve the identified problems and bottlenecks, in cooperation with stakeholders.

2.7 Consultation with stakeholders

2.8 Evaluation of scenarios and options. Evaluation of the identified scenarios and options with regard to their technical, hydrological, social, environmental, economic and institutional feasibility.

2.9 Prepare water resources management plans: Development of water resources management plans for each major river basin, which contain the most desirable scenarios and which provide the basic allocations of water to the different water users.

2.10 Approve water resources management plans

3. **Issue Water Use and Discharge Permits**

3.1 Issue water use permits. Issue permits to water users to use water, based on the basic allocations from the water resources management plans.

3.2 Issue water discharge permits. Issue permits to water users to discharge wastewater against set standards, based on the water resources management plans.

3.3 Issue environmental passports. Issue environmental passports to industrial enterprises after analysis of industrial processes and its environmental impacts.

3.4 Maintain the Water Cadaster. Keep the register of the use and discharge of water by different water users.

4. **Monitoring and Enforcement**

4.1 Monitoring of raw water quality. Strengthen monitoring system and implement regular measurements of water quality at selected points in the river basin.

4.2 Monitoring of drinking water quality. Strengthen monitoring system and implement regular measurements of the quality of drinking water.

4.3 Monitoring of wastewater quality. Strengthen monitoring system and implement regular measurement of wastewater quality at selected points in the river basin.

4.4 Monitoring of surface and groundwater flows. Strengthen monitoring system and implement regular measurements of surface and groundwater flows in the river basin.

4.5 Update and maintain a state water resources database or register. Update current Water Resource Database, make necessary changes to its structure, collect and maintain data and disseminate data to users.

4.6 State control on water use and discharge. Carry out regular control measurements of water quality and quantity, to control compliance with user and discharge permits.

4.7 Enforcement. Ensure compliance with permits, apply regulatory fines and if necessary take legal action.

5. **Financial Management**

5.1 Develop financial policies for water resources management. Develop financial policies including a resource pricing mechanism.

5.2 Develop financial policies for sector programs. Develop financial policies at the sector level, including the setting of water tariffs.

6. **Implementation and Other Activities**

6.1 Implement WRM investment programs. Develop and undertake the necessary water use, protection and management programs.

6.2 Operational water resources management. Regulate on a day to day basis the flow of water and the allocation of water to the different water users.

6.3 Implement water related sector programs: implement the necessary activities to achieve the objectives set by the sector, including investment programs and operation and maintenance.

6.4 Design and implement research programs: Design and implement research programs related to water resources management.

6.5 Develop international cooperation programs. Establish international cooperation programs as required.

6.6 Implement WRM-capacity building programs. Assess training needs and prepare and implement specific education and capacity building programs for water resources management.

6.7. Implement public information programs. Design and undertake public information programs related to the management and use of water.

ANNEX V: PARTICIPATORY PLANNING PROCESS IN THE PREPARATION OF THE IWRMP STUDY

The preparation of the IWRMP Study continued the extensive work done during the development of a participatory planning process that began under the Lake Sevan Action Program and the National Environmental Action Program. Various public meetings, seminars and workshops were held to facilitate review of the draft versions of the study reports and to assure continuous local support for a participatory planning and review process. The World Bank Institute (WBI) played a critical role in the stakeholder consultations. A brief description of the most important milestones in the preparation of the IWRMP Study are listed below:

- Prior to the start of the study, a series of meetings at the central and local levels were held to review the scope of the study and seek the views from involved government agencies, stakeholders, affected parties and NGOs.

- During the initial phase of the study, a First Seminar on IWRM was organized on April 19-22, 1999, with the aim of fostering an open discussion among key decision-makers on the most important issues related to the formulation of an Integrated Water Resources Management Plan. A summary of the conclusions reached at the seminar is attached as Attachment 1.

- Between February and March, 2000, consultations were held at the level of Marzes to get feedback on key water issues at the local level.

- A First Stakeholder Consultation was conducted on March 23, 2000, to present preliminary findings of the Stage I report of the study. The Draft Stage I Report was presented to representatives from Armenian decision-makers (government servants and technical experts) and opinion-makers (media communicators and non-governmental organizations) in the Second Stakeholder Consultation that took place on June 28, 2000. The conclusions of this second stakeholder consultation are presented in Attachment 2. A follow-up Second Seminar on IWRM took place on June 29-30, 2000, with the participation of civil servants, technical experts and Marz representatives to critically review the findings of the Stage I report, and to provide guidance for Stage II of the study. The conclusions of this second seminar are presented in Attachment 3.

- The Stage II Draft Report was discussed in a Third Stakeholder Consultation that took place on April 3, 2001. The stakeholders were in favor of the institutional framework proposed under the study and endorsed the proposed water resources policy statement. The stakeholders also expressed comments and suggestions on the draft report, which have been reflected in the final report.

- The Final Stage II Report was presented to the stakeholders on June 15, 2001.

In order to facilitate dissemination of results and elicit the participation of a larger number of stakeholders, three issues of a newsletter was issued during the study the study.

A high-level Inter-Ministry Committee (IMC) provided a venue for high-level dialogue in the preparation of the IWRMP Study. The Committee provided insight and advice to the team responsible for the preparation of the study. This allowed participation to be achieved at the policy level. The Technical Advisory Board (TAB) was also formed to ensure broad participation not only of technical specialists from concerned ministries and agencies but other stakeholders and civil society as well. The TAB assisted the team in reviewing the study outputs and reaching agreement on recommendations to the Government. It should be noted that due to the broad participation of several institutions, local experts, key stakeholder and decision-makers in the preparation of the IWRMP, many of the issues raised in this report, particularly those on the institutional framework, are currently being addressed by the Government of Armenia.

Attachment 1

First Seminar on Integrated Water Resources Management in Armenia
(Tsakhkadzor, Armenia; 19-22 April 1999)

Issues and Challenges for Development of an Integrated Water Resources Management Plan (IWRMP) in Armenia

Working Group Reports

Armenian participants to the Seminar on Integrated Water Resources Management in Armenia at Tsakhkadzor, Armenia on 19-22nd April 1999, had the occasion to discuss in small working groups the pressing issues and challenges faced by Armenia today in developing an integrated water resources management plan (IWRMP), and to make specific recommendations on how to address them during the preparation of the IWRMP. The working group discussions were organized around the following broad themes:

Theme #1: Competition for Water Resources

Discussions centered around the following issues: estimating the environmental demand for water, protecting surface and groundwater quality, mitigating salinity and water logging due to irrigation, estimating the value of water in alternative uses, and making trade-offs between water for power, agriculture, urban and environmental demands. In order to address the competition for water resources, the Seminar participants concluded that:

- **Legislation**: The lack of water resources management legislation was a major threat to any initiative to improve the use of the resource. Participants suggested:
  (a) that a new legislative framework should define water quality standards for water use, including ecological use, of both surface and groundwater;
  (b) that the establishment of a system of water (usage) rights should clearly define the rights and responsibilities of water users;
  (c) that the enactment of water legislation should be just one step towards improving the use of water, since real progress comes from the strict enforcement of laws and regulations;
  (d) that, when preparing the IWRMP, attention should be given to designing practical and feasible enforcement mechanisms.

- **Economic Incentives**: Introduction of economic incentives for water quality improvements and efficient use, such as introducing water charges that reflect the cost of pollution abatement and opportunity cost, was a good ingredient of any sound water resources planning effort.

- **Inter-sectoral Conflicts**: Inter-sectoral conflicts over water resources could be better addressed by reconciling between ecological and socio-economic concerns. The current

debate about the Arpa-Sevan-Vorotan system could be greatly improved by identifying agreed evaluation criteria early in the planning process, and by having a transparent approach to illustrate trade-offs among evaluation criteria.

- **Water Quality Standards**: Given that current water quality standards were taken from the FSU and adapted to Armenia, there is a need to evaluate alternative water quality standards and norms suitable to current hydrological conditions.

- **Ecosystem Rehabilitation**: Rehabilitation of deteriorated aquatic ecosystems should be carried out by means of scientifically justified measures that are authorized by government and legislative bodies. Research and development activities should be supported in the future in order to keep the water sector up-to-date.

- **Stakeholder Consultation**: Given the intensive competition for water resources among various sectors of the economy, the success of the IWRMP would depend on the establishment of a process for considering the views, interests, and perspectives of all stakeholders involved.

- **Bulk Water Management**: Introducing a system of bulk water management, by which specialized companies supply raw water to retail companies in accordance to the binding conditions of a contract, should provide a possible institutional option to reduce conflicts. These companies would be responsible for the management of the major hydraulic infrastructure, and would sell water to municipal water utilities and water users associations as per agreed contracts.

Theme #2: Water Supply and Demand Management

Discussions centered around the potential for improving the efficiency of water use, the role of water pricing to manage demand and eliminate waste, and the importance of cost recovery. Seminar participants concluded that:

- **Demand Management**: The IWRMP should address both supply and demand management issues, giving particular attention to water pricing, economic incentives, ownership of water assets, and regulatory structures (environmental regulation and business regulation); and increased attention should be given to demand management options.

- **Use Efficiency**: The potential for improving water use efficiency existed in both the irrigation and municipal sectors; and rehabilitation and modernization of water facilities and internal networks should reduce huge volumes of physical water losses.

- **Economic Instruments**: Given the scarcity of overall resources for the water sector, there was a pressing need to manage water resources using economic instruments such as water pricing, effluent charges, water markets, etc.

- **Tariff Structure**: Full water tariffs seem not feasible in the short -run. The current Government policy, which aims to achieve 100 percent full cost recovery of O&M costs in the irrigation and municipal sectors by year 2004, seems to leave little room for further improvements, i.e., marginal cost pricing.

- **Financing Checks and Balances**: Given the various financing mechanisms currently used in the water sector, i.e., users fees, subsidies, central budget transfers, and the on-going privatization in the water supply sector and the transfer of management functions to WUAs, the introduction of checks and balances for making optimal investment and operations decisions in the water sector is essential.

- **Lake Sevan**: Although the abstraction charges for raw water from Lake Sevan were in place, they unfortunately neither internalized environmental costs nor reflected opportunity costs.

- **Charges and Metering**: Introduction of volumetric charges and metering was currently envisaged by both the municipal and irrigation sectors as a critical step towards improving water use efficiency. Seminar participants recognized:
  (a) the need to link metering with water charges;
  (b) that price increases in the absence of volumetric charges would have no effect whatsoever on the overall demand for water; and
  (c) that a constraint to introducing universal metering is that old apartment buildings would require the installation of more than one meter; and
  (d) there was a need to identify costs and benefits before adopting this policy.

- **Water Conservation Technologies**: Adoption of water conservation technologies in the irrigation sector was constrained by the high content of solids in the water. Some piloting schemes with drip and sprinkler irrigation systems have brought about less than satisfactory results.

Theme #3: Institutional Framework for Water Resources Management

Discussion centered around policy, legislative and institutional issues on water resources management, including aspects related to sharing international watercourses. Seminar participants concluded that:

- **Water Code**: With regard to the current legislative framework for water resources management, the Armenia Water Code of 1992 is the major instrument that secures water resources management and regulates their use and protection. The reform of the country's administrative and territorial system in 1996 changed the responsibilities of the administrative and territorial authorities. The Water Code thus needs to be modified to comply with the requirements of the above-mentioned changes and to overcome contradictions imposed by a number of decisions, namely, in the action program for improvement of the irrigation system's financial situation, the irrigation water use register and set-up of reporting rules, the agricultural non-irrigated lands register, and the improvement of water use and wastewater treatment.

- **Complex Legislative Framework**: A complex legislative framework of related laws and regulations (i.e., water code, land code, law on nature use, water user fee rates, etc.) was required for clarifying the rights and obligations to the resource base, taking into consideration compliance with the 1999 Armenia Civil Code.

- **Agency Responsibilities**: The existing legislation failed to identify authorities and responsibilities of different agencies involved in water resources management. Seminar participants recommended re-distributing the responsibilities among the various agencies dealing with water resources taking into consideration environmental and economic efficiency criteria, as well as the requirements of the administrative and territorial structure.

- **WRM Board**: Taking into account the irrational administrative structure in the field of water resources management, Seminar participants recommended the establishment of a water resources management board under the Cabinet of Armenia.

- **Sharing Transboundary Waters**: With regard to sharing transboundary waters, Seminar participants noted that Armenia maintains all its allocation agreements regarding international rivers dating from Soviet times. The current problem regarding sharing of international watercourses is not in the content of the agreement but the lack of infrastructure to make use of all the water allocated to Armenia. A case in point is the sharing of the Araks River where, because of the lack of intake facilities, Armenia is unable to fully utilize its share.

- **International Agreements**: Current international agreements should be revised in light of generally accepted principles established in the Helsinki UN/ECE Convention on protection and use of transboundary watercourses and international lakes, i.e., paying equal attention to both quality and quantity aspects of water resources, agreements on information exchange, compensation, etc. Seminar participants welcomed the idea of joining the Convention.

Attachment 2

Second Stakeholder Consultation on Integrated Water Resources Management
YerevanJune 29, 2000

Recommendations by Armenian Stakeholders

Based on the presentation of the results of the Phase I Report on the Integrated Water Resources Management Plan (IWRMP) for Armenia, Working Groups of Armenian decision-makers (government servants and technical experts) and opinion-makers (media communicators and non-governmental organizations) (100 participants) discussed and concluded as follows on four issues:

(A) Information and Involvement:

- Involve all sectors and levels (central, regional and local) of government
- Provide full access to information
- Set up consultative structure involving government, regional authorities, academic, private sector, and NGO groups
- Enable two-way information sharing
- Use information at regional/Marz and local levels by involving NGOs in monitoring and implementation
- Share information between various sectoral projects funded by international organizations, including the World Bank.

(B) Payments and Willingness to Pay:

- Institute volumetric tariffs for urban and irrigation supply and services
- Improve collection rate of the Yerevan and Armenia Water Supply Companies once the delivery of water services is substantially improved
- Use zoning and meters to improve supply from rehabilitated systems
- Train water operators on qualitative and quantitative enforcement mechanisms
- Promote new infrastructure and investments to increase efficiency and cost-effectiveness of water supply
- Switch pumping irrigation to gravity-feed irrigation to reduce production cost.

(C) Sectoral Priorities and Objectives:

- Make drinking water supply the top priority on water allocation
- Make environmental protection more important than other remaining priorities
- Enhance water quality and quantity monitoring systems of surface water and groundwater sources
- Stop promoting sectors that are water/electricity intensive
- Preserve Lake Sevan and wetlands
- Make long-term planning and forecasts

- Improve environmental enforcement capability
- Promote small hydropower plants
- Develop a regional strategy for water and energy
- Address water resources issues in the context of the socio-economic trends in the country – allocation regime, economic security and regional development patterns.

(D) Institutional Arrangements:

- Establish an independent and inter-ministerial Water Resources Board, provided there is greater information transparency, since an interim body encounters many problems.
- Ensure status equivalent to a ministry for independent authority to deal with all ministries / stakeholders concerned with water (e.g. the Ministry of Nature Protection, the Ministry of Urban Development and Infrastructure, the Hydro-Meteorological Services, the Ministry of Agriculture) so that it can integrate functions since present difficulties in water resources management are due to fragmented responsibilities and lack of comprehensive coordination
- Clarity management responsibilities determined by the State in terms of normative (e.g. standards, laws), coordination (e.g. between sectors and agencies) and executive functions (e.g. issuing permits, fines), and sectoral responsibilities for exploration, exploitation, treatment, supply, industrialization, recovery and conservation
- Ensure viability in terms of size, status, power, functions, resources and leadership, and clarify funding sources and budgets
- Proceed by:
    - Establishing an interim structure and enabling its evolution
    - Defining its membership
    - Involving the private sector in privatizing services
    - Involving all sectors and actors
    - Strengthening environmental protection in the regions / Marzes
    - Ensuring an adequate legal framework for effective enforcement.

Source: Stakeholders' Consultations at the Teckeyan Conference Center, Yerevan, 28th June 2000 (World Bank – WBI & ECSSD – and Ministry of Nature Protection / Project Coordination Unit)

Attachment 3

Second Seminar on Integrated Water Resources Management in Armenia
Tasakhkadzor
June 29-30, 2000

Government Servants and Technical Experts Consultations

Working Groups of government servants (including representatives from regional governments or Marzes) and technical experts (60 participants in total) discussed and arrived at the following conclusions on six emerging issues important for shaping the scope of Phase II of the Integrated Water Resources Management Plan (IWRMP) in Armenia: (i) the role of the private sector in water resources management; (ii) abating pollution of water resources from municipal sources; (iii) modeling methodologies; (iv) water resources assessment; (v) groundwater management; and (vi) water-related challenges faced by Marzes (regions) and users. A seventh issue, that of international waters for Armenia, proved too sensitive to be included for discussion at this stage. Expert presentations provided the landscape for these discussions. The Working Group discussions were excellent, of high quality, and sometimes very passionate between different kinds of experts present. This process of open discussion was perhaps more important than the outputs, and was appreciated especially by the younger generation who had little exposure to this kind of interaction and 'brainstorming'; and differed from the previous IWRM Seminar in Armenia a year earlier, where senior technical experts dominated most of the discussions.

The Role of the Private Sector in Water Resources Management and Development

1. Water is owned by the State but can be managed and used by five entities: Organizations, Institutions, Enterprises (e.g. water supply, sewerage, and wastewater treatment), Self-Governing Authorities (e.g. for Lake Sevan), and Citizens.
2. There seem to be no obstacles to private sector involvement to varying degrees in water resources management and development provided the State was in control and the judiciary system was strengthened to handle emerging disputes.
3. Large entities (particularly those in irrigation) seem to have problems promoting private sector development, which needs to be examined.
4. Engaging the private sector in the water sector should start with arrangements that essentially promote service and management contracts and gradually move 'upstream' with arrangements that fully privatize the provision of water-related services as experience is gained by the State to regulate the private sector.
5. The overall Government strategy on privatization, which is coordinated by the Ministry of Finance, needs to include private sector participation in the water sector.
6. There is no precise legislation on private sector participation in groundwater management and development, where ownership issues are somewhat unclear.

Abating Pollution from Municipal Sources

1. Since water companies in Armenia are poor, it seems very unlikely that they will be able to treat wastewater in the short term and comply with environmental regulations.
2. Nonetheless, the drinking water supply and sanitation strategy should call for a phased approach to wastewater treatment, for addressing wastewater discharge into environmentally sensitive areas, and for protecting water source catchments.
3. The knowledge base on the current conditions of rivers and water bodies should improve in order to assess the magnitude of this problem.
4. There is a need to take measures of pollution loads – it seems that during drought periods, the problem of self-cleaning of the rivers in Armenia becomes more serious.

Water Resource Assessment

1. Available information is not reliable because of the lack of a monitoring system for the past twelve years. Therefore, there is a need to review stock assessment in view of the unreliability of data in Phase I of IWRMP, and to strengthen the monitoring capacity of the Hydro-Meteorological Services for securing new data (with USAID assistance). It is paramount that Armenia launch data collection activities to have a better assessment of its water resources (both surface and groundwater) flowing in and out of the country before any new international water sharing agreement can be concluded.
2. Environmental requirements of aquatic ecology and minimum sanitary flows cannot be overlooked during the formulation of the plan.
3. It seems necessary to re-assess whether the proposed 'model' is the right one for Armenia in view of the existence of a local model of the Hrazdan Basin, and the type of questions posed by the stakeholders.
4. If possible, modeling and monitoring should be carried out together during the planning process.

Modeling Methodologies

1. The analytical framework or 'model' being built under the IWRMP is capable of providing a good visualization of the current knowledge of water resources issues and problems in the country, and enhancing stakeholder involvement and inclusion in the decision-making process.
2. The 'model' will help to collect, organize, and display available information that could affect water resources management, and perform a variety of scenario analyses.
3. The 'model' will be built in stages at increasing levels of detail and sophistication based on data available and its intended purpose. In Armenia, it seems to be essential to develop a 'model' that:
    - Includes surface water and groundwater;
    - Takes into account different sector interests (hydropower, irrigation, municipal water supply, rural water supply, industry, and environment);
    - Has a good economic foundation;
    - Attempts to perform simulation and optimization;
    - Addresses water quality monitoring and assessment questions;
    - Analyses different hydrology regimes: dry, normal or wet years; and

- Analyzes potential effects of climate change.

4. Specific recommendations for the further development of the 'model' include:
    - Local experts must become familiar with the new analytical tools;
    - Data gaps must be identified and filled as soon as possible; and
    - The new Working Group on Modeling should include expertise on hydrogeology, environment, and economics among other disciplines.

Groundwater Management

1. Major groundwater issues facing Armenia include: declining groundwater yields, increasing production cost of water from artesian wells, declining groundwater quality, lack of groundwater monitoring, absence of groundwater extraction registration.
2. Some recommendations to improve groundwater management include:
    - Establishing a groundwater assessment pilot project to obtain more precise data on groundwater availability;
    - Improving the monitoring system; and
    - Re-establishing groundwater protection zones.

Issues and Challenges Faced by Marzes (Regions) and Users

There is a need to:

1. Rehabilitate irrigation systems in the Marzes and rural areas due to high leakages and little or no operational capacity;
2. Rehabilitate and improve reliability of reservoirs;
3. Establish wastewater treatment in the Marzes, so that water quality complies with national safety standards;
4. Substitute pumping irrigation with gravity irrigation systems in the Marzes to save on energy and reduce production costs for rural areas;
5. Introduce metering of water supply in urban and rural areas to manage water leakages and losses;
6. Promote agricultural extension services to reduce energy and water use in the rural areas;
7. Enhance the modernization of industries for the efficient use of water, including rural industries;
8. Enhance water supply and sanitation services to make metering cost-effective;
9. Review the provision of water supply to Georgia and Azerbaijan;
10. Irrigate orchard trees;
11. Involve the Marzes in the planning and decision-making process through consultation and participation;
12. Provide the Marzes with physical and economic information on agriculture to enable them to integrate with export trade and industry;
13. Enhance the development of groundwater and mineral water resources, such at Jermuk;
14. Strengthen the capacity of regional government in water resources management in view of decentralization and the devolution of responsibilities to local and regional governments;
15. Review the property rights of Lake Sevan since there are many sectors that benefit from its water, while the Garkunik Marze does not;

16. Differentiate water sources of national, regional and local significance based on consultations between the different levels of government; and
17. Address institutional issues related to the management of community-owned water resources and community-based water schemes to resolve upstream/downstream conflicts.

Source: Government Servants and Technical Experts Consultations at the Writers' Union Center, Tsakhkadzor, 29 th -30th June 2000 (World Bank – WBI & ECSSD/ECSIN and Ministry of Nature Protection / Project Coordination Unit)

IBRD 29906

This map was produced by the Map Design Unit of The World Bank. The boundaries, colors, denominations and any other information shown on this map do not imply, on the part of The World Bank Group, any judgment on the legal status of any territory, or any endorsement or acceptance of such boundaries.

The map at this site is for reference only and is not sanctioned for use in any World Bank Group document. Contact the Map Design Unit for the acquisition of maps to be used in World Bank Group documents.

FEBRUARY 1999