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Achieving Sustainable Groundwater Use in the Ararat Valley: the Role of the Fishery Sector

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Advanced Science and Partnerships for Integrated Resource Development Project

Achieving Sustainable Groundwater Use in the Ararat Valley: The Role of the Fishery Sector

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Prepared for:
United States Agency for International Development
Armenia Mission
1 American Avenue
Yerevan 0082, Armenia

Prepared by:
Mendez England and Associates (ME&A)
4300 Montgomery Ave.
Suite 103
Bethesda, MD 20814
Tel: +1 301 652 4334
Fax: +1 301.652.3733
www.mendezengland.com

Armenian Branch of ME&A
105/1 Teryan St., Suite 204,
Yerevan 0009
Republic of Armenia
Tel. +374 10 514 315
Fax: +374 10 514 317
Email: aspired@engl.com

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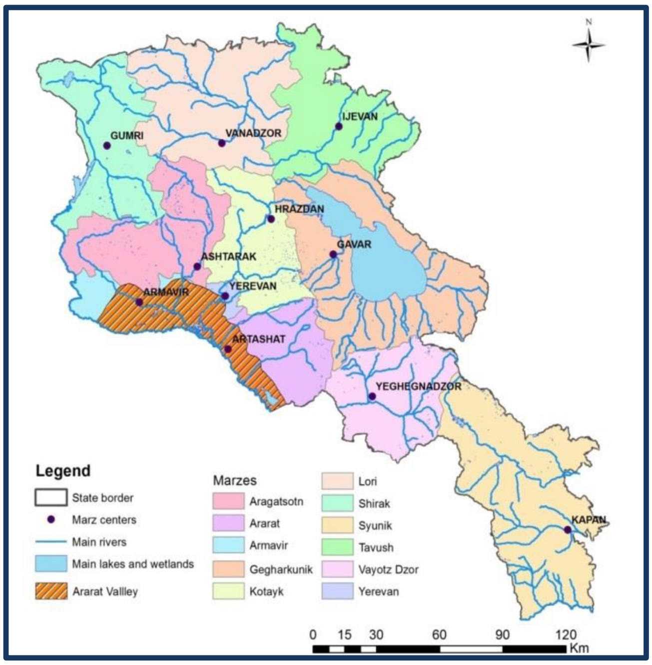
Abbreviations

AMD	Armenian Dram
ASPIRED	Advanced Science and Partnerships for Integrated Resource Development Project
ANPP	Armenian Nuclear Power Plant
AMD/USD	Exchange rate = 475
BMO	Basin Management Organization
EPIRB	Environmental Protection of International River Basins
EU	European Union
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GOA	Government of Armenia
HMC	Hydrogeological Monitoring Center
ITF	Interagency Task Force
Kg	Kilogram
Km	Kilometer
l/s	Liter per second
MA	Ministry of Agriculture
MCM	Million cubic meters
m^3	Cubic meters
MNP	Ministry of Nature Protection
OECD	Organization for Economic Cooperation and Development
RA	Republic of Armenia
RUB	Russian Rubble
SCADA	Supervisory Control and Data Acquisition
SEI	State Environmental Inspectorate
SWCIS	State Water Cadaster Information System
USAID	US Agency for International Development
USD	US Dollar
USGS	US Geological Survey
WRMA	Water Resources Management Agency
WUA	Water Users Association
WUP	Water Use Permit

EXECUTIVE SUMMARY

Groundwater Use in the Ararat Valley: Existing Pressures

The Ararat Valley is one of the largest plains of the Armenian Plateau. In Armenia, the Ararat Valley covers two administrative divisions: Ararat and Armavir marzes. It is located 800-1,000 meters above sea level and occupies an area of approximately 1,300 square kilometers within Armenia, representing about 4% of Armenia's territory. The Ararat Valley is one of the most significant basins of artesian aquifers in Armenia, and accounts for some 40% of the country's agricultural production. It represents a highly strategic reserve of quality groundwater resources, which to-date remain suitable for drinking purposes without additional treatment.



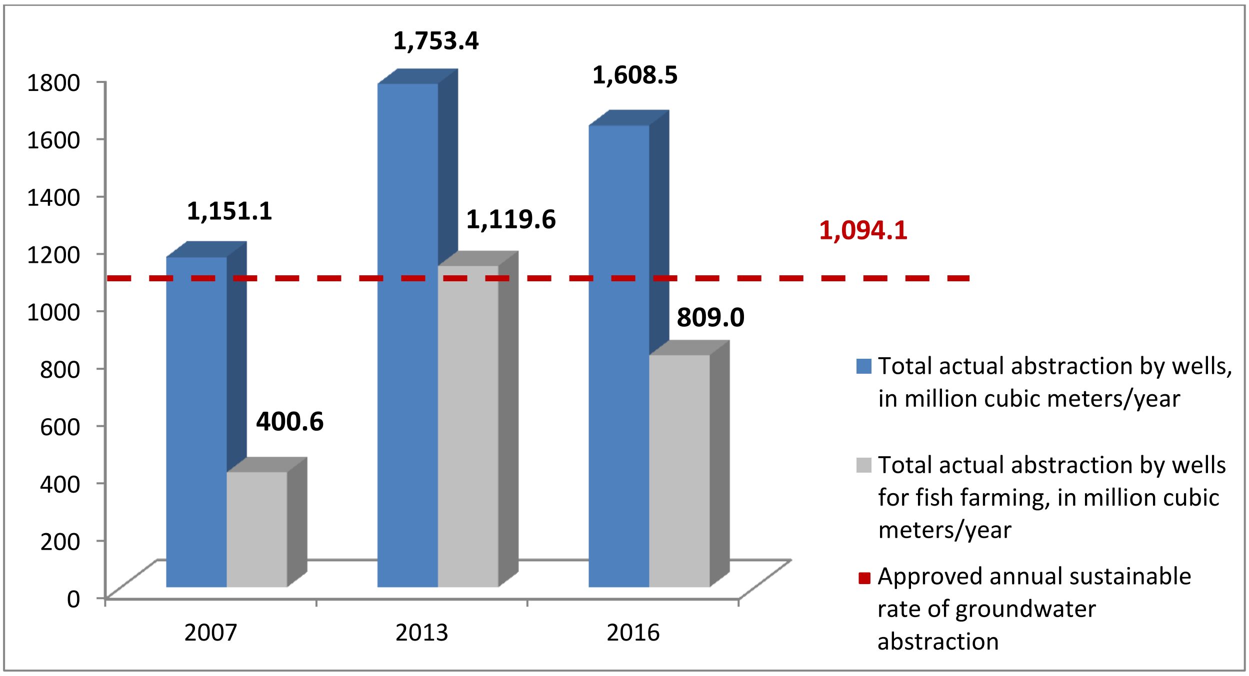
Benefitting from these high quality resources, a significant number of private fish farms have developed over the last decade in the Ararat Valley, with trout and the Siberian sturgeon being the most common species produced. This growth in the fishery sector has been supported in part thanks to fish production being included in the list of priority development programs of the Government of Armenia for the country. Starting from a very limited number (approximately 10 carp farms) in the 1990s, the number of fish farms grew to 190 by 2013. According to the Armenian Ministry of Agriculture, as of 2015 there were 182 fish farms registered in the Ararat Valley, 28 of which were not in operation. High quality, artesian groundwater resources are the main source of water supply for these fisheries.

Total groundwater abstraction in the Ararat Valley reached record levels in 2013, rising to 1.7 billion cubic meters, 1.1 billion cubic meters of which (or roughly 65%) was accounted for by fish farming alone[1]. According to the results of an inventory of groundwater wells and fish farms in the Ararat Valley, total groundwater abstraction in the region in 2016 was 1.6 billion cubic meters, 809 million cubic meters of which came from the fish farming sector.

While Armenia has made various legal and regulatory attempts over the years to rein in groundwater abstraction in the Ararat Valley, water usage remains unsustainable. In 1984, the State Committee on Reserves approved an annual volume of sustainable groundwater abstraction of 1.09 billion cubic meters for the Ararat Valley. This rate was also enacted into law in 2015 through the Republic of Armenia Law on the National Water Program. Despite this,

[1] According to opinion of the Team of Experts that conducted Assessment Study of Groundwater Resources in the Ararat Valley in 2014 (Assessment Study of Groundwater Resources of the Ararat Valley; Final report, USAID Clean Energy and Water Program, 2014), this data does not fully reflect the actual volume of groundwater abstraction. In the opinion of the Team of Experts, the actual abstraction is about 20% higher.

groundwater abstraction in the Ararat Valley has exceeded this legally approved level since 2007. In fact, groundwater abstraction for fish farming in 2013 alone exceeded the limit. While further new polices and regulations have been put in place by the GOA between 2013-2015 to address over-abstraction, the actual volume of groundwater abstracted in the Ararat Valley in 2016 still exceeded the enacted sustainable rate by over 45%.



Data source: Assessment Study of Groundwater Resources of the Ararat Valley. Final report, USAID Clean Energy and Water Program, 2014; Preliminary Results of Inventory of Groundwater Wells, Natural Springs and Fish Farms in the Ararat Valley, USAID Advanced Science and Partnerships for Integrated Resource Development Project, 2016.

Increased groundwater abstraction during the recent period of rapid development of the fish farming sector has impacted the long-term viability of groundwater aquifers as well as groundwater use by other sectors in the Ararat Valley. In particular, the following impacts have been noted:

- It is estimated that the artesian zone (confined groundwater area) of the Ararat Valley has been reduced by approximately 67%, from 32,760 hectares in 1983 to 10,706 in 2013.
- Piezometric levels of groundwater have decreased by on average up to 9.0 meters, sometimes reaching as much as 15 meters in certain regions. These reductions have been accompanied by decreases in well capacity of 6 to 200 liters per second. Water yields for more than 300 artesian wells have decreased by as much as a factor of 10 (from 6,118.6 liters per second to 606.4 liters/second). Furthermore, more than 200 wells have lost self-emission capacity due to reduced ground water pressure.
- The yield from natural springs has been reduced significantly. In 2013 water discharge of the Metsamor (Sevjur)-Aknalich group of springs was 3 cubic meters per second (well below the historic rate of 17.8 cubic meters per second in 1983). Water discharge from certain springs has stopped in 2016, including the Sevjur (Metsamor) river headwaters, Aknalich, Kulubeklu and Taronik (Zeiva) groups of natural springs.
- In 2014, irrigation of approximately 8,000 hectares in 29 communities of the Ararat Valley was endangered as a result of reduced yield from the Metsamor-Akhalich group of springs.

- As an emergency measure in response to 2014's irrigation water deficit, the GOA authorized the release of water from Lake Sevan in excess of the maximum annually allowed volume defined by the country's Law on Lake Sevan. An additional 70 MCM was released, thus imposing significant pressure on Lake's ecological balance[2].
- Approximately 1 billion Armenian Drams (AMD) was allocated from the state budget at the same period to implement measures addressing irrigation water deficit, including upgrading pumps and pump stations for existing irrigation infrastructure.
- Discharges from fish farms have overloaded the agricultural drainage network of the Ararat Valley. This has led to increasing water level in the drainage network, water logging of soil and settlements, salinization and alkalinisation of soil, reduction of drainage network capacity, and ultimately a reduction of crop productivity.
- 48 out of 60 households surveyed in 2016 indicated decreased availability of ground=water for the period 2010-2014. 11 out of 20 surveyed community Mayors indicated that the water reduction has been significant.
- Water User Associations (WUAs) surveyed in August 2016, representing more than 22,000 farmers, have reported decreased groundwater availability from wells as well as additional investment needed to address water scarcity.

The Government of Armenia, with the support of development partners, has put in place several measures to address the issue of water scarcity in the Ararat Valley. Starting in 2013, new policies and stricter regulations on water use were put in place and various activities were implemented to reduce groundwater abstraction. These include: (1) revising the groundwater abstraction fee rates for fish farming in Ararat and Armavir marzes; (2) changing the conditions and groundwater use regimes under water use permits (WUPs) issued in the region, (3) closing abandoned wells; and (4) expanding the groundwater monitoring network in the Ararat Valley. With the support of development partners (including the Food and Agriculture Organization, the European Union, and USAID), technological approaches were also introduced, including semi-closed water recycling, water and energy efficient technologies, hydrogeological and groundwater abstraction monitoring systems, and data driven advanced decision support tools for policymakers.

In 2015, the total permitted volume of water use in the Ararat Valley reached 1,182 MCM, of which 1,000 MCM represented groundwater and 182 MCM from surface water resources. Approximately 90% of the total permitted volume of groundwater abstraction was granted to the fish farming sector.

In spite of the positive measures implemented in the Ararat Valley over the last 3 years, it is notable that—as mentioned previously—the groundwater abstraction rate in 2016 still exceeded the sustainable limit stipulated by the National Water Program Law by an estimated 45%.

[2] According to the State Committee on Water Systems of the MA, water released from Lake Sevan is used by farmers in Aragatsotn and Kotayk Marzes (55%) and Ararat Valley (45%).

Groundwater Use in the Ararat Valley: Additional Future Pressures

In addition to existing pressures, in the coming decades Armenia's water resources (especially those in the Ararat Valley) will face additional threats, some of which are beyond the control of the Government of Armenia.

As indicated in Armenia's Second and Third National Communications on Climate Change to the United Nations Framework Convention on Climate Change (UNFCC),[3] average annual temperature in the Ararat Basin is projected to increase by 1^{0}C by 2030, 2^{0}C by 2070 and 3-5^{0}C by 2100. In tandem with increasing temperatures, annual precipitation is projected to decrease by 11%, 22% and 30% by 2030, 2070 and 2100 respectively.[4] According to climate change impact studies, crop yields are predicted to decline and irrigation demands to increase with climate change. Coupled with a projected decrease in overall water resources availability, any incremental irrigation demand may be difficult to meet.

A second, more manageable future pressure on Armenia's water resources is the construction of new reservoirs on the upstream sections of the Araks River and its tributaries. The projects may significantly adversely impact water resource availability in Armenia and the Ararat Valley. Armenian water sector experts have indicated that these developments will lead to significantly reduced flows in the transboundary Akhuryan and Araks Rivers and jeopardize Armenia's ability to use water from these rivers to cover regional demands.

Water availability in the Ararat Valley is thus expected to change considerably in the forthcoming decades due to climate as well as more directly man-made pressures. These changes have the potential to be devastating to the agricultural sector of Armenia and its economy. It is in this overall context that the adequate management of groundwater resources in the Ararat Valley assumes even greater urgency.

Fishery Sector: Development Overview

Key economic statistics pertaining to the fishery sector in Armenia include the following:

- Since 2003, Armenia's fishery sector has grown rapidly and become an important sector of activity with an estimated AMD 19 billion in annual revenue, generating approximately 600-800 jobs in 2015.
- In the Ararat Valley, fish production has reached an estimated 11.8 thousand tons, representing approximately 85% of Armenia's total fish production.
- While accounting for about 3% of the Ararat Valley's regional gross product, the fishery sector accounts for approximately 90% of total permitted water abstraction in the Valley (based on WUPs).
- Per-kilogram average fish production costs in the Ararat Valley have been estimated to be approximately AMD 1,260 for trout and AMD 1,650 for sturgeon after the 2014 fee increase. These production costs include a water resource fee of AMD 21.7 for trout and AMD 43.5 for sturgeon (thus representing 1.7% and 2.6% of total production costs, respectively).

[3] In accordance with the UNFCC, the Armenian Ministry of Nature Protection submitted its Second and Third National Communications on Climate Change in 2010 and 2015, respectively.
[4] Both average annual temperature increases and annual precipitation decreases in the UNFCC report were calculated against the baseline period of 1961-1990.

- Currently, fisheries in the Ararat Valley pay AMD 0.5 per cubic meter (m^3) of ground water used, representing a tenfold increase from the pre-2014 rate of 0.05 per m^3. Actual volume of water abstraction by fisheries in 2015 was reported to be 670 MCM, and in total the fishery sector paid approximately AMD 328 million in water resource fees.
- The fishery sector faced a number of challenges in 2014-2015, including an economic downturn and national currency crisis. Due to this, some fisheries have experienced losses, while others have ceased operation.

Important forthcoming developments in the fishery sector include:

- The Sevan Trout project: Launched by the Sevan Trout Closed Joint Stock Company (CJSC) to breed trout in Lake Sevan. Production capacity is expected to reach 50,000 tons a year by 2023, or 3.5 times larger than the total amount of fish currently produced in Armenia.
- Fish feed production: Fish feed is currently imported to Armenia mainly from the USA, EU, and Chile. There are also small local producers of fish feed. With the Sevan Trout project, the Government of Armenia plans to establish large-scale fish feed production in Armenia when trout production passes a threshold of 10,000 tons per year.
- New Tax Code: A new Tax Code has recently been adopted and is expected to be effective in 2018. The groundwater resource fee for fisheries is then expected to become AMD 0.55 per cubic meter with a gradual increase to AMD 0.65 by 2020.

Water Fee Structure

In order to assess an optimal water pricing structure that both (1) meets the objective of sustainable groundwater resources management in the Ararat Valley and (2) promotes the efficiency and competitiveness of the fishery sector, multiple water abstraction fee structures have been examined and ranked according to a number of criteria. The analysis clearly demonstrates that an increasing block pricing structure is most capable of achieving these stated objectives. Particularly, a two-part, increasing block tariff structure ranks relatively highly in terms of ecological sustainability, economic efficiency, financial sustainability, and equity. A caveat, however, is that effective implementation of this structure would require the development of adequate technological and institutional monitoring capacities.

Relative Rating of Water Pricing Structures

Pricing structure		Ecological sustainability	Economic efficiency	Financial sustainability	Equity	Ease of implementation
Uniform fixed (or flat) fee	Yes			√√		√√√
	No	XXX	XXX		XX	
Uniform volumetric rate	Yes	√√	√√	√		
	No				X	X
Increasing block structure	Yes	√√√	√√	√	√√	
	No					X
Two-part tariff structure with increasing block	Yes	√√√	√√√	√√	√√	
	No					X

Adoption of an increasing block pricing structure requires policy makers to define (1) the number of blocks, (2) the size of the blocks (in m^3), and (3) the fee level for each block. Determination of these factors depends on the nature of the water resources being managed as well as the types of water use required by various stakeholders. Thus, no single model is ideal across multiple contexts. For the purpose of informing policy makers in these areas, this study has developed and analyzed 16 pricing structure scenarios.

The analysis of 16 scenario options has been conducted using the following metrics: (1) proportion of fisheries in each block, (2) fiscal revenues generated, (3) impact on fisheries' production costs (4) the proportion of water use by fisheries in each block, and (5) the average and maximum resource fee paid by fisheries in each block. Out of the 16 scenarios, 6 have been short-listed as generating the most preferable outcomes to further inform policy makers.

Scenario name	Block name	Resource fee (AMD per m3)	Block level (liter/ second)	000 m3	% of fisheries	% of water abstraction
Scenario 1	Block 1	*1.0*	*500*	*15,768*	95%	54%
	Block 2	*1.5*	*1,000*	*31,536*	4%	17%
	Block 3	*3.0*	*No limit*	*No limit*	1%	29%
Scenario 3	Block 1	*1.0*	*250*	*7,884*	89%	43%
	Block 2	*1.5*	*1,000*	*31,536*	9%	28%
	Block 3	*3.0*	*No limit*	*No limit*	1%	29%
Scenario 8	Block 1	*1.0*	*50*	*1,577*	48%	7%
	Block 2	*1.5*	*1,000*	*31,536*	50%	64%
	Block 3	*3.0*	*No limit*	*No limit*	1%	29%
Scenario 10	Block 1	*0.5*	*500*	*15,768*	95%	54%
	Block 2	*1.0*	*800*	*25,229*	4%	17%
	Block 3	*3.0*	*No limit*	*No limit*	1%	29%
Scenario 13	Block 1	*0.5*	*250*	*7,884*	89%	43%
	Block 2	*1.0*	*500*	*15,768*	5%	11%
	Block 3	*3.0*	*No limit*	*No limit*	5%	46%
Scenario 14	Block 1	*0.5*	*50*	*1,577*	48%	7%
	Block 2	*1.0*	*500*	*15,768*	46%	46%
	Block 3	*3.0*	*No limit*	*No limit*	5%	46%

Note: The % may not sum to 100% due to rounding. In the above table, note that Block 1 is the same size in Scenario 1 and 10 highlighted in blue (0 to 500 liter/second), in Scenario 3 and 13 highlighted in pink (0 to 250 liter/second), and in Scenario 8 and 14 highlighted in green (0 to 50 liter/second).

Scenarios 1, 3, 8, 10, 13, and 14 have been selected as the most representative of the various potential outcomes resulting from different fee structures. If policy-makers were to be particularly concerned with the impact of the recommended fee structure on smaller fisheries (for equity concerns), then Scenarios 1 and 10 would be preferable as 95% of the fisheries would be included in Block 1 (the block with the lowest fee rate). On the other hand, if policy-makers wished to maximize revenue generation (financial sustainability), then Scenarios 13 and 14 would be more viable options.

Key Recommendations

The report offers the following key recommendations.

Recommendation 1: A combination of instruments

A number of policy and regulatory tools and measures are applied worldwide for the sustainable management of water resources. These are typically grouped broadly into categories such as:

- Command and control instruments: Water use permits; Water use standards, quotas, and restrictions; Administrative measures; and
- Economic instruments: Tradeable Water use permits; Water use fee structure.;

Management effectiveness is best achieved when a systemic approach is implemented using a combination of both command and control and economic instruments. The key advantage of economic instruments is that they provide incentives for users to change water consumption behavior. However, such incentives alone are unlikely to be sufficient for effective water use management, and clearly defined, enforceable water abstraction quotas should also be used simultaneously.

Recommendation 2: Water use pricing

There are various ways to price water abstraction. A two-part structure with an increasing block tariff is considered to be an optimal solution, capable of achieving sound management of groundwater resources and promoting ecological sustainability, economic efficiency, financial sustainability, and equity.

Recommendation 3: Additional activities

In addition to the resource fee recommendation presented above, a number of other activities need to be implemented to achieve sustainable groundwater use in the Ararat Valley. These are presented below.

Observations	Recommendations	Timing*/Cost	Results
New prudent policy on water sector management in the Ararat Valley			
• The ASPIRED Project, jointly with the US Geological Survey, will work with key stakeholders on groundwater analysis in the Ararat Valley, using sophisticated modeling tools. This collaboration provides a good foundation for future, more thorough assessment of Ararat Artesian Basin groundwater recharge and water abstraction limits.	• Limits for groundwater abstraction need to be defined based on the assessed groundwater recharge rates. • Before a new assessment is completed, strict measures need to be implemented to reduce the abstraction level to the defined sustainable rate - 1.1 billion cubic meters per year.	• Short-term	• Implementation of these efforts will provide the foundation for more sustainable use of groundwater resources and the opportunity for recovery groundwater aquifers. • These efforts will minimize the probability of future ecological and economic crises/risks caused by water shortages.
Enhance transparency, reliability and comparability of data			
• Datasets on water use and fish farm operation are collected and maintained by different Government agencies. They should be made more concise, compatible, up-to-date, reliable and transparent. • Despite the requirement that water meters be installed, preliminary results of field observations show that water meters on many wells are either out of order or wells are not equipped at all. There is a general lack of human and financial resources for conducting water use surveillance. • Automated, online groundwater withdrawal monitoring using the SCADA system was piloted on a number of fisheries. More pilots are planned by the ASPIRED Project for further replication.	• A georeferenced database on fish farms in the Ararat Valley should be designed for Armenian agencies that include, inter alia, the permitted and actual volumes of groundwater abstraction as well as production volumes. • Groundwater usage monitoring systems, using SCADA, need to be installed in all operational fisheries in Ararat Valley.	• Short-term • Overall investments required to implement real-time water use metering is estimated at AMD 588 million, or USD 1.24 million. • Annual maintenance is estimated to be AMD 33.6 million, or USD 70.7 thousand.	• Concise, up-to-date, reliable and transparent data will allow better analysis and more informed decision-making. • Installation of this technology will exclude the possibility of groundwater over-abstraction, corruption or fraud and will generate reliable data for analysis of the sector. This will facilitate effective implementation of an increasing block fee structure, as well as allow for reliable analysis of the impact of resource fees for future policy adjustments.

Observations	Recommendations	Timing*/Cost	Results
Closing abandoned wells that have flows			
• Based on the preliminary results of field inventory, total discharge of 128 unused groundwater wells reaches 1,096.4 liters/second or 34.6 MCM/year.	• Efforts taken by the Government toward temporary or permanent closure of unused groundwater wells in the Ararat Valley between 2014-2016 need to continue.	• Short-term effort • The required investment for this activity has been estimated at AMD 231 million, or USD 486 thousand.	• This may save approximately 34.6 MCM of groundwater annually.
Piloting water saving technologies and transfer of knowledge			
• The FAO is currently piloting water saving technology in one fishery in the Ararat Valley. • As a part of the ASPIRED Project, a pilot is currently underway to re-use discharged water from a fish farm for the irrigation of community land. The project is designed for the irrigation of 40 hectares of arable land in the community of Hayanist.	• Results from these pilot projects should to be thoroughly recorded and reported by the Ministry of Agriculture, with an additional focus on how lessons-learned can be applied to other fisheries in the region. • For the large scale implementation of secondary water use by the agriculture sector, a technical and economic feasibility assessment needs to be conducted, including assessment of the institutional, infrastructure and regulatory environment.	• Short-to-long term	• If the FAO pilot is successful, the fish production process can become up to 3-times more water-efficient than the current status-quo in Ararat Valley. The impact of any resource fee on fisheries' production costs would also be significantly reduced. • Considering the required investments, it is estimated that only larger fisheries will be able to implement sophisticated water saving technology in a cost effective way, given the Government provides concessional support for adoption of the technology. • Successful and effective technological solution will reduce water abstraction volume and increase overall production output.

Observations	Recommendations	Timing*/Cost	Results
Financing options for new technologies			
• Affordable financing options to fund new capital investments are critical for fostering technology development and adoption.	• The Ministries of Agriculture, Economic Development and Finance must assess the potential for providing financing options to fisheries willing to install new water saving technologies. Mechanisms may include: subsidized loans, direct financing, tax privileges, leasing options, and special guarantees. • Incremental fiscal revenues generated from increased groundwater use fees may be used in part for special projects to finance water saving technology adoption.	• Short-to-medium	• Reduced financial burden for fisheries in adopting new technologies.

** Note: Short-term – up 3 years, medium-term – up to 5 years, and long-term – up to 10 years.*

Key Message

A key take-away from the analysis is that regardless of the tools or combination of tools selected to achieve sustainable water abstraction in the Ararat Valley, resources, staffing, and capacity are needed to achieve effective implementation. In particular, up-to-date, reliable data and information is needed to (1) assess the status of implementation of the selected tools; (2) to estimate the impacts of the selected tools on water users and on water use; and (3) to facilitate the review of the tools as socio-economic conditions change over time.

Selected Priorities

In addition to the recommendations offered above, a number of next steps would appear to be of immediate, and arguably urgent, importance. Three such steps are briefly presented below. These (and other) actions would have to be further developed, perhaps within the context of an *Ararat Valley Groundwater Conservation Action Plan*. Such an action plan would detail: (1) the appropriate timing and sequence of the implementation of the various recommendations presented in this report, including the selected priorities mentioned below; (2) the roles and responsibilities of various stakeholders, including those of the selected implementing entity; and (3) the nature and role of Armenia's development partners in support of the overall objectives of the action plan.

<u>Selected Priority 1</u>

In the course of this study, various water abstraction datasets were used. These were found to be of varying reliability and consistency. A *primary priority* is thus to put in place a comprehensive and reliable data collection and management system for groundwater resource use in the Ararat Valley. Among other components, this will include:

- A data collection (metering) system to monitor water abstraction, recognizing that the nature and degree of sophistication of the water abstraction monitoring system need not be the same across all groundwater users;
- A centralized database management system;
- Adequate and appropriate staffing and resources, along with strong data analysis capacity.

It cannot be overstated that this is a critical priority, as effective implementation – and measurement of the results – depends on reliable data collection. It must therefore be put in place regardless of the nature of the actions or activities selected by government to conserve the groundwater resources of the Ararat Valley.

It should also be noted that the data collection and management system should target all users of groundwater resources and not solely the fishery sector. Furthermore, the timing of this priority should be such that the impacts of the selected actions and activities on water users and on water use can be measured against a baseline (prior to implementation).

<u>Selected Priority 2</u>

In order to protect the groundwater resources of the Ararat Valley, water abstraction (demand) must not exceed the natural recharge rate of the resources (supply). Monitoring demand (as indicated above) is a key component to achieving this purpose. In addition, reliably establishing the resource recharge rate will be a critical task.

The second priority will thus be to conduct an assessment of the existing sustainable water abstraction rate established in 1984 (and adopted into law in 2015). Implementation of this priority may involve:

- Consultation with experts to determine the reliability of the existing sustainable water abstraction estimate; and then
- If needed, conduct a scientific study to review the existing estimate.

With the implementation of the above two activities, it will be possible to establish a target in terms of desired reductions in groundwater resources abstraction in the Ararat Valley.

<u>Selected Priority 3</u>

Assuming the adoption of a water pricing approach along the lines recommended in this report, a key issue will involve the use of the incremental revenues generated by the revised pricing structure.

As shown in this report, the adoption of a block tariff structure will generate incremental fiscal revenues. While these may be deposited into a general government fund, it is strongly recommended that a mechanism by implemented that allows for the earmarking of a portion of these revenues toward water user adaptation. Specifically, financial support should be provided for the adoption of approaches and technologies to reduce groundwater resources abstraction. Failure to dedicate a portion of funds in this manner may result in significantly reduced support for the recommended water abstraction pricing approach.

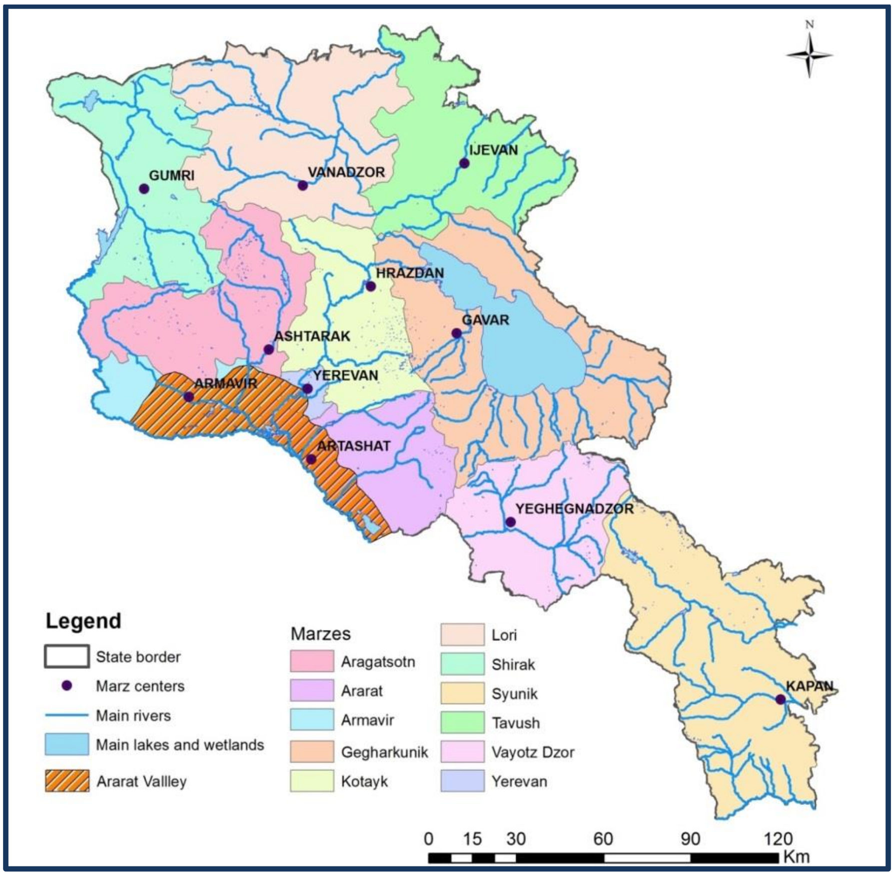
Hence, a third priority is to set in place a transparent and accountable financial mechanism – in compliance with the laws and regulations of the Republic of Armenia – to facilitate the earmarking of some or all revenues generated from the adoption of the revised groundwater pricing approach.

Finally, given water users' intimate understanding of the nature and characteristics of their production processes, they should be in the best position to determine ways, means, and technologies with which to respond to the various measures selected by government to conserve Ararat Valley's groundwater resources.

INTRODUCTION

The Ararat Valley is one of the largest plains of the Armenian Plateau. It stretches west of the Sevan Basin at the foothills of the Geghama Mountains. The plain borders with Mount Aragats to the north and the Mount Ararat to the south. It is divided into two sections by the Araks River, with the northern part lying within Armenia's borders and the southern part in Turkey.[5]

In Armenia, the Ararat Valley covers two administrative divisions: Ararat and Armavir marzes. It is located 800-1,000 meters above sea level and occupies an area of approximately 1,300 square kilometers within Armenia (see Figure below).



Location of the Ararat Valley[6]

The Ararat Valley is one of the most significant basins of artesian aquifers in Armenia, representing a highly strategic reserve of quality groundwater resources which to-date remain suitable for drinking purposes without additional treatment. It is also the largest agricultural production zone in the country, and has traditionally accounted for approximately 40% national agricultural production.

Over the last decade and particularly since fish production was included among a list of priority areas of development by Armenia, many private fish farms have developed in the Ararat Valley.

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[5] Dowsett, Charles. "Armenia". Encyclopedia Britannica. Retrieved 10 January 2015.

[6] Source: Assessment Study of Groundwater Resources of the Ararat Valley. Final report, USAID Clean Energy and Water Program, 2014.

The number of fish farms increased from a limited number in 1990s (approximately 10 carp farms) to 190 by 2013,[7] with the majority producing trout and Siberian sturgeon. According to the Republic of Armenia (RA) Ministry of Agriculture, there were 182 fish farms registered in the Ararat Valley in 2015, (28 of which were not in operation despite being registered). High quality, artesian groundwater resources are the main source of water supply for the fisheries.

Abstraction of artesian groundwater resources by the expanding fishery sector has led to a number of negative ecological impacts in the region. For the period of 1983 to 2013, piezometric water levels decreased significantly (by an average of 6-9 meters and up to as much as 15 meters), groundwater well capacity was reduced (by 6-200 liters per second), and flows from the Sevjur-Aknalich group of springs decreased from 17.8 to 3 cubic meters per second.[8] In 2016, several groups of the natural springs stopped flowing altogether. The artesian zone in the Valley also decreased by approximately 67% (from 32,760 hectares to 10,706) for the period of 1983 to 2013., resulting in a serious water shortages in some 30 communities of the Ararat Valley and the Armenian Nuclear power plant (ANPP).[9]

In a response to these alarming trends, the Government of Armenia (GOA), with the support of development partners, began implementing various measures towards improved management of groundwater resources starting in 2014. These measures are based on a set of technical, legal and institutional recommendations provided in the *Assessment Study of Groundwater Resources of the Ararat Valley* that was prepared by the USAID Clean Energy and Water Program in 2014 at the GOA's request.

In 2015, USAID launched its new Advanced Science and Partnerships for Integrated Resource Development (ASPIRED) Project. The Project supports the GOA in the management of groundwater resource and promotes sustainable practices of water users through the use of science, technology, innovation and partnerships. The ultimate goal of the project is to reduce the rate of groundwater abstraction in the Ararat Valley to sustainable level. Activities will be implemented in coordination with various stakeholders in the following critical areas: water resource data, technology, and water regulation and enforcement.[10]

The project also supports the GOA through the preparation of this study on water use in the Ararat Valley and recommendations for achieving sustainable management of groundwater resources.

This study aims to inform Armenia's policy makers on conservation of the strategic water resources in the Ararat Valley.[11] A further objective is to promote sustainable resource management without hindering the development of the fishery sector.

The study has been conducted by a team of national and international experts in close collaboration with members of an Interagency Task Force (ITF). The ITF was established in December 2015, with representatives nominated from the offices of the RA President, the RA

[7] Ibid.
[8] Measurements calculated between 1983 and 2013.
[9] Ibid.
[10] USAID ASPIRED Project: http://www.aspired.wadi-mea.com/en/
[11] As agreed within the framework of Amendment Number Six to the Assistance Agreement for a More Competitive and Diversified Private Sector signed between the Government of the United States of America and Government of the Republic of Armenia in June 2015.

Ministries of Nature Protection, Agriculture, Economy, Finance and Justice, the Standing Committee on Agriculture and Environment of the RA National Assembly, the Union of Fish Producers and Exporters of Armenia, the Union of Armenian Fish Farmers, and the Association of Young Environment Lawyers and Economists.[12] Four ITF meetings have been conducted since its establishment. Discussion points at these meetings have included: methodological approaches for conducting analysis, interim findings on analysis of fisheries in the Ararat Valley , and recommended schemes for groundwater abstraction fees. In addition to the ITF meetings, bilateral technical meetings were conducted with the ITF members to discuss separate aspects and technicalities of the study.

This report presents findings of a thorough, evidence-based analysis of the existing groundwater resource fee policy applied to fisheries in the Ararat Valley and provides recommendations for improved efficiency through adoption of a new fee structure as well as other key complementary measures. It is indeed recognized that a new fee structure alone is unlikely to achieve effective water resource management without the support of the additional policies recommended herewith.

The report is organized into three major sections. Part A describes groundwater use trends in the Ararat Valley. Existing and future challenges within the basin are also highlighted, with due consideration given to the impacts of climate change and irrigation project developments in Turkey. This section lastly provides a description of relevant policies and measures implemented by the GOA and estimates impact of the measures on water resources in the Ararat Valley. Part B of the report focuses on the status of the fish farming sector in the Ararat Valley and models the impacts of various fee structures. An assessment is included on the impacts of these policies on the fishery sector as well as on overall water usage in the region and on state revenues. Finally, Part C provides a comprehensive set of recommendations, including proposed groundwater fee levels and complementary recommendations toward achieving groundwater conservation in the Ararat Valley.

[12] The list of ITF members is shown on the Annex 1.

PART A. EXISTING SITUATION

1. Groundwater Use in the Ararat Valley: Existing and Forthcoming Situation

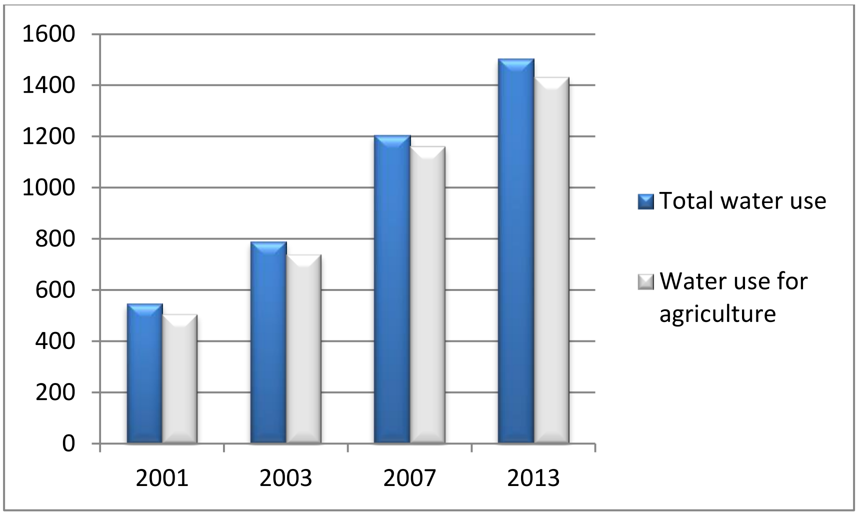
1.1. Water Use Trends in the Ararat Valley

While the Ararat Valley accounts for only 4% of the territory of Armenia, it represents most of the country's arable land. The soil is fertile, and climatic conditions are favorable for crop production. The Valley has specialized in high-value vegetable and fruit production, wine production, and to a lesser extent the raising of livestock and poultry.[13] Both surface and groundwater resources are used for irrigation purposes.

According to the Food and Agriculture Organization (FAO),[14] the quality of groundwater resources in the Ararat Valley ranks highly, making the region suitable for high-value fish production. The artesian water arrives under pressure from a depth of 100-180 meters at a temperature of 13-15^{0}C. Since the mid-2000s, aquaculture production has intensified in the Ararat Valley, turning the Valley into the largest fish farming zone in Armenia and increasing its strategic importance to the country's economy. Many fish farms have been established, with groundwater resources being used for the production of trout, sturgeon, carp, barbell and other cyprinids.

Figure 1.1 -Total water use for agricultural purposes (including irrigation, aquaculture and agriculture) in the Ararat Valley (Ararat and Armavir marzes of Armenia) for the period of 2001-2013 according to the statistical database of the National Statistical Service of the Republic of Armenia (NSS)[15].

Figure 1-1: Water use trends in the Ararat Valley, in MCM/year



Data source: National Statistical Service (NSS) of the Republic of Armenia.

Actual total abstraction of groundwater resources (both permitted and unpermitted) in the Ararat Valley in 2007 was 1,151.1 MCM/year, including 400.6 MCM/year for fish farming

[13] Country Pasture and Forage Resource Profiles, Armenia, FAO. http://www.fao.org/ag/agp/agpc/doc/counprof/Armenia/Armenia.htm

[14] Review of Fisheries and Aquaculture Development Potentials in Armenia. FAO, 2011. http://www.fao.org/docrep/014/i2103e/i2103e00.pdf

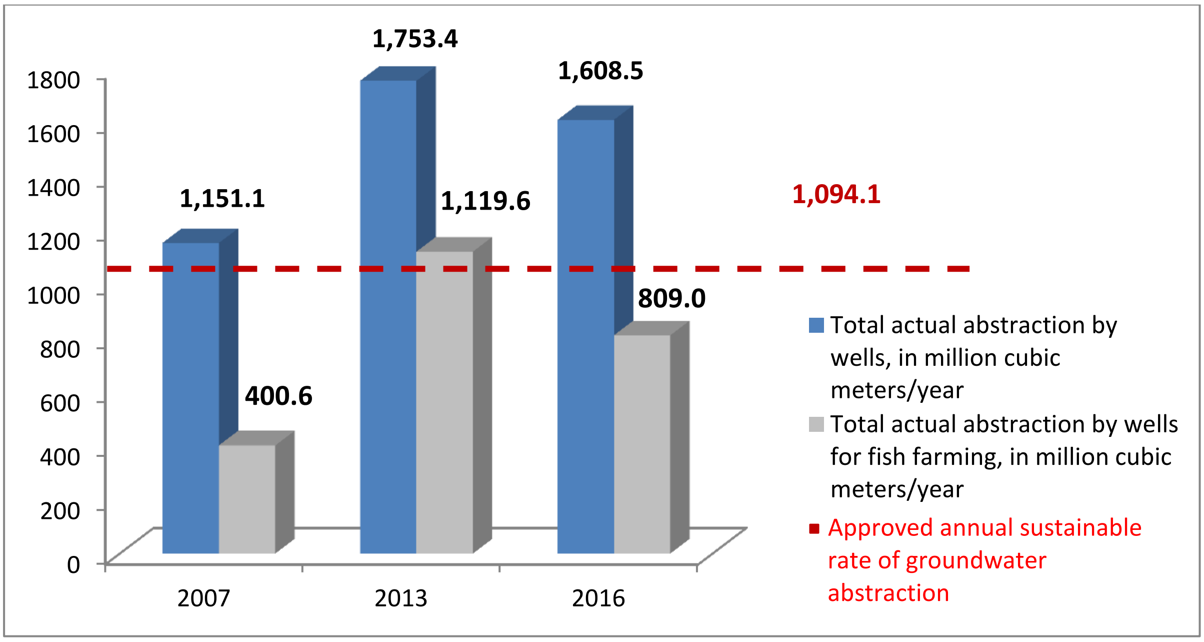
[15] National Statistical Service of the Republic of Armenia: Publications by years: http://armstat.am/en/?nid=82

purposes. In 2013, this figure rose to 1,753.4 MCM/year, with actual water use for fish farming alone comprising 1,119.6 MCM/year[16].

This level of water abstraction exceeds the safe annual yield established in 1984 by the State Committee on Reserves. This safe annual yield, which is also stipulated in the RA Law on National Water Program, was determined to be 1,785 MCM/year, or 1,094 MCM from wells and 691 MCM from natural springs). It was determined that groundwater abstraction below this approved level would not distort the natural hydrodynamic and hydrochemical balance of the subsurface system.[17]

In 2013, total groundwater abstraction by wells was 1.6 times the safe annual yield, with groundwater use by fish farms alone exceeding the sustainable level (Figure 1.2)[18]. In 2016, the actual volume of groundwater abstraction still exceeded the safe annual yield by 45%.

Figure 1-2: Actual water abstraction by wells in the Ararat Valley in 2007 – 2016, in MCM/year



Data source: Assessment Study of Groundwater Resources of the Ararat Valley. Final report, USAID Clean Energy and Water Program, 2014. Preliminary Results of Inventory of Groundwater Wells, Natural Springs and Fish Farms in the Ararat Valley, USAID Advanced Science and Partnerships for Integrated Resource Development Project, 2016.

1.2. Impacts of Groundwater Overuse in the Ararat Valley Over the Period of 2000 to 2016

The impacts of unregulated and unsustainable groundwater abstraction in the Ararat Valley during the period of intensive fishery industry development have been thoroughly analyzed in the interim and final reports on the 2014 *Assessment Study of Groundwater Resources of Ararat Valley*. The analysis was based on archived material and reports, monitoring data,

[16] Assessment Study of Groundwater Resources of the Ararat Valley; Final report, USAID Clean Energy and Water Program, 2014.
[17] Ibid.
[18] According to opinion of the Team of Experts that conducted Assessment Study of Groundwater Resources in the Ararat Valley in 2014 (Assessment Study of Groundwater Resources of the Ararat Valley; Final report, USAID Clean Energy and Water Program, 2014), this data does not fully reflect the actual volume of groundwater abstraction. In the opinion of the Team of Experts, the actual abstraction is about 20% higher.

datasets received from stakeholder agencies and communities, and seasonal observations that were conducted in 2013 and 2014 in 64 randomly selected groundwater wells in the Ararat Valley. In 2016, the ASPIRED Project conducted surveys of 20 communities and five Water User Associations (WUAs) in the Ararat Valley to further identify impacts of groundwater overuse in the region. A comprehensive inventory of groundwater wells, natural springs and fish farms is also currently underway.

The major impacts identified from these studies (both completed and currently underway) are as follows:

- The artesian zone (confined groundwater area) of the Ararat Valley has been reduced by approximately 67%, from 32,760 hectares in 1983 to 10,706 in 2013 (Annex 4).
- 31 communities have been partially or totally left without access to irrigation and/or drinking water.
- Piezometric levels of groundwater have decreased by an average of 6-9 meters, sometimes reaching as much as 15 meters. This has been accompanied by reductions in well capacity by 6.0 to 200.0 liters per second.
- While the total yield for a sample of 300 wells was 6,118.6 liters per second in the 1990s, this figure had dropped to just 606.4 liters per second in 2012, representing a decrease by a factor of 10. Due to reduced ground water pressure, approximately 205 wells have lost self-emission capacity.
- The yield of natural springs has been reduced significantly. In particular, the discharge of the Metsamor (Sevjur)-Aknalich group of springs dropped by more than 80% (from 17.8 cubic meters per second down to 3 cubic meters per second) between 1983 and 2013.
- According to initial data from the inventory of natural springs, groundwater wells, and fish farms that is currently being conducted within the framework of the ASPIRED Project, discharges from a select group of springs in the region have stopped altogether. Among these are springs located at the Sevjur (Metsamor) river headwaters, Aknalich, Kulubeklu, Taronik (Zeiva) groups of springs, and springs used for the water supply of the Armenian Nuclear Power Plant (ANPP).[19]
- This sharp reduction in natural spring discharge may endanger the safety of the ANPP's operation. The plant currently requires about 600 liters/second from the Metsamor-Aknalich group of springs for its operational needs and cooling system. Due to reduced flow from these natural springs, including the Taronik (Zeiva) springs, new groundwater wells have been drilled since 2013 to provide supplemental water for the ANPP at a cost of approximately AMD 506.0 million. The ANNP plans to continue to drill new wells to secure its operational requirements. Details are discussed in the Box 1.
- In 2014, irrigation of approximately 8,000 hectares (ha) in 29 communities in the Ararat Valley was endangered as a result of reduced yield from the Metsamor-Akhalich group of springs. As an emergency mitigation measure, the GOA authorized the release of water from Lake Sevan in excess of the maximum annually allowed volume defined by the country's Law on Lake Sevan. An additional 70 MCM was released, thus imposing significant pressure on Lake's ecological balance[20]. In addition, approximately AMD 1 billion was allocated from the state budget to implement measures to address the irrigation

[19] Interim Report on Inventory of Groundwater Springs, Wells and Fish Farms in the Ararat Valley, USAID ASPIRED Project, 2016.
[20] According to the State Committee on Water Systems of the MA, water released from Lake Sevan is used by farmers in Aragatsotn and Kotayk Marzes (55%) and Ararat Valley (45%).

water deficit, including upgrades to pumps and pump stations.

Box 1: Water Abstraction by the ANPP

To gain better insight into water use by the ANPP, the ASPIRED Project team met with core engineering staff from the plant on September 16, 2016.

Currently, the ANPP withdraws water from two sources to meet the plant's operational water demand: (1) the Taronik (Zeiva) springs of the Metsamor-Aknalich group (which discharge into the Metsamor river), and (2) three groundwater wells, which have been put in operation since September 2013.

Starting in 2008, the ANPP observed an alarming reduction in discharge from 36 springs belonging to the Metsamor-Aknalich group of natural springs, which at the time were the primary source of water supply for the ANPP. From 2011-2013, the ANPP observed a further rapid reduction in yield from these springs, which became completely dry in 2013. The ANPP submitted a request to the GOA to allow for the drilling of new groundwater wells. Three groundwater wells (with depth ranging from 140 to 170 meters) were put into operation in September 2013. Investments are estimated to have been AMD 506 million for the design, drilling, and installation of pumps .

Total water abstraction by the ANPP is currently about 600 liters/second or 2,160 m^3/hour. The permitted amount is 1,000 liters/second, or 3,600 m^3/hour. The maximum estimated operational water requirement for the ANPP is estimated at 2,700-3,000 m^3/hour, which will remain unchanged during the coming 3 to 5 years. The ANPP pays a water fee of AMD 1.0 per m^3 as defined by legislation as well as operational costs (electricity cost for the wells and catchment structure at the Metsamor/Sevjur river, maintenance of about 9 km long water pipeline from the catchment structure to the plant, and treatment of water taken from the Metsamor/Sevjur river as the current water quality is very poor).

In order to secure long-term water supply for the plant's operational needs, the ANPP applied to the GOA in 2014-2015 with a request to drill 10 new groundwater wells. Despite the capital investments needed (estimated at about AMD 1.7 billion) operation and maintenance costs would be lessened due to shorter water transfer distance. While these new wells would be considered to be more reliable at this point in time, continued unsustainable groundwater use in the Ararat Valley—particularly by the fishery sector—will cause more wells to fail and thus pose high risks for safety of the ANPP.

- Discharged water from fish farms has overloaded the agricultural drainage network of the Ararat Valley. Since 2003, the volume absorbed by the drainage network has begun to increase—first gradually, and then sharply. The volume reached 1,832.6 MCM/year in 2013 (877 MCM of which was from fish farms), exceeding the design capacity of the network by 60%.[21] This has led to increased water levels in the drainage network, increased groundwater levels in the surrounding areas, water logging of soil and settlements, salinization and alkalinisation of soil, reduction of drainage network capacity, and ultimately a reduction of crop productivity. Costs for operation and maintenance of the drainage network have also increased.

[21] Assessment Study of Groundwater Resources of the Ararat Valley. Final report, USAID Clean Energy and Water Program, 2014.

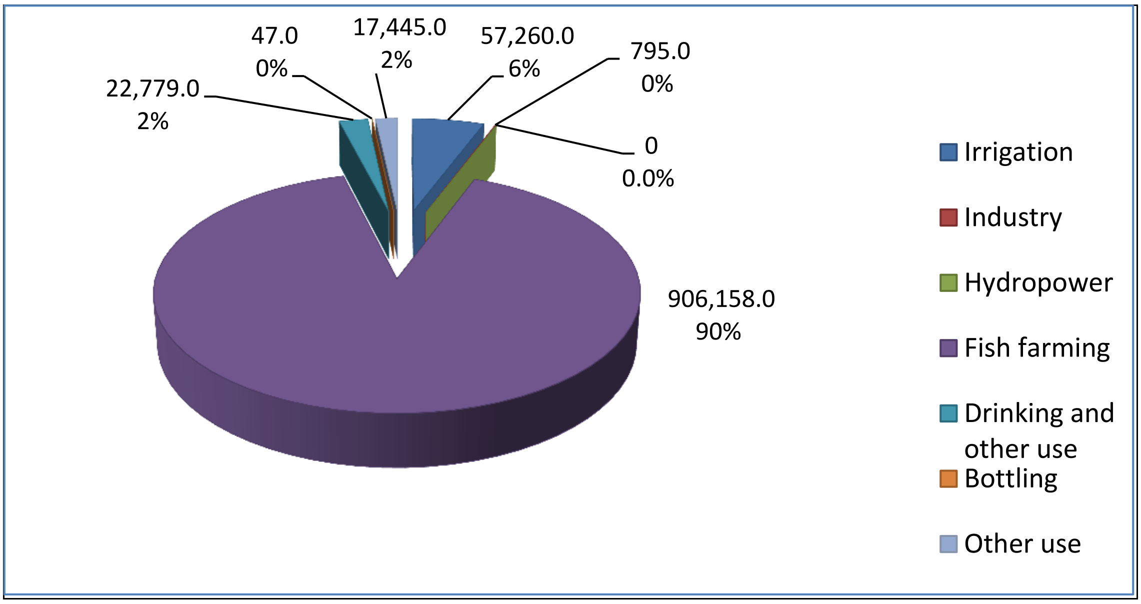
- In a 2016 survey of 20 communities in affected areas of the Ararat valley conducted by the ASPIRED Project team, 48 of 60 households indicated a reduction in water availability over the period 2010 to 2014. Among community heads, 11 out of 20 indicated that significant water reduction had occurred. Seven also indicated that there are fisheries near their communities.[22]
- In interviews with five WUA heads (representing some 22,000 farmers) also conducted by the ASPIRED Project team, all five indicated a decrease in groundwater availability from wells. Two of the five also indicated that the decrease had occurred since 2007. The respondents also indicated additional costs being incurred in order to make existing wells deeper when the pressure dropped down.[23]

1.3. Existing Water Uses in the Ararat Valley

According to the water use permits (WUPs) issued by the Ministry of Nature Protection (MNP), total permitted water use in the Ararat Valley in 2015 was 1,182 MCM, including 1,000 MCM of groundwater and 182 MCM of surface water resources.[24] Figures 1.3 and 1.4 present a breakdown of permitted volumes of water use by various sectors from the groundwater and surface water resources respectively. The bulk (approximately 90%) of groundwater abstraction serves the water supply needs of the fish farming sector. Surface water use is more evenly distributed across sectors.

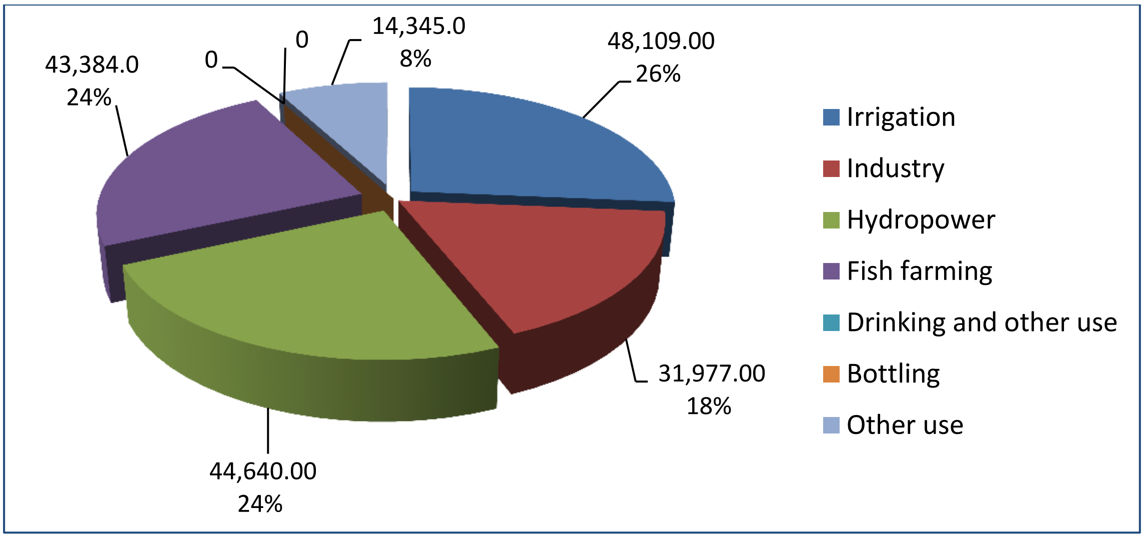
According to preliminary results of the inventory of groundwater wells, natural springs, and fish farms in the Ararat Valley conducted in 2016, the actual volume of groundwater use in the Ararat Valley in 2016 was 1,608.54 MCM. This figure exceeds the permitted volume by approximately 608 MCM/year or 60%.

Figure 1-3: Permitted volumes of groundwater use in the Ararat Valley, 000 m3



[22] Detailed summary table of this survey is shown in the Annex 2.
[23] Additional details are provided in Annex 3.
24 Water Use Permits Database, Water Resources Management Agency of the RA Ministry of Nature Protection, 2016.

Figure 1-4: Permitted volumes of surface water use in the Ararat Valley, 000 m3

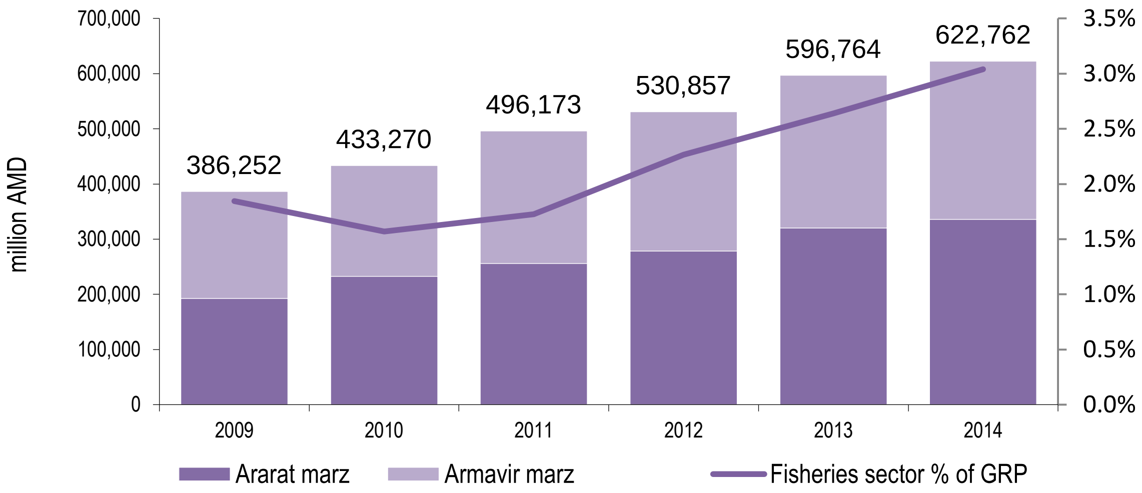


Data Source: Water Resources Management Agency of the RA Ministry of Nature Protection

1.4. Contribution of Fish Farming to Budget and GDP

Fish farming has been one of the fastest growing sectors in the Ararat Valley in the last 5 years. In 2009, total fishery output was about 1.8% of regional gross product in the Ararat Valley. It increased to 3% in 2014.

Figure 1-5: GDP growth trend and fisheries contribution



Data Source: National Statistics Service of RA, webpage: http://armstatbank.am/; *Consultants analysis and assessment*
Note: National Statistics does not provide figures for fishery sector production value and GRP (Gross Regional Product) by regions of Armenia. However based on the available data of production volume and sector outputs in the Ararat and Armavir marzes provided by NSS, we have assessed the regional products and fishery sector output for last 5 years.

It is estimated that the fishery sector is producing AMD 19 billion in revenue annually, with about 600-800 jobs in the sector, including self-employed small producers. Total revenues from resource fees paid by fish farmers for groundwater use in the Ararat Valley in 2015 came to about AMD 328 million.

1.5. Forthcoming Challenges for the Water Sector in Armenia and the Ararat Valley

Armenia's water resources, especially those in the Ararat Valley – the country's largest repository of high-quality groundwater reserves – are threatened by additional sources of pressure, the most urgent of which are climate change and intensive human activity.

Armenia is highly vulnerable to climatic changes relative to other countries of the region. As a country with multiple semi-arid regions and limited resources, Armenia exhibits high exposure, high sensitivity and limited adaptive capacity to climate change. Climate change projections indicate continued increases in temperature and decreases in precipitation for the region.[25]

According to Armenia's Second and Third National Communications on Climate Change, the average annual air temperature in Armenia increased by 1.03^{0}C over the period 1935-2012, exceeding the global average temperature increase by approximately 0.33^{0}C. These studies also indicate that Ararat Valley is one of the most vulnerable regions in the country due to projected climate change.

The Ararat Valley is projected to suffer the greatest reduction in precipitation in the country. Due to projected reduction in atmospheric precipitation and increase in air temperature throughout the next decade, the Ararat basin is highly likely to suffer from prolonged droughts, leading to more intensified desertification. The potential water stress in the basin is expected to create further indirect impacts on the region's water-dependent sectors: fisheries, agriculture, energy (hydropower), industry, recreation and human health.

Armenia's Second and Third National Communications on Climate Change also report that the average annual temperature in the Ararat Basin is projected to increase by 1^{0}C, 2^{0}C and $3\text{-}5^{0}$C during 2030, 2070 and 2100, respectively, against the baseline average temperature for the basin (calculated for the period of 1961-1990).[26] Meanwhile, annual precipitation is projected to decrease by 11%, 22% and 30% in 2030, 2070 and 2100, respectively, against the baseline average precipitation in the basin (again calculated for the period of 1961-1990).

According to the studies, crop yields are predicted to decline and irrigation demands to increase with climate change as well. In the Ararat Valley, irrigation water requirements for vegetables are predicted to increase by 38–42 percent by 2100.[27] The MNP estimates that by 2030, yields of the main regional crops will decrease by 8-14 percent without adaptation (9–13 percent for cereals, 7–14 percent for vegetables, 8–10 percent for potatoes, and 5–8 percent for fruits). In order to maintain crop yields, substantially more irrigation and adaptive measures will be needed.

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[25] Toward Integrated Water Resources Management in Armenia, World Bank, 2015

[26] Armenia's Second National Communication on Climate Change (2010) and Armenia's Third National Communication on Climate Change (2015), RA Ministry of Nature Protection, UNDP. http://unfccc.int/resource/docs/natc/armnc3.pdf.

[27] Vulnerability of Water Resources in the Republic of Armenia under Climate Change. RA Ministry of Nature Protection, UNDP/GEF, 2009

With the projected decline in water resources availability, these incremental demands for irrigation may be difficult to fully meet in the future. According to estimates made by the MNP in 2009, a 25% reduction in river flow is projected to result in a 15–34 percent reduction in the productivity of irrigated cropland (average 24 percent). The total future losses to the agricultural sector are estimated at around 75 billion to 170 billion Armenian drams (USD 180 million to USD 405 million). This is equivalent to a loss of 2–5 percent of GDP (by 2009 figures) or more if indirect losses are included (for example, food processing industry, input markets).

Another factor that may significantly affect water resources availability in Armenia and the Ararat Valley is the construction of new reservoirs on the Araks River and its tributaries in Turkey. These will be built in addition to the already existing Kagizman (150 MCM), Baybuet (52 MCM) and Sirinkoy (1.9 MCM) reservoirs. The new reservoirs include: (1) a reservoir with a capacity of 285 MCM in the Araks River; (2) the Kars reservoir, with a capacity of 232 MCM, on the Kars tributary of Araks River; and (3) the Karakurd reservoir with a capcity of 1 BMC on the Araks River. These are planned to meet irrigation and energy demands in the Igdir and Kars regions of the Turkey. According to expert assessment by water sector professionals in Armenia, these developments are going to lead to significantly reduced flows in the transboundary Akhuryan and Araks River and put under significant risk Armenia's ability to use water from these rivers to meet its demands.[28]

Water availability in the Ararat Valley is thus expected to change considerably in the forthcoming decades. These changes are not expected to be favorable to the agricultural sector of Armenia and its economy. It is in this overall context that adequate management of groundwater resources in the Ararat Valley assumes even greater importance and urgency.

[28] This section was prepared using publications in local mass media about reservoirs development projects in Turkey (http://www.ankakh.com/article/?id=16950/%E2%80%8Bthurqian-araqsi-djryern-ambarum-e--isk-hayastani-djryere-thapvum-yen-kaspits-tsvov and http://168.am/2013/04/05/206400.html) as well as information from the website of the General Directorate of State Hydraulic Works of the Republic of Turkey Ministry of Forestry and Water Affairs. http://en.dsi.gov.tr/

2. Existing Policies and Ongoing Actions in Water Sector of the Ararat Valley and Estimated Impacts on Water Resource

2.1. Existing Policies and Government Actions

With the support of development partners, the Government of Armenia has put in place several measures to address increasing water scarcity in the Ararat Valley.

In December 2010, following growing concern over depletion and changes in the quality of groundwater resources, the GOA requested USAID's assistance in assessing the status of groundwater resources in the Ararat Valley. Interim findings of the assessment study demonstrated worrisome evidence of significant risks to the sustainability of the Valley's strategic groundwater resources and – by extension – Armenia's national security. The study provided supporting data for the findings and provided a list of technical, legal and institutional measures to be implemented in order to prevent further depletion of the groundwater aquifers.

The most important of the measures implemented by the GOA are briefly described below.

Resource Fee Increase

Since 2013, the GOA has hardened its policy toward control of groundwater use in the Ararat Valley. An amendment to the RA Law on Payments for Nature Protection and Natural Resources Utilization came into force January 1, 2014 that increased - groundwater use charges in Ararat and Armavir marzes.[29] While the amendment maintained the previous fee of AMD 1.0 per cubic meter, it increased the proportion of withdrawals that the fee applied to from just 5% to 50% of total water abstraction (thus making the effective fee AMD 0.5 per cubic meter).

Implementation of New Regulations

Amendments to the RA Water Code were adopted in 2015 that included new provisions for the improved monitoring of water resources, data management and sharing through the State Water Cadaster Information System (SWCIS), and water use permitting procedures. A provision was also included to promote the re-use of water discharged from aquaculture activities for irrigation or industrial purposes. New protocols to protect groundwater resources were also established, including a moratorium on all new drilling permits for groundwater wells in Ararat and Armavir marzes until integrated basin management plans could be developed and approved for each region.

The RA Law on National Water Program was also amended in 2015, establishing the safe rate of groundwater abstraction in the Ararat Valley at 1.1 billion cubic meters per year.

The following additional relevant regulations were adopted during the period of 2013-2016 by the GOA:

[29] RA Law on Amending the RA Law on Payments for Nature Protection and Natural Resources Utilization adopted in 1998. http://parliament.am/legislation.php?sel=show&ID=4870&lang=arm

- GOA Decision N: 340-N, April 4, 2014 adopting a procedure for issuing WUPs for the wells that were illegally used as of 2014, as well as closure of unused and/or abandoned wells in the Ararat Valley.
- Extract N: 27 of the GOA Protocol from the Government session held on June 26, 2014 that approves Terms of reference for introducing an automated, centralized water use management system for the Ararat Valley of Armenia.
- GOA Decision N: 1111-N, September 18, 2014 on water deficit and drought in the Ararat, Hrazdan and Akhuryan basin management areas.
- GOA Decision N: 338-N, April 14, 2016 on approving Ararat basin management area plan and priority measures for effective management for 2016-2021.
- New regulations (currently being drafted by the MNP) on streamlining procedures for water use permitting and compliance assurance and improving the SWCIS.

Closure of Abandoned Wells and Valve Regulation

In tandem with new policies and regulations, technical measures have been implemented by the GOA from 2013-2016 to improve conservation of groundwater resources in the Ararat Valley.

Starting October 2013, the MNP began a process of identifying illegally operating, non-operating, and abandoned wells in Ararat and Armavir marzes and placing them under temporary closure (conservation), permanent closure (liquidation) or valve regulation. Table 2.1 presents information on wells that have been identified and acted upon from 2013-2016 along with the resulting savings of the groundwater.

Table 2-1: Data on permanent closure, temporary closure, and valve regulation of groundwater wells and estimated groundwater savings in the Ararat and Armavir marzes in 2014-2016

2014-2015	Saving, liters per second	Number of wells	Estimated water saving million cubic of meters/year
Permanent closure	3,205	50	101
Plugging or temporary closure	2,062	40	65
Valve regulation	16,977	225	535
2016			0
Permanent closure	62	4	2
Plugging or temporary closure	n/a	11	n/a
Valve regulation	2,816	n/a	89

Data Source: RA Ministry of Nature Protection, information provided on July 28, 2016

These activities have resulted in annual savings of approximately 792 MCM of groundwater resources in the Ararat Valley. According to the MNP, the average actual cost for permanent or temporary closure of one groundwater well is about AMD 2.5 million (as it is required by the above mentioned GOA Decision N: 340-N, April 4, 2014). Total expenditures from the state budget for implementing these technical measures by December 25, 2015 were AMD 107,497,400 according to GOA Decision N: 1233-N, dated October 31, 2013.

Revision of Permitted Volumes of Groundwater Abstraction

Following GOA Decision N: 1111-N in 2014, the MNP revised the water use permits of operational fish farms in the Ararat Valley, reducing the volumes and regime of groundwater abstraction. According to information provided by the MNP, the total permitted volume in Ararat and Armavir marzes was reduced from 1,460 to 843.35 MCM/year, resulting in a total annual reduction of 618.8 MCM.

Expanded Groundwater Monitoring Network in the Ararat Valley

The national groundwater monitoring network in the Ararat Valley has been expanded. As of 2015, groundwater level and temperature observations are conducted in 52 hydrogeological monitoring wells and 3 natural springs by the Hydrogeological Monitoring Center (HMC) of the MNP.

According to the MNP report on measures implemented by the Ministry in 2015, groundwater levels in the central part of the Ararat Valley increased in 2015 by 0.26 to 1.16 meters (measured from the hydrogeological monitoring wells in the communities of Hovtashat and Dashtavan in Ararat Marz and the communities of Gai, Aratashen, Aknashen and Vardanashen in Armavir Marz).[30]

2.2. International Cooperation Actions

From 2014-2016, the GOA also continued its close collaboration with international development projects in addressing water scarcity and groundwater use issues in the Ararat Valley.

Pilot Project with FAO

The MA has started working with fish farms on introducing semi-closed water recycling technologies. To assist fish farmers with this goal, the FAO has been asked to pilot a solution that allows for reduced water requirements for fish production while maintaining the quantity and quality of fish produced. At the time of the preparation of this report, the project is currently underway.

Flow Meters Provided by USAID Clean Energy and Water Program

In 2015, two flow meters were provided to the Hydrogeological Monitoring Centre (HMC) of the MNP by the USAID Clean Energy and Water Program. The meters are designed for the measurement of flow in full and semi-full pipes, and were provided as technical support for the improvement of groundwater monitoring in Armenia and in the Ararat Valley in particular.

New Hydrological Monitoring with EPIRB

The European Union (EU) Project on Environmental Protection of International River Basins (EPIRB) assisted the HMC with developing a new hydrogeological monitoring well in Aknashen village that was equipped with a GSM telemetric water level meter. Three systems for automated online groundwater use monitoring, using the Supervisory Control and Data Acquisition (SCADA) system, were piloted on groundwater wells at three separate fish farms in Armavir Marz. The systems provide real-time and logged data to the WRMA, Akhuryan BMO and SEI on actual water abstraction from the target well.

[30] Report of the RA Ministry of Nature Protection on main results for 2015, http://www.mnp.am/?p=168

ASPIRED Project Activities

USAID launched its ASPIRED Project in October 2015. The project supports activities targeted at more sustainable management of groundwater resources and water use practices. Within the framework of this project, a comprehensive field inventory of groundwater wells, natural springs and fish farms in the Ararat Valley is currently underway.

As of October 2016, about 2,807 groundwater wells and 14 groups of natural springs were measured in the field. When completed, the inventory will provide a comprehensive status of groundwater use in the Ararat Valley from both wells and natural springs by various sectors, including drinking/municipal use, irrigation, industrial, fish farming, etc. It will also provide a clear picture of the wells that are not used and/or abandoned in the region along with an estimate of groundwater discharge by such wells.

The Project, with support from the US Geological Survey (USGS), will be working with key stakeholder agencies in determining groundwater recharge rates and safe groundwater abstraction rates using hydrogeological modeling tools. From 2016-2020, the Project will be working with the WRMA along with its Ararat, Hrazdan and Akhuryan BMOs on the installation of an automated online groundwater use monitoring system for 20 fish farms in the Ararat Valley in order improve compliance monitoring of groundwater use by the fish farms.

As a part of the ASPIRED Project, a pilot project is currently underway to re-use discharged water from fisheries for the irrigation of community lands. The project is designed for the irrigation of 40 ha of arable land in the community Hayanist (which has been left fallow in recent years due to lack of irrigation water that had once flowed from the community owned groundwater well). The quality of the discharged water was tested at the design phase and is deemed suitable for irrigation purposes according to FAO standards. The overall project cost is estimated to be approximately USD 138,000, including an improved irrigation network. The proposed improvement will provide irrigation services to 120 households (approximately 85 agricultural farmers) of the Hayanist community. Annual savings in terms of groundwater abstraction are estimated at 1.1 MCM. The payback period is estimated to be less than 1 year.[31]

Along this pilot project, other water efficient technologies will be introduced within the framework of the ASPIRED Project from 2016-2019.[32]

While acknowledging the contribution of these activities to the preservation and more efficient allocation of the Valley's groundwater resources, there is a need to significantly intensify the process of adopting new policies and measures targeted at addressing water scarcity and groundwater depletion in Armenia and in the Ararat Valley in particular.

[31] Concept level design for Irrigation Improvement project in Hayanist community, developed by ASPIRED Project, 2016.
[32] USAID ASPIRED Project: http://www.aspired.wadi-mea.com/en/

PART B. FISHERY SECTOR AND IMPACT ASSESSMENT OF REVISED FEE LEVEL AND STRUCTURE

3. Description of the Fishery Sector

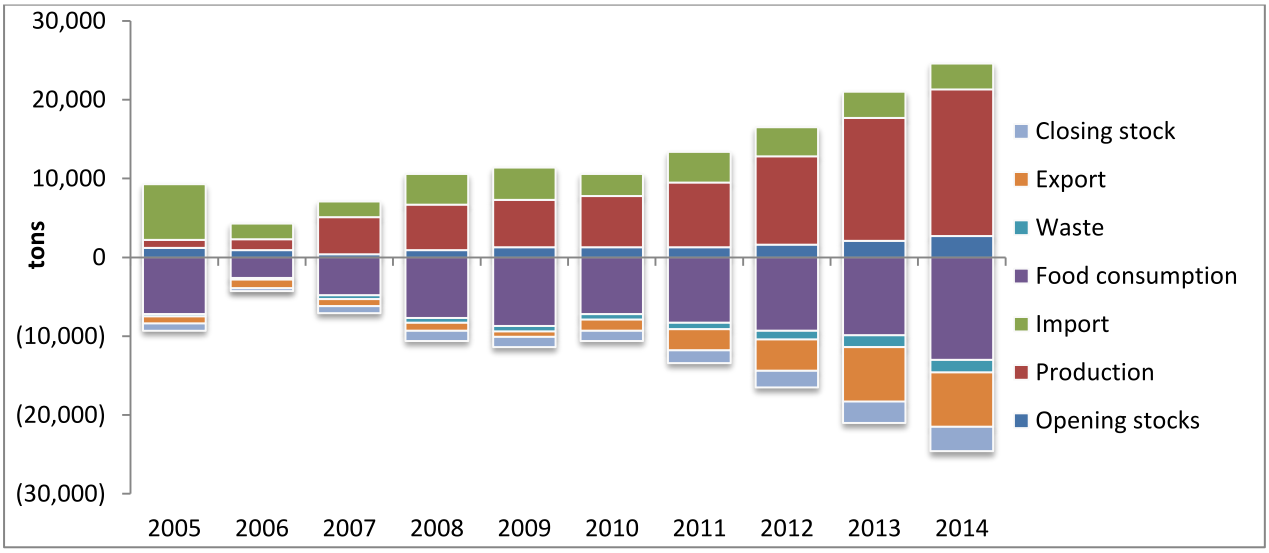
3.1. Historical Development of Fishery Sector in Armenia

Aquaculture has grown rapidly over the last ten years in Armenia and has become an important sector of the economy. The aquaculture sector includes both caught and bred fish as well as crustaceans. Since 2005, the sector's production volume has grown from 1,000 tons to 18,600 tons. Annual production growth was about 34%, while annual consumption growth was about 6%. Exports, a major source of growth for the industry, recorded 37% of annual growth. Since 2012, the self-sufficiency ratio (production to consumption) of aquaculture has been higher than 100% in Armenia.

Armenian per capita consumption reached 12.3 g/day in 2014, and from 2005 to 2014 per capita consumption grew by a factor of 1.9. Armenia's local consumption level is still low, however, relative to other countries where per capita consumption level may reach up to 85 g/day. It should be noted that this figure is highly dependent on income/price ratios, food culture and existence of substitute products in the country.

Figure 3.1 demonstrates development of the sector in Armenia over the previous decade.

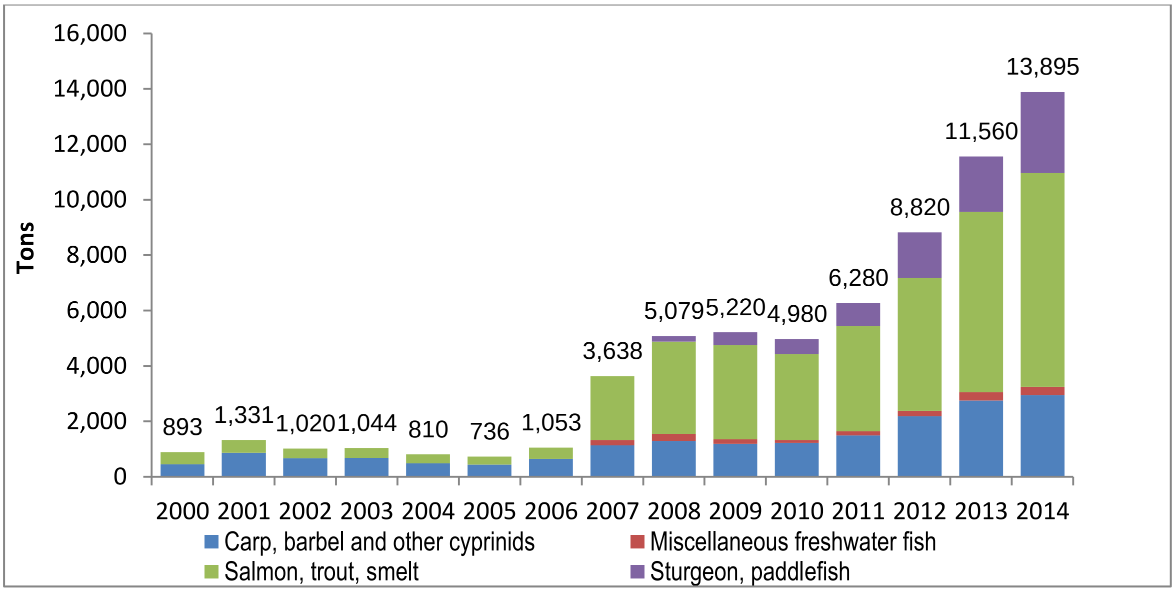
Figure 3-1: Aquaculture sector balance in Armenia



Data Source: National Statistics Service of RA, webpage: http://armstatbank.am/

In 2014, total aquaculture production in Armenia reached approximately 18.6 thousand tons, while imports were approximately 3.3 thousand tons. Of Armenia's total production, about 14 thousand tons came from fish production while the rest came from freshwater crustacean production. Imported aquaculture production comprised mainly processed or frozen fish and seafood, while local production comprised mainly chilled or fresh fish.

Figure 3-2: Fish production structure and trend in Armenia



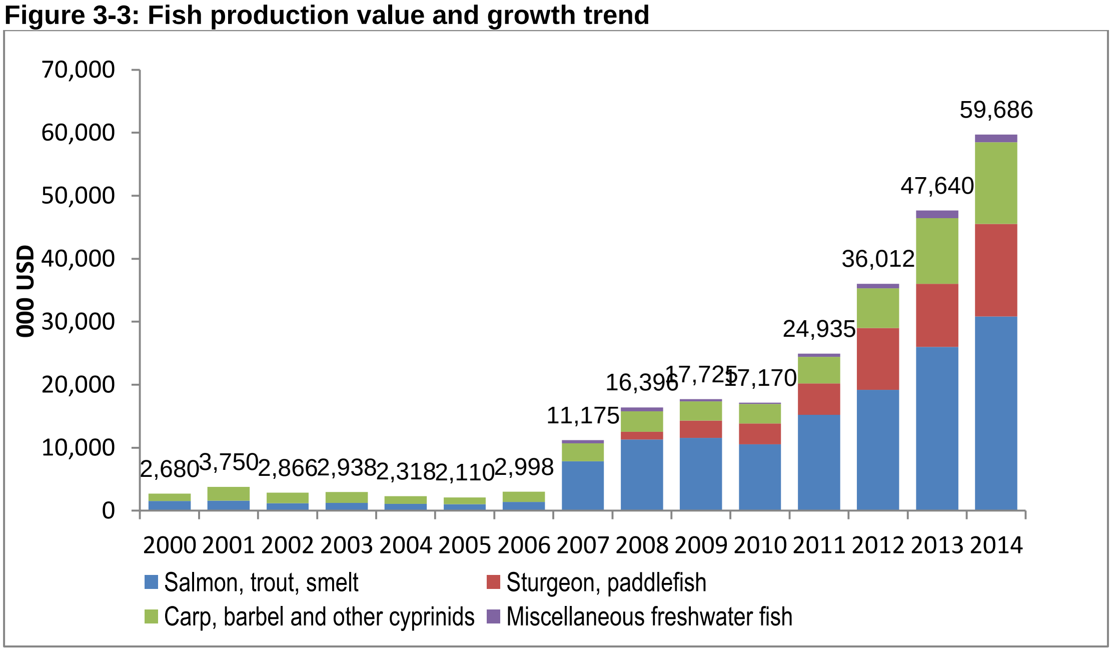
Data Source: Food and Agriculture Organization of the United Nations, webpage: http://www.fao.org/

Trout is the most popular breed of fish in Armenia for fisheries; it amounts to about 55% of total fish production. Carp and Sturgeon represent a share of about 21% of total fish production each.

The total value of Armenia's fish production is approximately USD 60 million or AMD 28 billion per year (latest statistics from 2014).

According to the Customs Service of RA, the annual value of exported fish production from Armenia was about USD 17 million for 2013-2015. The main export markets are the Russian Federation, Georgia, Turkmenistan and Kazakhstan. The average export price per kg was USD 7.6, 7.2, and 7 for 2013, 2014 and 2015 respectively.

Figure 3-3: Fish production value and growth trend



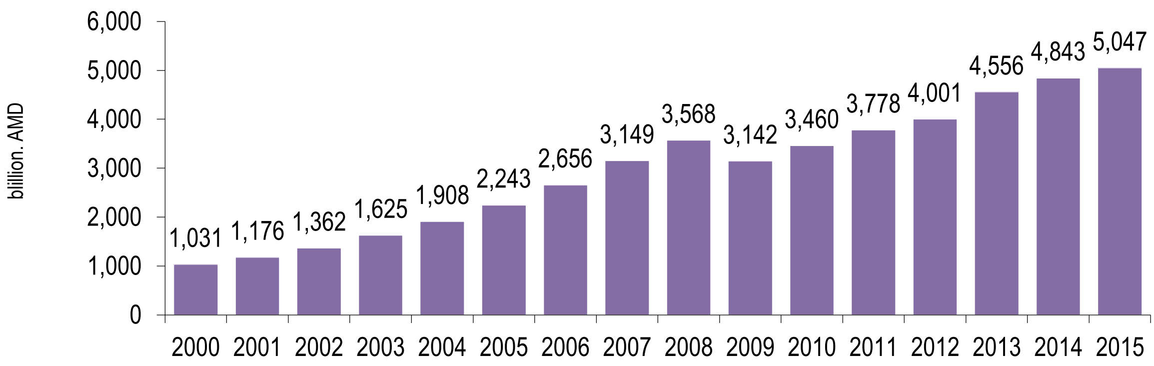
Data Source: Food and Agriculture Organization of the United Nations, webpage: http://www.fao.org/

3.2. Challenges Faced by Fisheries

In 2014 and 2015, fisheries faced serious challenges that impacted their business, including:

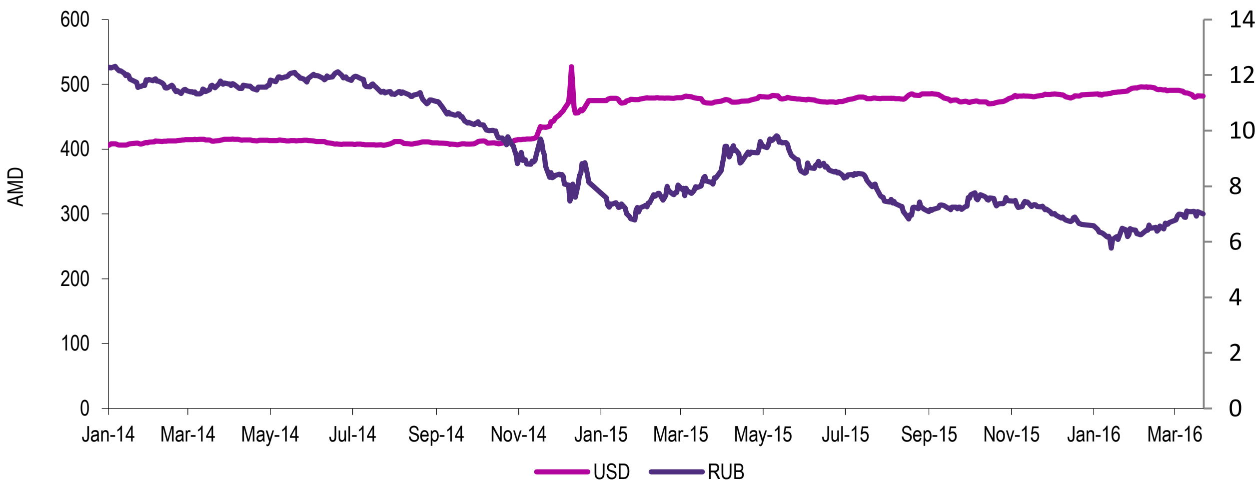
- Economic downturn in Armenia and the surrounding region. In 2015, economic growth slowed to 3-3.5% in terms of local currency, and actually decreased by 9% after converting the GDP from AMD to USD.

Figure 3-4: GDP trend of RA



Data Source: National Statistics Service of RA, webpage: http://armstatbank.am/

Figure 3-5: AMD and RUB movements against USD



Data Source: Central Bank of RA

- Currency crisis: depreciation of the Ruble (and AMD by extension) against USD. Since June 2014 RUB depreciated against AMD by 43% and AMD depreciated against USD by 19%. Since the Russian market was the main export market for Armenian fisheries, this development has put fish exporters in an unfavorable position among competitors.

- Increased financing costs and debt obligations for fisheries as a result of USD appreciation relative to local currency. Fisheries that had debt financing in USD terms faced increased financing costs and outstanding debt on their balance sheets.
- Electricity cost increase: The Armenian Public Services Regulatory Committee (PSRC) increased the price of electricity by AMD 7 per kilowatt hour in 2015, impacting the bottom line of fisheries.
- As of January 2014, the effective groundwater use fee for fisheries in Ararat and Armavir marzes increased from AMD 0.05 to AMD 0.5 per m^3. The surface water resource fee also increased from AMD 0.05 to AMD 0.1. In other marzes outside of Ararat and Armavir, however, fisheries still pay AMD 0.05 per m^3 of ground and surface water.

In the near to mid-term, fisheries are expected to continue to face economic and fiscal challenges, including: (1) slow local economic growth (under 3% forecasted real growth); (2) continuation of Russian economic crisis in the mid-term; and (3) a need for debt restructuration for businesses with debt financed in USD terms on their balance sheets.

3.3. Fishery sector in the Ararat Valley

The majority of private fisheries in Armenia are located in the Ararat Valley (in Ararat and Armavir marzes). According to the Ministry of Agriculture (MA) of the RA, there were 182 fisheries registered in the Ararat Valley in 2015, including 147 in Ararat Marz and 35 in Armavir marz, out of which 28 were not operating.

An analysis of WUPs and resource fee payments revealed 149 active fisheries that used groundwater for production. However, there might be cases when more than one registered fishery is using same WUP, therefore for further analysis, number of fisheries of the MA was used, except for special cases when the analysis were based solely on the WUP or actual reported water use data.

Fish producers report annual production volumes to the MA. However, given the limited monitoring exercised by the Ministry, it is generally believed that the reported amount (e.g. 6.3 thousand tons in 2015) is largely understated. To adjust for underreported production, fisheries included in the survey were first matched with the list of fisheries reporting to the MA. After matching 31 fisheries in this manner and assessing actual annual production volumes one by one, it was identified that on average reported production is understated by a factor of 1.87. This estimated coefficient was then applied to adjust reported production volumes.

Box 2: Survey study

To gain better insight on the actual production, sales, costs, and water use of fisheries in the Ararat Valley, the ASPIRED Project team implemented a survey of fisheries.

The survey was conducted over the period of March - May 2016. More than 100 fisheries were contacted for survey, out of which 51 questionnaires were completed and included in the analysis (See Appendix 2 for template of questionnaire). The survey was conducted in 19 communities in Ararat and Armavir marzes. Below is a description of the survey and key outcomes:

- Respondents were directors, accountants or other employees of the fisheries.
- The fisheries surveyed were producing one or more fish breeds as follows: 47 were producing

Trout, 2 Salmon, 19 Sturgeon and 6 Carp.

- All 51 respondents use groundwater for fish production.
- Only 18 answered the question regarding the amount of water abstraction. Of those who responded, average water abstraction was 2 MCM/year, with a maximum of 12 MCM/year.
- Only 40 provided an answer regarding quantity of fish stock. Of those who responded, average stock was about 15 tons for Trout, 2 tons for Salmon, 17 tons for Sturgeon, and 0.85 tons for Carp.
- For 2015, average production of Trout was about 21 tons (from 37 respondents) and 105 tons for Sturgeon (from 7 respondents).
- The respondents indicated an average selling price for Trout of AMD 1,295 per kg in local markets (41 respondents) and AMD 1,566 per kg for export markets (3 respondents). The average selling price indicated for Sturgeon in local markets was AMD 2,012 per kg (12 respondents) and 2,087 per kg in export markets (4 respondents).
- According to respondents, the average cost of production has increased by about 9% and 18% from 2013 to 2015 for Trout and Sturgeon, respectively. The average cost of production was AMD 1258 per kg for Trout (36 respondents) and AMD 1623 per kg for Sturgeon (6 respondents) in 2015.
- 49 respondents indicated that they use traditional breeding (flow through systems) for production and 51 indicated that they have open production systems.
- The main export market indicated was Russia.

Table 3-1: Fish production adjustment coefficient estimation

Code	Reported annual production (kg)	Survey results annual production (kg)	Coefficient of discrepancies
N1	4,000.00	15,000.00	3.75
N2	150,000.00	151,208.00	1.01
N3	12,000.00	45,000.00	3.75
N4	25,000.00	8,000.00	0.32
N5	60,000.00	60,000.00	1.00
N6	3,000.00	4,000.00	1.33
N7	20,000.00	30,000.00	1.50
N8	19,000.00	8,000.00	0.42
N9	14,000.00	8,000.00	0.57
N10	40,000.00	15,000.00	0.38
N11	25,000.00	15,000.00	0.60
N12	25,000.00	27,000.00	1.08
N13	25,000.00	12,000.00	0.48
N14	15,000.00	5,000.00	0.33
N15	25,000.00	75,000.00	3.00
N16	20,000.00	25,000.00	1.25
N17	70,000.00	75,000.00	1.07
N18	25,000.00	25,000.00	1.00
N19	15,000.00	13,000.00	0.87
N20	15,000.00	30,000.00	2.00
N21	25,000.00	30,000.00	1.20
N22	2,000.00	2,000.00	1.00
N23	1,000.00	8,000.00	8.00

Code	Reported annual production (kg)	Survey results annual production (kg)	Coefficient of discrepancies
N24	4,000.00	10,000.00	2.50
N25	10,000.00	18,000.00	1.80
N26	12,000.00	8,000.00	0.67
N27	5,000.00	5,000.00	1.00
N28	2,000.00	25,000.00	12.50
N29	10,000.00	15,000.00	1.50
N30	40,000.00	25,000.00	0.63
N31	10,000.00	15,000.00	1.50
Average			1.87

Data Source: Ministry of Agriculture of RA; Survey Study Implemented by ASPIRED, Consultants analysis

Through use of a coefficient to adjust for underreporting, a more realistic picture of the fish production in the Ararat Valley was thus obtained. While the production amounts shown below are therefore only estimated figures, it can reliably be asserted that these amounts are likely to be much closer to the actual figures for the region.

Table 3-2: Fish production in the Ararat Valley

Type of breeds	Number	Annual production (tons)	*% of Total*
Trout and Sturgeon	22	3,635	*31%*
Trout	89	3,409	*29%*
Carp, barbel and other cyprinids	32	529	*4%*
Sturgeon	8	4,200	*36%*
Trout and Carp	1	2	*0%*
Trout, Carp and Sturgeon	2	55	*0%*
Not operating	28	-	*0%*
Total	**182**	**11,831**	***100%***

Data Source: Ministry of Agriculture of RA; Survey Study Implemented by ASPIRED, Consultants analysis

Table 3-2 shows that adjusted total fish production in the Ararat Valley is estimated at 11.8 thousand tons for 2015. This amounts to approximately 85% of total fish production in Armenia. Our estimation is that the fishing sector generates about USD 40 million or AMD 19 billion in revenue per year in Ararat Valley.

3.4. Production Costs of Fisheries

Sturgeon and trout together represent approximately 95% of Ararat Valley fish production. Hence, this analysis focuses solely on these two fish breeds.

Based on the survey results, the production cost of 1 kg is about AMD 1,258 for trout and AMD 1,623 for Sturgeon. Our estimation of cost of production based on standard costing is shown in Table 3-3.

Table 3-3: Cost of production of fish in Ararat Valley

Cost item*	Sturgeon			*Trout*		
	%	*AMD per kg*	*USD per kg*	*%*	*AMD per kg*	*USD per kg*
Feed	78.98%	1,305.60	2.72	84.00%	1,060.80	2.21
Fry	3.87%	64.00	0.13	2.21%	27.86	0.06
Labor	8.71%	144.00	0.30	7.13%	90.00	0.19
Electricity	2.90%	48.00	0.10	1.90%	24.00	0.05

Water use	2.63%	43.55	0.09	1.72%	21.77	0.05
Other	2.90%	48.00	0.10	3.04%	38.40	0.08
Total		**1,653.15**	**3.44**		**1,262.83**	**2.63**

**cost of production does not include depreciation of fixed assets and administration costs*

Actual cost of production may vary for different producers depending on the fish mix, production type, pond type and design, production scale, water quality, etc. The estimated figures are for the average producer in the Ararat Valley.

Estimated production costs were also based on the following supporting assumptions. These assumptions have been discussed with fishery sector representatives and validated by a sector review of studies conducted by the World Bank (on the aquaculture sector of Armenia) and by the FOA (on implementation water saving technologies in Armenia):

- Feed costs USD 1.7 per kg and the utilization coefficient is 1.6 for Sturgeon and 1.3 for Trout.
- Production cycle is 24 months for Sturgeon and 12 months Trout.
- Water use to production coefficient is 1.4 liters per second for 1 ton of annual fish production.
- Cost per kg of fry is AMD 1.2 million for Sturgeon and AMD 156 thousand for Trout.
- Average labor cost is estimated at AMD 150 thousand per worker, per month.
- Average electricity costs are estimated at AMD 2.4 million annually for 100 tons of production.
- Other costs include vaccination and other small cost items.

Our estimation of cost of production is confirmed by the average figures obtained from the survey study of fisheries. Individual fisheries may have different actual production figures; however the figures and assumptions of this report are a representative for the sector.

3.5. Water Abstraction Amounts and Analysis

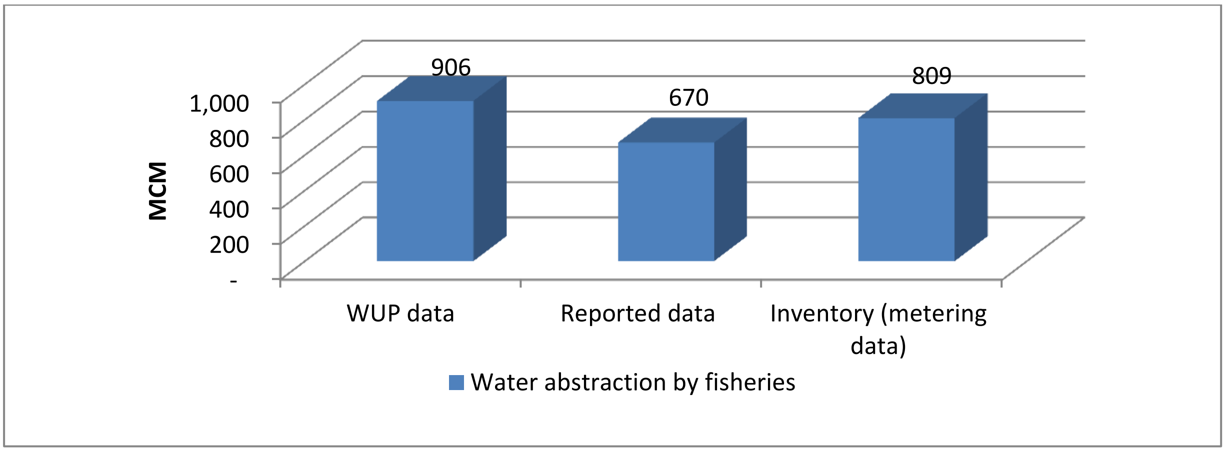
For the water abstraction analysis, three different datasets on water use by the fisheries in the Ararat Valley were used:

- WUP data (maximum allowed amount) – this describes the policy level allocation of water resources among fisheries.
- Actual reported water use – this data does not necessarily reflect the total amount of abstracted water, but does show the total volume of water for which a resource fee has been paid.
- Interim results of field measurements as a part of an ongoing inventory of groundwater wells, natural springs and fish farms in the Ararat Valley by the ASPIRED Project team. This shows actual abstraction at the date of metering.

Analysis in this section will rely on WUP and actual reported data, as both of these data sources are official.

According to the WUP database of the WRMA, total permitted water abstraction in the Ararat Valley across all water use sectors is approximately 1 billion m^3 for groundwater and 182 million m^3 for surface water (Table 3-4). Fisheries comprise 90% of permitted groundwater abstraction. According to data from the State Environmental Inspectorate (SEI) of the MNP, actual water use in 2015 by fisheries in the Ararat Valley was about 670 million m^3 (70.5% of amount permitted by WUPs).

Figure 3-6: Water abstraction by fisheries in Ararat valley according to different databases



Data Source: Ministry of Nature Protection of RA; Consultants analysis

Table 3-4: Water use structure in Ararat valley in 2015 based on WUPs

	Ground water		Surface water	
	MCM/year	*% of Total*	**MCM/year**	*% of Total*
Irrigation	57	*6%*	48	*26%*
Manufacturing	1	*0%*	32	*18%*
Hydroelectricity	-	*0%*	45	*24%*
Fish farming	906	*90%*	43	*24%*
Drinking and other use	22	*2%*	-	*0%*
Bottling	0.1	*0%*	-	*0%*
Other use	17	*2%*	14	*8%*
Total	**1,004**	***100%***	**182**	***100%***

Data Source: Ministry of Nature Protection of RA; Consultants analysis

Inventory data of groundwater wells, natural spring and fish farms in the Ararat Valley shows that the actual volume of groundwater use in the Ararat Valley in 2016 was 1,608.54 MCM, which exceeds the total permitted volume by approximately 608 MCM/year.

Table 3-5: Water use structure in Ararat Valley based on preliminary inventory results

Used wells	**Ararat Marz**		**Armavir Marz**		**Total**	
	Number of wells	Abstraction MCM/ Year	Number of wells	Abstraction MCM/ Year	Number of wells	Abstraction MCM/ Year
Drinking and domestic use	45	81	224	112	269	193
Irrigation*	522	359	613	637	1,135	996
Fish farming	236	689	100	120	336	809
Manufacturing	18	11	17	15	35	25
Total	**821**	**1,140**	**954**	**883**	**1,775**	**2,024**

* This volume is presented on an annual basis. Irrigation season in the Ararat Valley is in April-October.

Data Source: Inventory of wells in Ararat valley in 2016 by ASPIRED Project; Consultants analysis

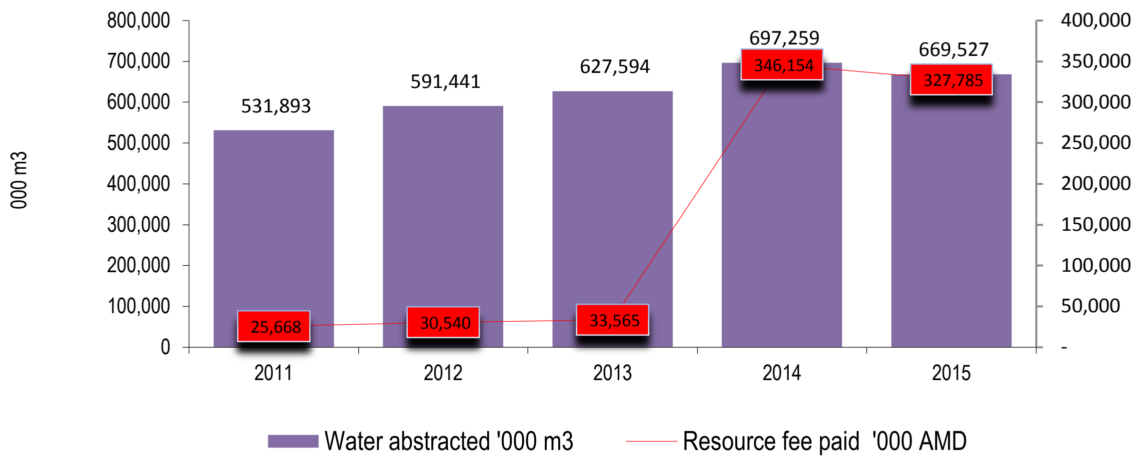
Table 3-6: Groundwater wells by type and measured discharge based on preliminary inventory results

Type of the well	Ararat Marz		Armavir Marz		Total	
	Number of wells	Discharge, MCM/ Year	Number of wells	Discharge, MCM/ Year	Number of wells	Discharge, MCM/ Year
Self-emitting/ artesian	480	857	196	152	676	1,009
Pumped	341	283	758	732	1,099	1,015
Total	**821**	**1,140**	**954**	**883**	**1,775**	**2,024**

Data Source: Inventory of wells in Ararat valley in 2016 by ASPIRED Project; Consultants analysis

The review of reported water abstraction data shows that since 2014, after a tenfold increase of the resource fee for Ararat Valley fisheries, reported water used declined by 4%. However, it cannot be assumed with certainty that this decline was the result of the increased fee. As mentioned previously in this report, the water resource fee increase was implemented in combination with other tools which may have also had an impact on water use.

Figure 3-7: Reported water abstraction and water resource fee payment trend



Data Source: Ministry of Nature Protection of RA; Consultants analysis

Total resource fee payments received from fisheries was approximately AMD 328 million in 2015, representing a tenfold increase since 2014.

For further analysis of water use and fish production amounts, a number of databases were used concurrently. These included WUP data for the Ararat Valley, reported to the SEI actual water use data, fish production data (based on adjusted figures as discussed earlier), water resource fee data, and fisheries survey data gathered in Ararat Valley. The following specific data were used:

- WUP data for 2015
- Reported water use for 2015 and resource fees paid
- Estimated fish production figures for 2015
- Estimated fisheries revenues for 2015

Fisheries were grouped according to relative rankings on various categories such as fish production quantity, water use, etc. These groupings and average figures for each data category are shown below:

Table 3-7: Average figures from combined datasets for permitted and actual water use, fish production and estimated revenues of fisheries

Ranking	WUP maximum allowed	Actual water abstracted	Resource fee paid	Fish production	Estimated revenue
	Average (000 m3)	Average (000 m3)	Average (000 AMD)	Average (ton)	Average (000 AMD)
Top 5	78,410.10	51,561.48	25,780.74	1,141	1,826,126
Top 6-10	18,297.74	12,975.12	6,487.47	255	408,633
Top 11-20	9,192.54	7,978.87	3,527.60	127	202,903
Top 21-40	5,615.79	4,896.46	2,364.41	59	94,536
Top 41-80	3,332.67	2,851.02	1,421.14	33	53,080
Top 81-	940.34	639.38	312.98	12	19,578

Data Source: Ministry of Agriculture of RA; Ministry of Nature Protection of RA; Survey Study Implemented by ASPIRED Project, Consultants analysis

Six groups of fisheries were constructed for each criterion, and permitted volumes vs. actual water abstraction were compared.

Table 3-8: Comparison analysis of actual water abstraction with the WUPs

Ranking	WUP maximum allowed	Actual water abstracted	Comparison of permitted and actual abstraction
	Average (000 m3)	Average (000 m3)	% of WUP
Top 5	78,410.10	51,561.48	66%
6-10	18,297.74	12,975.12	71%
11-20	9,192.54	7,978.87	87%
21-40	5,615.79	4,896.46	87%
41-80	3,332.67	2,851.02	86%
≥ 81	940.34	639.38	68%

Data Source: Ministry of Agriculture of RA; Ministry of Nature Protection of RA; Survey Study Implemented by ASPIRED Project, Consultants analysis

The analysis shows that on average middle-ranked groups of fisheries use a higher proportion of WUP allowance than groups at either end of the rankings (top 5 fisheries and smallest fisheries).

Table 3-9: Water user efficiency analysis

Ranking	WUP maximum allowed	Actual water abstracted	Fish production	Water use per ton production (based on WUPs)		Water use per ton production (based on actual)	
	Average (000 m3)	Average (000 m3)	Average (ton)	000 m3 per ton per year	liter second per ton per year	000 m3 per ton per year	liter second per ton per year
Top 5	78,410.10	51,561.48	1,141	68.7	2.2	45.2	1.4
Top 6-10	18,297.74	12,975.12	255	71.6	2.3	50.8	1.6
Top 11-20	9,192.54	7,978.87	127	72.5	2.3	62.9	2.0
Top 21-40	5,615.79	4,896.46	59	95.0	3.0	82.9	2.6
Top 41-80	3,332.67	2,851.02	33	100.5	3.2	85.9	2.7
Top 81-	940.34	639.38	12	76.9	2.4	52.3	1.7

Data Source: Ministry of Agriculture of RA; Ministry of Nature Protection of RA; Survey Study Implemented by ASPIRED Project, Consultants analysis

After comparing water use figures to production volumes, water use performance for the fisheries in the Ararat Valley was estimated. It was found that on average, 63,300 m^3 of water is abstracted per year to produce 1 ton of fish. However, discussions with fish farmers suggested that a normal figure would be 31,500 m^3 annually. One of the reasons for the discrepancy is the aforementioned understatement of actual production volumes by fisheries. Analysis results show that in general larger producers are more water efficient than smaller ones, except for the very smallest producers.

Comparative analysis of estimated revenues of fisheries and resource fees actually paid suggests that resource fees represent about 1.9% of revenues. Fisheries pay AMD 0.5 per cubic meter of water, but generate a value of AMD 26.8 per cubic meter of water used.

The analysis suggests that:

- The largest and smallest fisheries use less water that permitted by WUPs
- The largest and smallest producers are more efficient in their water use

Table 3-10: Analysis of revenue vs. resource fees paid

Ranking	Resource fee paid	Estimated revenue	Actual water abstracted	Resource fee to estimated revenue	Estimated revenue to actual water abstraction
	Average (000 AMD)	Average (000 AMD)	Average (000 m3)	% of revenue	AMD per m3
Top 5	25,780.74	1,826,126	51,561.48	1.4%	35.4
Top 6-10	6,487.47	408,633	12,975.12	1.6%	31.5
Top 11-20	3,527.60	202,903	7,978.87	1.7%	25.4
Top 21-40	2,364.41	94,536	4,896.46	2.5%	19.3
Top 41-80	1,421.14	53,080	2,851.02	2.7%	18.6
Top 81-	312.98	19,578	639.38	1.6%	30.6

Data Source: Ministry of Agriculture of RA; Ministry of Nature Protection of RA; Survey Study Implemented by ASPIRED Project, Consultants analysis

3.6. Expected Future Development

A number of future developments will be of significant interest for further analysis. These include:

Sevan Trout Project: The project is being launched in Lake Sevan by the Sevan Trout Closed Joint Stock Company (CJSC) to breed trout. It intends achieve total fish production of 50,000 tons a year by 2023. This is 3.5 times larger than current amount of fish produced in Armenia, and would thus affect local prices and the overall market significantly.

Fish feed Production: Fish feed is mainly imported to Armenia from the USA, EU and Chile. There are also small local producers (10-12 businesses are engaged in fish feed production). With the implementation of the Sevan Trout project, the GOA plans to establish large-scale fish feed production in Armenia. It is estimated that when the Sevan Trout Project breaches 10,000 tons of fish per year, it will be feasible to start large-scale fish feed production in Armenia.

New Tax Legislation: The New Tax Code of Armenia was adopted in October 2016, and will come into effect starting January 1, 2018. According to the Code, the groundwater resource fee for fisheries in Ararat and Armavir marzes per cubic meter is defined as AMD 1, with the following schedule of increases:

- As of January 1, 2018 the defined rate will be multiplied by 1.1
- As of January 1, 2019 the defined rate will be multiplied by 1.2
- As of January 1, 2020 the defined rate will be multiplied by 1.3

As fisheries in Ararat and Armavir marzes — following *Article 205* of the Armenian Tax Code — will pay the water resource fee for 50% of the total volume of groundwater abstracted, the new regulation will increase the effective water resource fee for fisheries in Ararat Valley as follows:

- As of January 1, 2018: AMD 0.55 per cubic meter
- As of January 1, 2019: AMD 0.6 per cubic meter
- As of January 1, 2020: AMD 0.65 per cubic meter

The new legislation also stipulates a penalty for water abstraction above amounts allowed by WUPs of three times the normal defined resource fee per cubic meter.

For the abstraction of water above defined "zero level" (as defined in the Tax Code) in Ararat and Armavir marzes, the fine will be 10 fold of the defined resource fee and in the rest of the country 5 fold of defined fee.

4. WATER RESOURCE FEE STRUCTURES AND ESTIMATED IMPACTS OF FEE SCENARIOS

A number of policy and regulatory tools are applied worldwide for the sustainable management of water resources. These are typically grouped broadly into categories such as:

- Command and control instruments: Water use permits; Water use standards, quotas, and restrictions; Administrative measures.
- Economic instruments: Water use permit trading schemes, water use fee structures.
- Other, alternative tools.

Management effectiveness is best achieved when a systemic approach is implemented using a combination of both command and control and economic instruments. The key advantage of economic instruments is that they provide incentives for users to change water consumption behavior. However, economic instruments alone are unlikely to be sufficient for effective water use management.

The sections below describe alternative pricing structures for water resource management.

4.1. Pricing Structures for Water Abstraction: Principles and International Experience

This section first describes the nature of alternative water pricing structures commonly use around the world. Then, a number of criteria to assess the relative performance of these alternative water pricing structures are discussed. Finally, relevant cases of the application of alternative water pricing structures around the world are examined.

Alternative Pricing Structures

Groundwater abstraction (and more generally water consumption) is priced through multiple mechanisms around the world. The four types of pricing schemes most commonly use are:[33]

1. A uniform fixed (or flat) charge paid on a monthly or an annual basis, allowing the abstraction of any quantity of water. With such a pricing scheme, the price paid for each additional unit (for example cubic meter – m^3) of water abstracted is effectively zero. With a uniform fixed price, the total payment for water abstraction by the water user is simply the set fixed (monthly or annual) fee.

It may be noted that a uniform fixed (or flat) fee may simultaneously be accompanied by a water abstraction quota. In such circumstances, the level of the uniform fixed fee may also be a function of the water abstraction quota available to the water user (see Box 1 below). Finally, with a uniform fixed fee, different types of water users (e.g. domestic water users, agricultural water users, and industrial water users) may face different flat fees.

[33] A more detailed description of the different types of water abstraction pricing is available in European Commission (2012), OECD (2009), Berbel et al. (2007) and Molle and Berkoff (2007). Canada West Foundation (2011) provides a description of water pricing in Canada. Chiplunkar et al. (2012) provides a good description of water pricing practices in urban water management setting for Bangkok, Colombo, Jamshedpur, Kuala Lumpur, Manila, Phnom Penh, Shenzen, and Singapore. Most of these municipalities have implemented an increasing block pricing structure.

Box 1: Fixed Fee with Quota

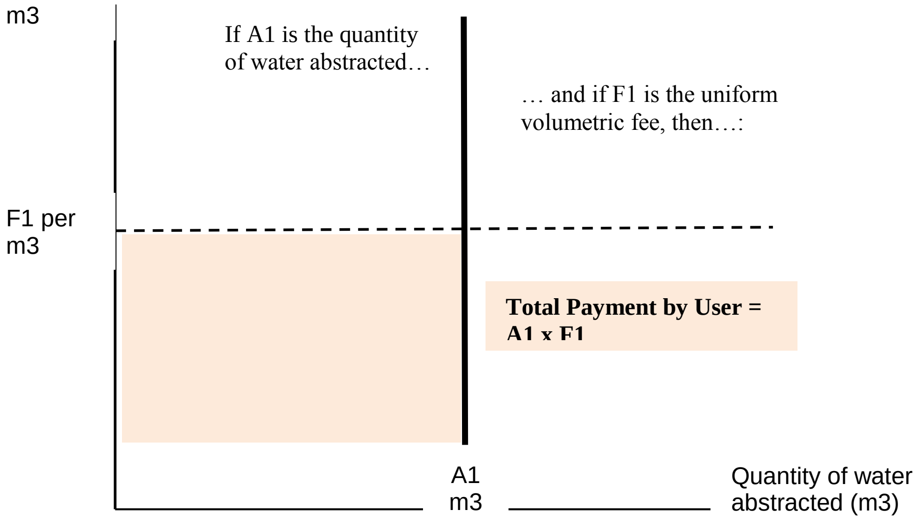
Suppose an annual water abstraction license allows a water user to abstract up to A1 cubic meter (m^3) of water (per unit of time – e.g. per year). Then, a fixed fee schedule with quota may be as follows:

- If A1 lies between 0 and Q1 m^3, the annual fixed fee is X1;
- If A1 lies between Q1 and Q2 m^3, the annual fixed fee is X2; and
- If A1 is larger than Q2 m3, the annual fixed fee is X3.

Provided that Q2 > Q1 > 0, then X3 > X2 > X1.

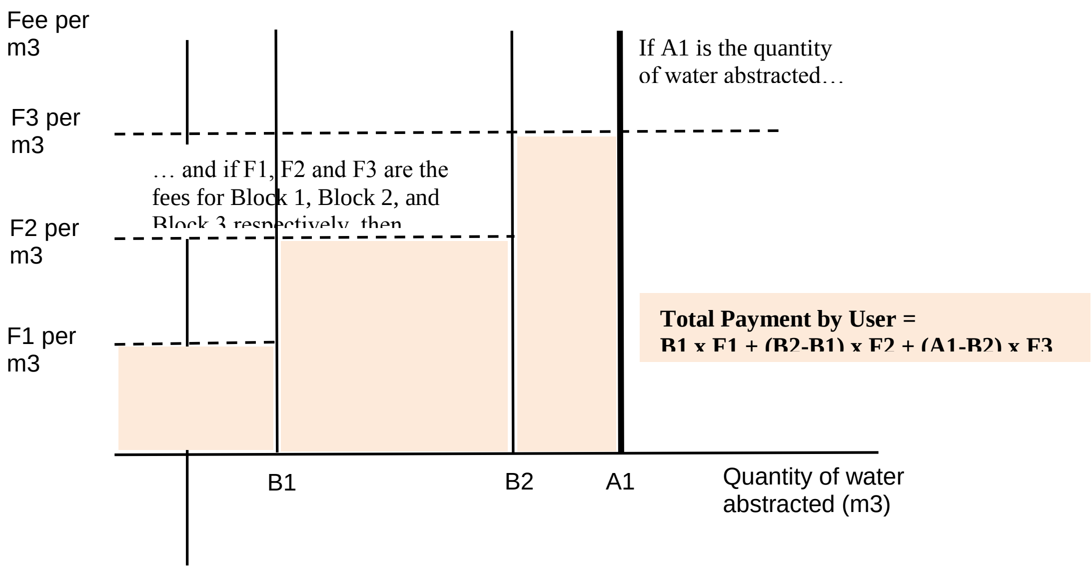
2. A uniform volumetric charge, where the water user must pay a price for every unit (e.g. m^3) of water abstracted, with the price being the same (hence the wording uniform) regardless of the quantity of water abstracted. For a uniform volumetric pricing structure, the total payment for water abstraction by a water user is shown in Figure 4-1.

Figure 4-1: Uniform volumetric price



3. A block volumetric charge, where a volumetric fee is set for different quantities (or blocks) of water abstraction, generally with a higher fee for larger blocks of water abstraction. With an increasing block pricing structure, the total payment by a water user is shown in Figure 4-2.

Figure 4-22 Increasing block price structure



Note that with an increasing block pricing structure, the water pricing authority must determine: (1) the number of blocks that the water pricing structure will comprise (while the above figure suggests 3 blocks, the number of blocks may be larger or smaller[34]); (2) the size of each block (in the above figure, this pertains to setting the value of B1 and B2); and (3) the fee level for each block (in the above figure, this pertains to setting F1 (for the first block), F2 (for the second block), and F3 (for the third and last block).

4. A two-part pricing structure which comprises both a fixed (or flat) fee (paid on a monthly or annual basis) and a volumetric fee. In this instance, the volumetric fee may be a uniform volumetric fee or take the form of an increasing block fee as discussed above.

Criteria to Assess Alternative Pricing Structures

In order to assess an optimal water pricing structure, a number of criteria may be used. The nature of these criteria may also be a function of the specific socio-economic characteristics of the area (national or sub-national) for which the pricing structure will apply.

In a 2009 publication, the Organization for Economic Cooperation and Development (OECD) suggested the following criteria to assess the adequacy of various pricing structures (OECD 2009):

Ecological Sustainability: The water resource being a scarce and vulnerable resource (which is likely to be significantly impacted by climate change), it should be used not only to satisfy the needs of the current generation, but it should also be used to protect ecological functions and be preserved for the use and benefits of future generations.

Economic Efficiency: The water resource being an economically valuable resource, it should be allocated to the uses that maximize overall benefits to society. In circumstances where it remains public property, regulatory authority should aim to capture (by means of pricing) a portion of the benefits associated with the use of the water resource.

Financial Sustainability: As water resources provision and management remains a costly activity requiring staffing, equipment, technology, and skills, revenue generation remains an important criterion to ensure the long-term ecological sustainability and economically efficient allocation of the water resources.

Equity (Social Concerns): It is generally accepted that acceptable levels of water provision should be accessible and affordable to all, including to lower-income groups and/or small water users. The focus is primarily on how to protect vulnerable groups and ensure that they have access to water services that remain affordable over time.

To the above criteria found in OECD (2009), the existing study adds “Ease of Implementation” as an important criterion which may be considered by a water pricing authority especially in circumstances where monitoring and enforcement resources are limited. All other things being equal, water pricing structures which are easier to implement will be preferable.

[34] For example, the water pricing structure in use in the city of Mexico comprises 14 blocks (source: OECD 2009).

Each of the 4 water pricing structures discussed earlier may be assessed against each of the 5 criteria presented above. The outcome is presented in Table 4-1 below.

Table 4-1: Assessing water pricing structures against performance criteria

Pricing structure	Ecological sustainability	Economic efficiency	Financial sustainability	Equity	Ease of implementation
Uniform fixed (or flat) fee	No incentive for ecologically sustainable water use.	Economically inefficient as no linkage between fee and behaviour of water users.	Generate revenues in a predictable manner. Financial sustainability may be achieved if fee is set to recover costs.	Inequitable for poor and small users as all pay the same uniform flat fee.	Easy to implement as it does not require water use monitoring unless quotas are also used.
Uniform volumetric rate	Provide incentives for ecologically sustainable water use if rate is high enough.	Economically efficient if the level of the fee reflects the economic value of the water.	May generate sufficient revenues if fee is set to recover costs, but revenues may be unpredictable.	Inequitable for poor and small users as all pay the same price per unit of water.	Relatively easy to implement but requires monitoring of water abstraction.
Increasing block pricing structure	Good incentive for ecologically sustainable water use if rate in upper blocks is high enough.	Economically efficient if the level of the fee reflects economic value of water.	May generate sufficient revenues if fee is set to recover costs, but revenues may be unpredictable.	May be more equitable for poor and small users depending on the design of first block.	Less easy to implement as it requires adequate monitoring.
Two-part tariff structure (fixed fee plus volumetric rate)	Good incentive for ecologically sustainable water use if volumetric rate is high enough.	Economically efficient if the level of the fee reflects economic value of water.	May generate sufficient revenues in a predictable manner.	May be more equitable for poor and small users depending on the design of first block.	Less easy to implement as it requires adequate monitoring.

Source: Adapted from OECD (2009).

It is apparent from the table that the uniform fixed (flat) fee significantly fails on the ground of ecological sustainability, economic efficiency, and equity. However, by its nature it remains easy to implement as it does not imply monitoring requirements.[35]

On the other hand, a two-part tariff is can achieve all policy objectives. However, unlike the uniform fixed fee, it does demand that water abstraction be adequately monitored.

The above rating system also helps explain why the increasing block pricing structure has increasingly been adopted around the world.

International Experience with Water Pricing

In its 2009 review of water pricing, the OECD noted a continued decline in the use of flat fee systems in favor of a two-part pricing structure involving a fixed charge plus variable fees with a uniform or increasing block volumetric component.[36] To foster greater equity among water

[35] See Easter and Liu (2005) for another discussion of the pros and cons of alternative water pricing schemes.
[36] See also Danilenko et al. (2014).

users, increasing block pricing structures with an initial “subsistence” block with zero or very low charges have also been adopted by a large number of OECD and non-OECD countries (Table 4-2).

Table 4-2: Water pricing structures in use in OECD countries

	Uniform fixed (flat) fee	Uniform volumetric fee	Increasing block pricing
Australia	-	√√√	√
Canada	√√	√√	√
France	√	√√√	-
Hungary	-	√√√	√
Japan	-	√	√√√
Netherlands	√	√√√	√
Norway	√√√	-	√
Spain	-	√	√√√
Sweden	-	√√√	-
Turkey	-	-	√√√
UK[37]	√	√√	-
US	-	√√	√√

Among Pacific countries in the World Bank’s IBNET Tariff Database, an increasing block tariff is used in almost all countries in the region (Table 4-3). Most are structured with three to four blocks with Papua New Guinea having the most at 6 blocks. Some countries apply solely increasing block tariff while others have fixed charges as well (as a two-part tariff structure).[38]

Table 4-3: Tariff structure in selected Pacific Island countries and FSM

Utility	Tariff structure
Solomon Islands (Solomon Water)	Increasing block pricing (3 blocks)
Fiji (WAF)	Increasing block pricing (3 blocks)
Vanuatu (UNELCO)	Increasing block pricing (4 blocks) *plus* fixed charge
Papua New Guinea	Increasing block pricing (6 blocks) *plus* fixed charge
American Samoa	Increasing block pricing (4 blocks) *plus* fixed charge
Palau	Uniform volumetric price

Source: World Bank IBNET tariff database. Additional details are available in PWWA (2013).

In a survey of 260 municipalities in India, it was found that where volumetric pricing is used, an increasing block pricing structure is the most common form of pricing structure, with the number of blocks varying between 3 and 6 (Energy and Resources Institute 2010).

Given the above brief review of the principles guiding water pricing and of international experience, it is the conclusion of this study that a two-part tariff system which includes an

[37] See UK Government (2016) for a detailed description of the calculation of water abstraction charges.
[38] An in-depth discussion of water pricing in the Pacific countries is available in Nimmo-Bell (2016).

increasing block pricing component would be optimal for the context of the Ararat Valley (Table 4-4).

Table 4-4: Relative rating of water pricing structures

Pricing structure		Ecological sustainability	Economic efficiency	Financial sustainability	Equity	Ease of implementation
Uniform fixed (or flat) fee	Yes			√√		√√√
	No	XXX	XXX		XX	
Uniform volumetric rate	Yes	√√	√√	√		
	No				X	X
Increasing block structure	Yes	√√√	√√	√	√√	
	No					X
Two-part tariff structure	Yes	√√√	√√√	√√	√√	
	No					X

However, as indicated earlier, for this type of tariff structure decisions must also be made pertaining to the selection of the number of blocks, the size of each block and the fee to be applied to each block. These issues are discussed in further detail in the next section.

4.2. Description of Scenarios

Based on the rationale and criteria discussed in the previous section, it is believed that a block fee structure best meets the objectives of this study. More specifically, a block fee structure would strengthen economic incentives to preserve water resources while not placing undue restrictions on fisheries in the Ararat Valley.

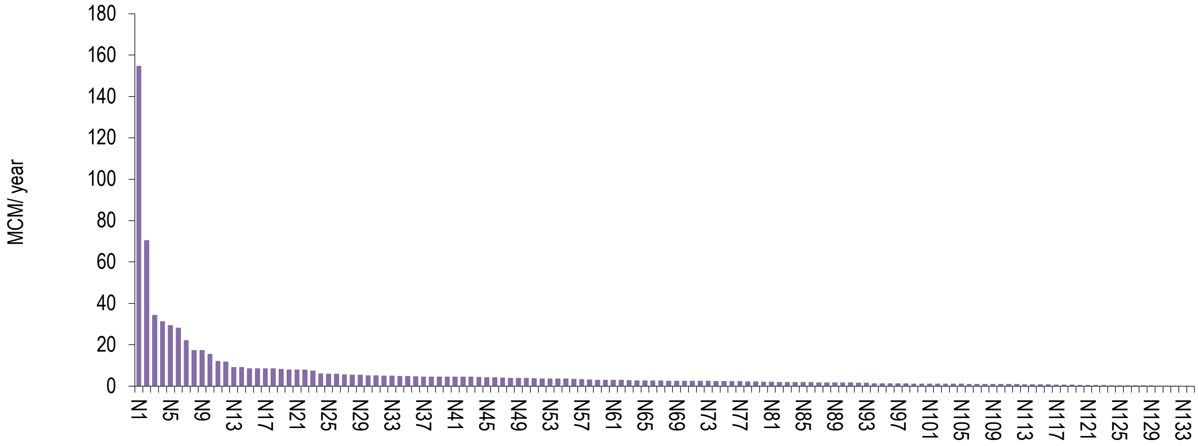
To define appropriate water usage thresholds for each block, all three datasets (WUP data, official reported abstraction data from the SEI, and field inventory data) were analyzed. Groundwater abstraction by Ararat Valley fisheries based on these different datasets, are presented in the figures below:

Figure 4-3, which presents abstraction according to WUPs, shows that the highest amount permitted for any single fishery in the Ararat Valley is 154 MCM/year of groundwater. By contrast, the smallest permitted amount of groundwater abstraction is 0.2 MCM/year, while the average permitted volume is about 6.2 MCM/year.

Figure 4-4, which shows water abstraction by fisheries based on reported amounts for the year 2015, shows that the maximum volume abstracted by any single fishery was 125 MCM/year. The minimum was approximately 0.01 MCM/year, while the average was 4.4 MCM/year.

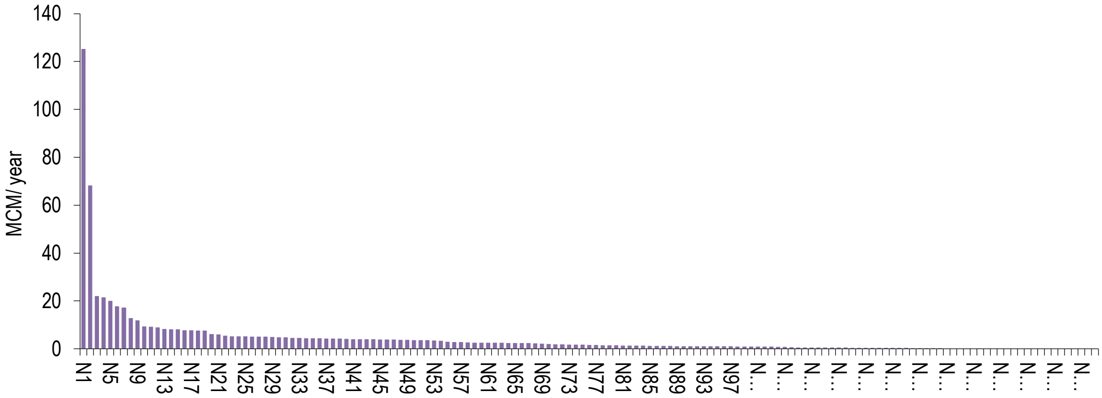
Based on the field inventory data (figure 4-5), the highest actual volume of groundwater abstracted by a single fish farm was 155 MCM/year, the minimum was 0.2 MCM/year, and the average was 6.2 MCM/year.

Figure 4-3: Fisheries ranked according to permitted water abstraction amount (WUP data)



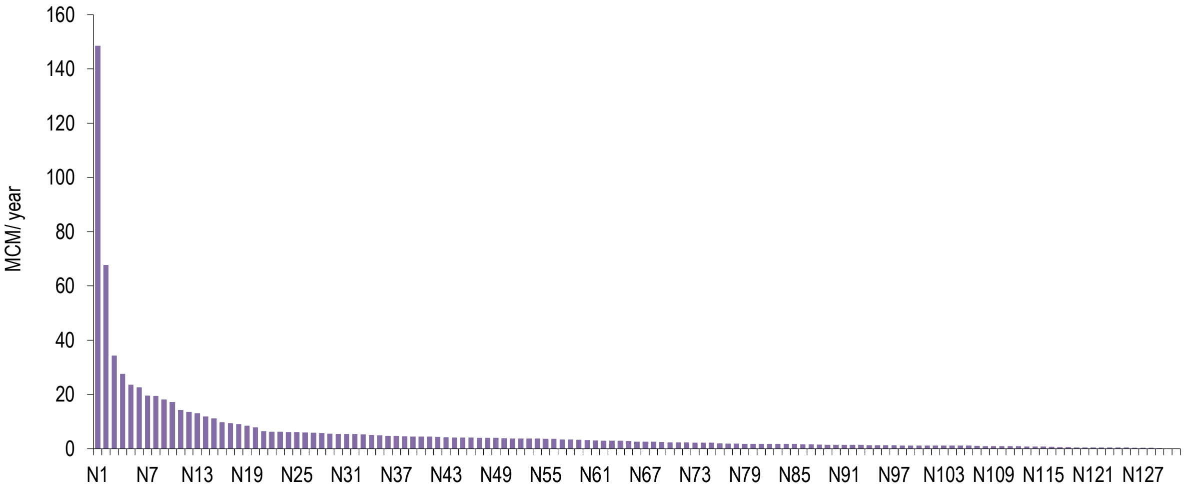
Data Source: Ministry of Nature Protection of RA

Figure 4-4: Fisheries ranked according to reported actual water abstraction amount (data for 2015)



Data Source: Ministry of Nature Protection of RA

Figure 4-5: Fisheries ranked according to metered water abstraction amount (filed inventory results)



Data Source: Interim results of the ASPIRED Project filed inventory

Review of the above shown datasets led to the following critical assessments:

- A threshold of 800 l/second, or 25.3 MCM/ year, is potentially viable for the highest block of water users. Up to 6 water users surpass this threshold.
- An even higher potentially viable threshold of 1000 l/second, or about 31.5 MCM/year, can also be considered for top water users. Up to 4 water users surpass this threshold.
- A threshold of 500 l/second, or 15.8 MCM/year, is potentially viable for mid-to-high level water users. Up to twelve water users surpass this threshold.
- A threshold of 250 l/ second, or 7.9 MCM/year, is potentially viable for mid-level water users. About 22 water users surpass this threshold.
- Finally, a threshold of 50 l/second, or 1.6 MCM/year, is potentially viable for lower-level water users. About 90 fisheries surpass this threshold and about 50 water users would fall below this amount.

Based on this analysis, scenarios have been developed to model the impacts of the above mentioned combinations of thresholds: 31.5 MCM/year, 25.3 MCM/year, 15.8 MCM/year, 7.9 MCM/year, and 1.6 MCM/year.

A scheme with three blocks is considered to be optimal, allowing for producers to be charged at levels appropriate for their scale and for authorities to appropriately monitor and ensure effective levels of control over usage. Thus, all scenarios below comprise three blocks.

Table 4-5: Block structures

	Block definitions, liters/second					
	Block 1		Block 2		Block 3	
Block structures	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
Block structure 1	0	500	501	1,000	1,001	No limit
Block structure 2	0	500	501	800	801	No limit
Block structure 3	0	250	251	1,000	1,001	No limit
Block structure 4	0	250	251	800	801	No limit
Block structure 5	0	250	251	500	501	No limit
Block structure 6	0	50	51	500	501	No limit
Block structure 7	0	50	51	800	801	No limit
Block structure 8	0	50	51	1,000	1001	No limit

Each block has maximum and minimum amount of allowed water abstraction. The fee for each subsequent level applies only for amounts abstracted in excess of the previous level.

The calculations for each block of water users are as follows:

- Resource fee calculation for fisheries in **block 1:**

$$\textbf{Resource fee} = \textbf{Water used} \times \textbf{Block 1 Resource fee}$$

- Resource fee calculation for fisheries in **block 2:**

$$\textbf{Resource fee} = \textbf{Block 1 maximum amount} \times \textbf{Block 1 resource fee} \\ + (\textbf{Water used} - \textbf{Block 1 maximum amount}) \times \textbf{Block 2 resource fee}$$

- Resource fee calculation for fisheries in **block 3:**

$$\textbf{Resource fee} = \textbf{Block 1 maximum amount} \times \textbf{Block 1 resource fee} + (\textbf{Block 2 maximum amount} - \textbf{Block 1 maximum amount}) \times \textbf{Block 2 resource fee} + (\textbf{Water used} - \textbf{Block 2 maximum amount}) \times \textbf{Block 3 resource fee}$$

The assumed resource fee levels are the following:

- AMD 0.5 per cubic meter (equal to current level).
- AMD 1.0 per cubic meter (equal to the level recently adopted in the New Tax Code; however, unlike the New Tax Code, it is assumed here that 100% of use will be subjected to pricing rather than 50% water use).
- AMD 1.5 per cubic meter.
- AMD 3.0 per cubic meter (applicable only for the largest block (block 3) of water abstraction).

Based on the combination of 2 fee structures and 8 block structures, 16 scenario options have been modeled (Table 4-6). Scenarios have been color-coded according the definitions for block 1 (e.g. scenarios 1, 2, 9 and 10 – highlighted in blue – have the same parameters for block 1 of 0-500 l/s).

Table 4-6: Block scheme options presented in liters per second metrics

	Block definitions, liter/second						Resource fee for blocks		
	Block 1		Block 2		Block 3		Block 1	Block 2	Block 3
Scenarios	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**AMD per m^3**	**AMD per m^3**	**AMD per m^3**
Scenario 1	0	500	501	1,000	1,001	No limit	1	1.5	3
Scenario 2	0	500	501	800	801	No limit	1	1.5	3
Scenario 3	0	250	251	1,000	1,001	No limit	1	1.5	3
Scenario 4	0	250	251	800	801	No limit	1	1.5	3
Scenario 5	0	250	251	500	501	No limit	1	1.5	3
Scenario 6	0	50	51	500	501	No limit	1	1.5	3
Scenario 7	0	50	51	800	801	No limit	1	1.5	3
Scenario 8	0	50	51	1,000	1001	No limit	1	1.5	3
Scenario 9	0	500	501	1,000	1001	No limit	0.5	1	3
Scenario 10	0	500	501	800	801	No limit	0.5	1	3
Scenario 11	0	250	251	1,000	1001	No limit	0.5	1	3
Scenario 12	0	250	251	800	801	No limit	0.5	1	3
Scenario 13	0	250	251	500	501	No limit	0.5	1	3
Scenario 14	0	50	51	500	501	No limit	0.5	1	3
Scenario 15	0	50	51	800	801	No limit	0.5	1	3
Scenario 16	0	50	51	1,000	1001	No limit	0.5	1	3

The scenario options are shown in square meter metrics as well:

Table 4-7: Block scheme options presented in cubic meters per year

Scenarios	Block definitions, 000 cubic meters/year						Resource fee for blocks		
	Block 1		Block 2		Block 3		Block 1	Block 2	Block 3
	Min	Max	Min	Max	Min	Max	AMD per m^3	AMD per m^3	AMD per m^3
Scenario 1	-	15,768	15,769	31,536	31,537	No limit	1	1.5	3
Scenario 2	-	15,768	15,769	25,229	25,230	No limit	1	1.5	3
Scenario 3	-	7,884	7,885	31,536	31,537	No limit	1	1.5	3
Scenario 4	-	7,884	7,885	25,229	25,230	No limit	1	1.5	3
Scenario 5	-	7,884	7,885	15,768	15,769	No limit	1	1.5	3
Scenario 6	-	1,577	1,578	15,768	15,769	No limit	1	1.5	3
Scenario 7	-	1,577	1,578	25,229	25,230	No limit	1	1.5	3
Scenario 8	-	1,577	1,578	31,536	31,537	No limit	1	1.5	3
Scenario 9	-	15,768	15,769	31,536	31,537	No limit	0.5	1	3
Scenario 10	-	15,768	15,769	25,229	25,230	No limit	0.5	1	3
Scenario 11	-	7,884	7,885	31,536	31,537	No limit	0.5	1	3
Scenario 12	-	7,884	7,885	25,229	25,230	No limit	0.5	1	3
Scenario 13	-	7,884	7,885	15,768	15,769	No limit	0.5	1	3
Scenario 14	-	1,577	1,578	15,768	15,769	No limit	0.5	1	3
Scenario 15	-	1,577	1,578	25,229	25,230	No limit	0.5	1	3
Scenario 16	-	1,577	1,578	31,536	31,537	No limit	0.5	1	3

4.3. Estimated Impacts on Fishery Sector

The current section estimates the impact of each of the above scenarios on the fishery sector. As with previous sections, this assessment has been based on the three datasets used throughout this report: WUP data, reported actual water usage, and field inventory results. In particular, this section provides an impact assessment based on reported actual water usage data, as this shows actual water usage for which a fee has been levied. However, similar calculations have been done based on the other two datasets as well, with summary tables shown in Appendix 6 and Appendix 7.

The following metrics were calculated for the impact assessment: (1) percentage of fisheries included in each block; (2) fiscal revenue generated by each block; (3) average resource fee and maximum resource fee per block as well as overall average. The first 8 scenarios modelled are based on the following resource fees and corresponding blocks:

- Block 1 – AMD 1 per cubic meter of water used
- Block 2 – AMD 1.5 per cubic meter of water used
- Block 3 – AMD 3 per cubic meter of water used

Scenarios 9 to 16 are based on the following resource fees and various block thresholds:

- Block 1 – AMD 0.5 per cubic meter of water used
- Block 2 – AMD 1 per cubic meter of water used
- Block 3 – AMD 3 per cubic meter of water used.

Detailed scenario outcomes are shown in the following table (4-8). The outcomes are shown in the form of range based on the minimum and maximum results of application of different datasets on water use (WUPs, Actual water use and Inventory metering results).

Table 4-8: Scenario outcomes

Scenario name	Block name	Resource fee (AMD per m3)	Block level (l/s)	Number of fisheries	% of fisheries	Annual fiscal revenue generated (000 AMD)	Average resource fee per fishery in the block (000 AMD)	Maximum resource per fishery in the block (000 AMD)
Scenario 1	Block 1	1	500	141	95%	359,383	2,549	11,988
	Block 2	1.5	1000	6	4%	127,346	21,224	25,463
	Block 3	3	No limit	2	1%	518,060	259,030	344,620
	Total			149	100%	**1,004,789**	**6,744**	**344,620**
Scenario 2	Block 1	1	500	141	95%	359,383	2,549	11,988
	Block 2	1.5	800	6	4%	127,346	21,224	25,463
	Block 3	3	No limit	2	1%	536,982	268,491	354,081
	Total			149	100%	**1,023,711**	**6,871**	**354,081**
Scenario 3	Block 1	1	250	133	89%	286,443	2,154	7,884
	Block 2	1.5	1000	14	9%	228,872	16,348	29,405
	Block 3	3	No limit	2	1%	502,292	251,146	336,736
	Total			149	100%	**1,017,607**	**6,830**	**336,736**
Scenario 4	Block 1	1	250	133	89%	286,443	2,154	7,884
	Block 2	1.5	800	14	9%	228,872	16,348	29,405
	Block 3	3	No limit	2	1%	521,214	260,607	346,197
	Total			149	100%	**1,036,529**	**6,957**	**346,197**
Scenario 5	Block 1	1	250	133	89%	286,443	2,154	7,884
	Block 2	1.5	500	8	5%	77,874	9,734	14,040
	Block 3	3	No limit	8	5%	804,289	100,536	360,388
	Total			149	100%	**1,168,605**	**7,843**	**360,388**
Scenario 6	Block 1	1	50	72	48%	48,726	677	1,577
	Block 2	1.5	500	69	46%	411,586	5,965	17,194
	Block 3	3	No limit	8	5%	753,831	94,229	354,081
	Total			149	100%	**1,214,142**	**8,149**	**354,081**
Scenario 7	Block 1	1	50	72	48%	48,726	677	1,577
	Block 2	1.5	800	75	50%	581,505	7,753	32,559
	Block 3	3	No limit	2	1%	508,599	254,300	339,889
	Total			149	100%	**1,138,831**	**7,643**	**339,889**
Scenario 8	Block 1	1	50	72	48%	48,726	677	1,577
	Block 2	1.5	1000	75	50%	581,505	7,753	32,559
	Block 3	3	No limit	2	1%	489,678	244,839	330,429
	Total			149	100%	**1,119,909**	**7,516**	**330,429**
Scenario 9	Block 1	0.5	500	141	95%	179,691	1,274	5,994
	Block 2	1	1000	6	4%	69,130	11,522	14,348
	Block 3	3	No limit	2	1%	470,756	235,378	320,968
	Total			149	100%	**719,577**	**4,829**	**320,968**
Scenario 10	Block 1	0.5	500	141	95%	179,691	1,274	5,994
	Block 2	1	800	6	4%	69,130	11,522	14,348
	Block 3	3	No limit	2	1%	495,985	247,992	333,582
	Total			149	100%	**744,806**	**4,999**	**333,582**
Scenario 11	Block 1	0.5	250	133	89%	143,221	1,077	3,942
	Block 2	1	1000	14	9%	134,186	9,585	18,290
	Block 3	3	No limit	2	1%	462,872	231,436	317,026
	Total			149	100%	**740,279**	**4,968**	**317,026**
Scenario 12	Block 1	0.5	250	133	89%	143,221	1,077	3,942
	Block 2	1	800	14	9%	134,186	9,585	18,290
	Block 3	3	No limit	2	1%	488,101	244,050	329,640
	Total			149	100%	**765,508**	**5,138**	**329,640**
Scenario 13	Block 1	0.5	250	133	89%	143,221	1,077	3,942
	Block 2	1	500	8	5%	41,404	5,176	8,046
	Block 3	3	No limit	8	5%	709,681	88,710	348,562
	Total			149	100%	**894,306**	**6,002**	**348,562**
Scenario 14	Block 1	0.5	50	72	48%	24,363	338	788
	Block 2	1	500	69	46%	256,257	3,714	11,200
	Block 3	3	No limit	8	5%	684,452	85,556	345,408
	Total			149	100%	**965,072**	**6,477**	**345,408**
Scenario 15	Block 1	0.5	50	72	48%	24,363	338	788
	Block 2	1	800	75	50%	367,960	4,906	21,443
	Block 3	3	No limit	2	1%	481,794	240,897	326,487
	Total			149	100%	**874,117**	**5,867**	**326,487**
Scenario 16	Block 1	0.5	50	72	48%	24,363	338	788
	Block 2	1	1000	75	50%	367,960	4,906	21,443
	Block 3	3	No limit	2	1%	456,565	228,282	313,872
	Total			149	100%	**848,888**	**5,697**	**313,872**

The outcomes highlight that the new resource fee structure will have a strong impact on the largest water users, while the effect on smaller and medium sized users varies depending on the block structure. The 2 largest firms within Block 3 pay on average approximately 59% of total fees generated across all scenarios. This result clearly illustrates the consequence of the increasing block tariff.

Another type of analysis was conducted to measure the impact of varying levels of resource fees on fishery revenues. The registry of fisheries in the Ararat Valley was analyzed and water use data was matched to production volume. At first, data on water use volumes from the actual reported volumes was used, then inventory metering volume and only after permitted volumes of water use.

- As a next step, an initial sample of fisheries with corresponding water usage and production data was selected.
- Water use efficiency (water usage per ton of production) was calculated.
- Fisheries with outlier efficiency data were removed and a final sample list was selected. The final sample included 45 fisheries out of 149 (or approximately 30%). The sample included small, medium and large fisheries.
- The fee structure scenarios were applied to the sample list to assess impact.

Key results are summarized in the following table (4-9):

Table 4-9: Outcome of the scenarios

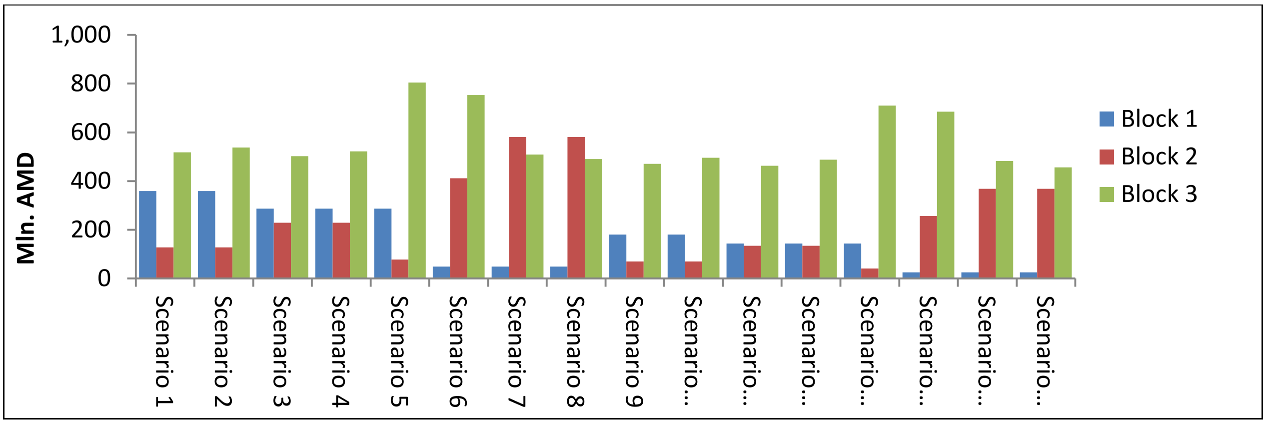
Scenario name	Resource fee (AMD per m3)	Block level (liter/ second)	Block name	Average production (ton)	Maximum production (ton)	Minimum production (ton)	Estimated average revenue (000 AMD)	Resource fee per kg (AMD)	Resource fee % of revenue
Scenario 1	1	500	Block 1	71	374	6	113,983	55	2.5%
	1.5	1000	Block 2	585	1,123	374	935,516	51	2.3%
	3	No limit	Block 3	3,461	3,461	3,461	5,538,252	139	6.2%
			Total	192	3,461	6	307,548	88	3.9%
Scenario 2	1	500	Block 1	71	374	6	113,983	55	2.5%
	1.5	800	Block 2	585	1,123	374	935,516	51	2.3%
	3	No limit	Block 3	3,461	3,461	3,461	5,538,252	143	6.4%
			Total	192	3,461	6	307,548	89	4.0%
Scenario 3	1	250	Block 1	63	374	6	101,380	51	2.3%
	1.5	1000	Block 2	406	1,123	94	650,050	63	2.8%
	3	No limit	Block 3	3,461	3,461	3,461	5,538,252	136	6.1%
			Total	192	3,461	6	307,548	89	4.0%
Scenario 4	1	250	Block 1	63	374	6	101,380	51	2.3%
	1.5	800	Block 2	406	1,123	94	650,050	63	2.8%
	3	No limit	Block 3	3,461	3,461	3,461	5,538,252	140	6.3%
			Total	192	3,461	6	307,548	91	4.0%
Scenario 5	1	250	Block 1	63	374	6	101,380	51	2.3%
	1.5	500	Block 2	168	281	94	269,428	76	3.4%
	3	No limit	Block 3	1,160	3,461	374	1,856,063	128	5.7%
			Total	192	3,461	6	307,548	104	4.7%
Scenario 6	1	50	Block 1	33	112	6	53,054	43	1.9%
	1.5	500	Block 2	102	374	22	163,834	77	3.4%
	3	No limit	Block 3	1,160	3,461	374	1,856,063	120	5.4%
			Total	192	3,461	6	307,548	104	4.6%
Scenario 7	1	50	Block 1	33	112	6	53,054	43	1.9%
	1.5	800	Block 2	177	1,123	22	282,554	72	3.2%
	3	No limit	Block 3	3,461	3,461	3,461	5,538,252	137	6.1%
			Total	192	3,461	6	307,548	96	4.3%
Scenario 8	1	50	Block 1	33	112	6	53,054	43	1.9%
	1.5	1000	Block 2	177	1,123	22	282,554	72	3.2%
	3	No limit	Block 3	3,461	3,461	3,461	5,538,252	134	6.0%
			Total	192	3,461	6	307,548	95	4.2%

Scenario name	Resource fee (AMD per m3)	Block level (liter/ second)	Block name	Average production (ton)	Maximum production (ton)	Minimum production (ton)	Estimated average revenue (000 AMD)	Resource fee per kg (AMD)	Resource fee % of revenue
Scenario 9	0.5	500	Block 1	71	374	6	113,983	28	1.2%
	1	1000	Block 2	585	1,123	374	935,516	28	1.2%
	3	No limit	Block 3	3,461	3,461	3,461	5,538,252	130	5.8%
			Total	192	3,461	6	307,548	68	3.1%
Scenario 10	0.5	500	Block 1	71	374	6	113,983	28	1.2%
	1	800	Block 2	585	1,123	374	935,516	28	1.2%
	3	No limit	Block 3	3,461	3,461	3,461	5,538,252	135	6.0%
			Total	192	3,461	6	307,548	71	3.1%
Scenario 11	0.5	250	Block 1	63	374	6	101,380	26	1.1%
	1	1000	Block 2	406	1,123	94	650,050	38	1.7%
	3	No limit	Block 3	3,461	3,461	3,461	5,538,252	128	5.7%
			Total	192	3,461	6	307,548	71	3.2%
Scenario 12	0.5	250	Block 1	63	374	6	101,380	26	1.1%
	1	800	Block 2	406	1,123	94	650,050	38	1.7%
	3	No limit	Block 3	3,461	3,461	3,461	5,538,252	133	6.0%
			Total	192	3,461	6	307,548	73	3.2%
Scenario 13	0.5	250	Block 1	63	374	6	101,380	26	1.1%
	1	500	Block 2	168	281	94	269,428	40	1.8%
	3	No limit	Block 3	1,160	3,461	374	1,856,063	114	5.1%
			Total	192	3,461	6	307,548	86	3.8%
Scenario 14	0.5	50	Block 1	33	112	6	53,054	21	1.0%
	1	500	Block 2	102	374	22	163,834	48	2.1%
	3	No limit	Block 3	1,160	3,461	374	1,856,063	110	4.9%
			Total	192	3,461	6	307,548	88	3.9%
Scenario 15	0.5	50	Block 1	33	112	6	53,054	21	1.0%
	1	800	Block 2	177	1,123	22	282,554	46	2.1%
	3	No limit	Block 3	3,461	3,461	3,461	5,538,252	132	5.9%
			Total	192	3,461	6	307,548	79	3.5%
Scenario 16	0.5	50	Block 1	33	112	6	53,054	21	1.0%
	1	1000	Block 2	177	1,123	22	282,554	46	2.1%
	3	No limit	Block 3	3,461	3,461	3,461	5,538,252	127	5.7%
			Total	192	3,461	6	307,548	77	3.4%

4.4. Estimated Fiscal Revenues and Resource Fee Impact on Cost of Production

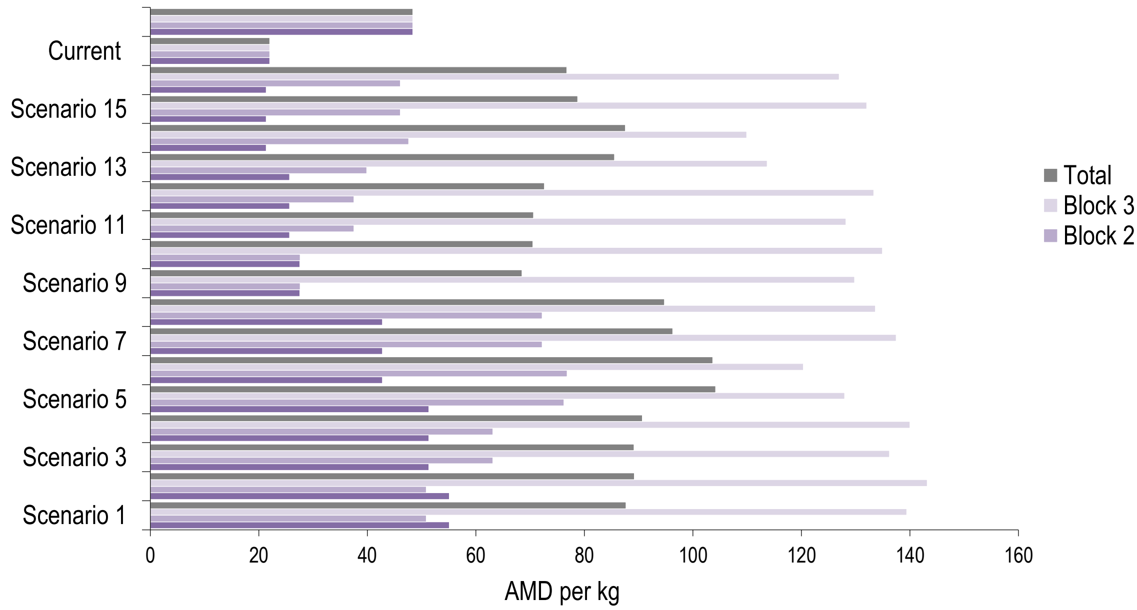
For comparison of possible fiscal revenue outcomes, average figures for the estimated range were calculated. The highest fiscal revenue is estimated for the Scenario 6, and the lowest for Scenario 9. However, all scenario estimations predict a significant increase of fiscal revenues compared to the current level. The major contributors to fiscal revenue increases for all scenarios are fisheries in Block 3.

Figure 4-6: Estimated fiscal revenue comparison among blocks



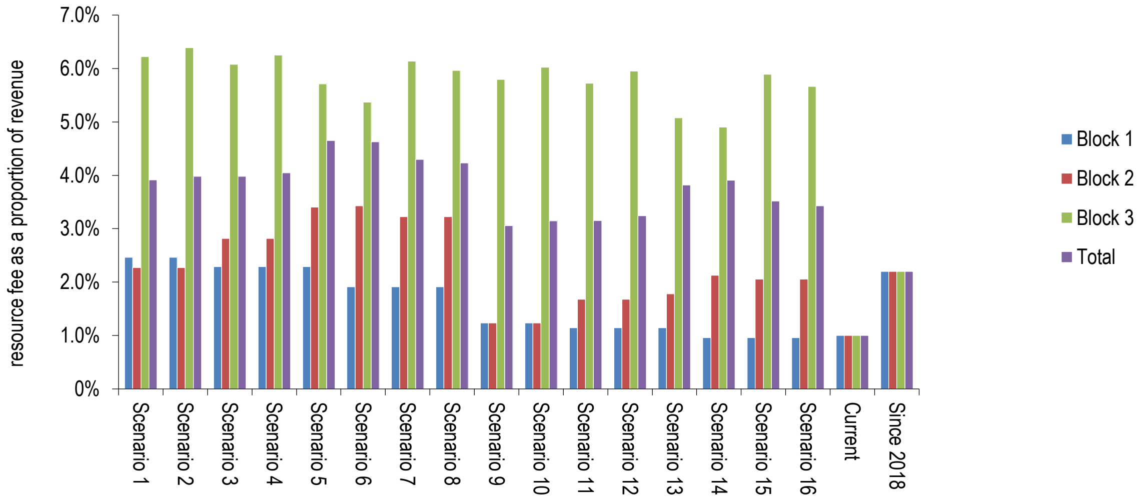
As a next step in the assessment, the impact of increased resource fees on the cost of production for fisheries was estimated. The resource fee contribution to the cost of production for fisheries is assessed by blocks and shown in the following figure (4-7).

Figure 4-7: Resource fee per kg / scenario comparison



It can be observed that the impact is significant for the fisheries in block 3, which, however, are the largest producers and thus the highest water abstracters. These producers would thus receive a greater incentive to use water saving technologies to tackle the increased resource fee challenge.

Figure 4-8. Resource fee as % of revenue / scenario comparison



Resource fee as a proportion of estimated revenue of fisheries was also assessed (figure 4-8). The maximum proportion was 6.4%, which occurred for block 3 fisheries in scenario 2. The minimum proportion was 1%, which occurred for Block 1 fisheries in scenarios 11 through 16.

Average resource fees as a proportion of revenue will increase compared to the current situation for all increasing block structures and expected changes in 2018. However, fisheries in Block 1 will see very little impact following the changes while the very few large fisheries will see a significant impact.

PART C. WATER MANAGEMENT POLICY RECOMMENDATIONS, INCLUDING WATER FEE STRUCTURES

5. Recommendations Pertaining to Groundwater Resource Fees

5.1. Representative Scenario Options

The projected outcomes of new fee structure scenarios were reviewed with the intention of selecting the most representative scenarios to inform policy makers. Able to clearly see a representative selection of the various projected impacts, policy makers may then choose the most effective option in light of policy objectives.

Scenarios 1, 3, and 8 have been determined to be representative of options starting with a higher fee level. This selection was made in favor of the least cost options for fisheries within each group of scenarios. This selection is balancing between water preservation and fisheries competitiveness objectives.

Scenarios 10, 13, and 14 have been determined to be representative of options starting with a lower fee level. This selection was made in favor of the most effective options within each group of scenarios. In this case also the selection is balancing between water preservation and fisheries competitiveness objectives.

Table 5-1: Selected scenarios

Scenario name	Block name	Resource fee (AMD per m3)	Block level (liter/ second)	000 m3	% of fisheries	% of water abstraction
Scenario 1	Block 1	*1.0*	*500*	*15,768*	95%	54%
	Block 2	*1.5*	*1,000*	*31,536*	4%	17%
	Block 3	*3.0*	*No limit*	*No limit*	1%	29%
Scenario 3	Block 1	*1.0*	*250*	*7,884*	89%	43%
	Block 2	*1.5*	*1,000*	*31,536*	9%	28%
	Block 3	*3.0*	*No limit*	*No limit*	1%	29%
Scenario 8	Block 1	*1.0*	*50*	*1,577*	48%	7%
	Block 2	*1.5*	*1,000*	*31,536*	50%	64%
	Block 3	*3.0*	*No limit*	*No limit*	1%	29%
Scenario 10	Block 1	*0.5*	*500*	*15,768*	95%	54%
	Block 2	*1.0*	*800*	*25,229*	4%	17%
	Block 3	*3.0*	*No limit*	*No limit*	1%	29%
Scenario 13	Block 1	*0.5*	*250*	*7,884*	89%	43%
	Block 2	*1.0*	*500*	*15,768*	5%	11%
	Block 3	*3.0*	*No limit*	*No limit*	5%	46%
Scenario 14	Block 1	*0.5*	*50*	*1,577*	48%	7%
	Block 2	*1.0*	*500*	*15,768*	46%	46%
	Block 3	*3.0*	*No limit*	*No limit*	5%	46%

Note: the % may not sum to 100% due to rounding

Figure 5-1: Scenario 1 and Scenario 10 structures

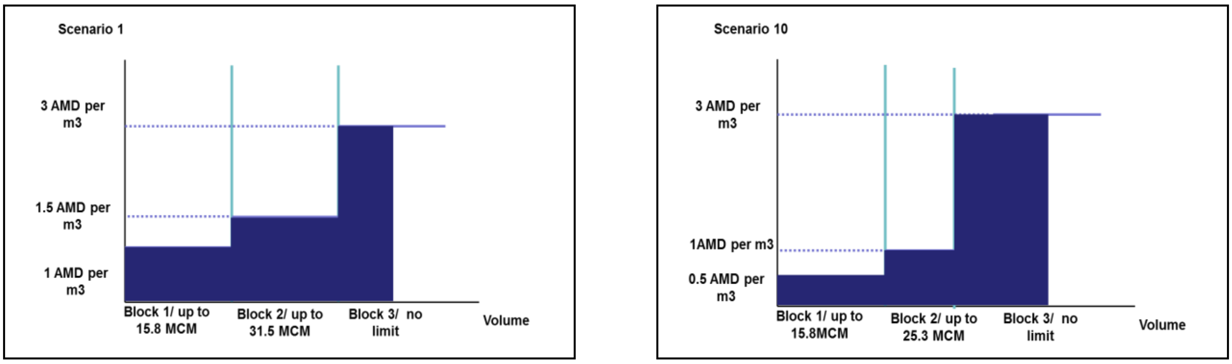


Figure 5-2: Scenario 8 and Scenario 14 structures

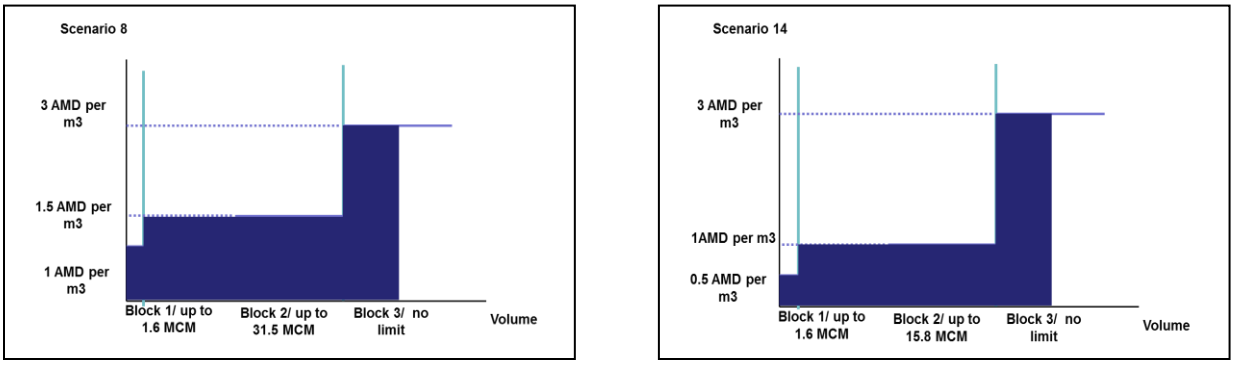
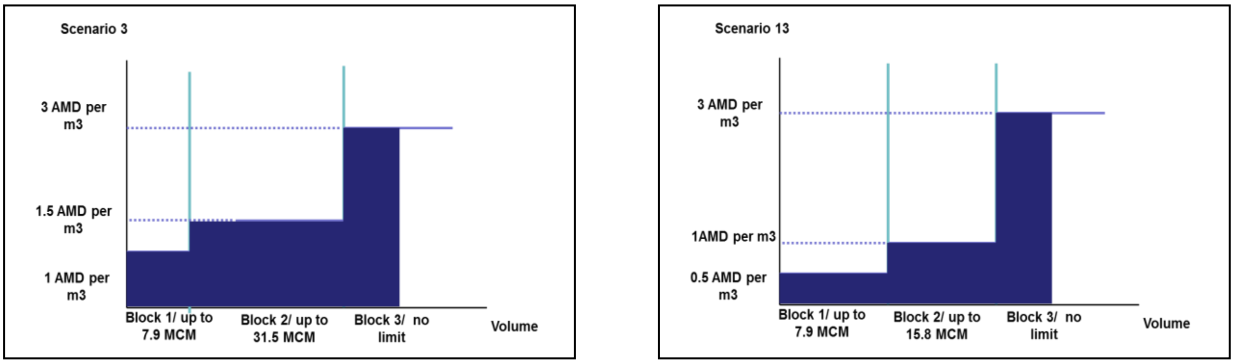


Figure 5-3: Scenario 3 and Scenario 13 structures



5.2. Comparative Analysis of Preferred Options

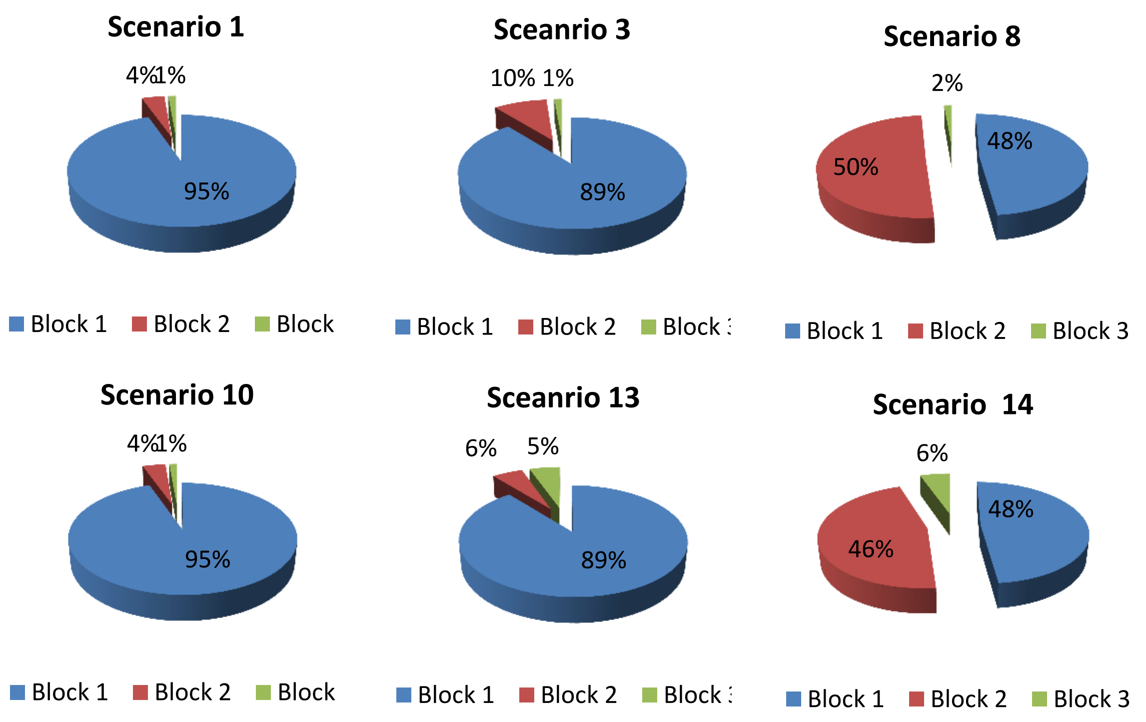
The distribution of fisheries among blocks based according to actual reported water use data (for 2015) by selected fisheries is shown in the next table (5-2). The table also shows the proportion of water used by each block fisheries as a percentage of the total volume of water used.

Table 5-2: Distribution of fisheries based on actual reported water use for 2015

Scenario	Blocks	Number of fisheries	% of fisheries	% of water used
Scenario 1	Block 1	141	*95%*	*54%*
	Block 2	6	*4%*	*17%*
	Block 3	2	*1%*	*29%*
	Total	149	100%	100%
Scenario 3	Block 1	133	*89%*	*43%*
	Block 2	14	*9%*	*28%*
	Block 3	2	*1%*	*29%*
	Total	149	*100%*	*100%*
Scenario 8	Block 1	72	*48%*	*7%*
	Block 2	75	*50%*	*64%*
	Block 3	2	*1%*	*29%*
	Total	149	*100%*	*100%*
Scenario 10	Block 1	141	*95%*	*54%*
	Block 2	6	*4%*	*17%*
	Block 3	2	*1%*	*29%*
	Total	149	100%	100%
Scenario 13	Block 1	133	*89%*	*43%*
	Block 2	8	*5%*	*11%*
	Block 3	8	*5%*	*46%*
	Total	149	*100%*	*100%*
Scenario 14	Block 1	72	*48%*	*7%*
	Block 2	69	*46%*	*46%*
	Block 3	8	*5%*	*46%*
	Total	149	*100%*	*100%*

If policy-makers were to be particularly concerned with the impact of the recommended fee structure on smaller fisheries (for equity concerns), then Scenarios 1 and 10 would be preferable as 95% of the fisheries would be included in Block 1 (the block with the lowest fee rate). On the other hand, if policy-makers wished to maximize revenue generation (financial sustainability), then Scenarios 13 and 14 would be more viable options.

Figure 5-4: Distribution of fisheries among blocks by selected scenarios



Fiscal revenues generated, average resource fee per fishery per block, average production volume, resource fee per kg of fish produced and resource fee as a percentage of revenue of fisheries are also assessed.

Table 5-3: Comparison of selected scenarios

Scenario name	Block name	Resource fee (AMD/ m3)	Block level (liter/ sec)	Fiscal revenue generated	Average resource fee	Average production (ton)	Resource fee per kg (AMD)	Resource fee % of revenue
Scenario 1	Block 1	1	500	359 mln. AMD	2.5 mln. AMD	71	55	2%
	Block 2	1.5	1000	127 mln. AMD	21.2 mln. AMD	585	51	2%
	Block 3	3	No limit	518 mln. AMD	259 mln. AMD	3,461	139	6%
	Total			1005 mln. AMD	6.7 mln. AMD	192	88	4%
Scenario 3	Block 1	1	250	286 mln. AMD	2.2 mln. AMD	63	51	2%
	Block 2	1.5	1000	229 mln. AMD	16.3 mln. AMD	406	63	3%
	Block 3	3	No limit	502 mln. AMD	251.1 mln. AMD	3,461	136	6%
	Total			1018 mln. AMD	6.8 mln. AMD	192	89	4%
Scenario 8	Block 1	1	50	49 mln. AMD	0.7 mln. AMD	33	43	2%
	Block 2	1.5	1000	582 mln. AMD	7.8 mln. AMD	177	72	3%
	Block 3	3	No limit	490 mln. AMD	244.8 mln. AMD	3,461	134	6%
	Total			1120 mln. AMD	7.5 mln. AMD	192	95	4%
Scenario 10	Block 1	0.5	500	180 mln. AMD	1.3 mln. AMD	71	28	1%
	Block 2	1	800	69 mln. AMD	11.5 mln. AMD	585	28	1%
	Block 3	3	No limit	496 mln. AMD	248 mln. AMD	3,461	135	6%
	Total			745 mln. AMD	5 mln. AMD	192	71	3%
Scenario 13	Block 1	0.5	250	143 mln. AMD	1.1 mln. AMD	63	26	1%
	Block 2	1	500	41 mln. AMD	5.2 mln. AMD	168	40	2%
	Block 3	3	No limit	710 mln. AMD	88.7 mln. AMD	1,160	114	5%
	Total			894 mln. AMD	6 mln. AMD	192	86	4%
Scenario 14	Block 1	0.5	50	24 mln. AMD	0.3 mln. AMD	33	21	1%
	Block 2	1	500	256 mln. AMD	3.7 mln. AMD	102	48	2%
	Block 3	3	No limit	684 mln. AMD	85.6 mln. AMD	1,160	110	5%
	Total			965 mln. AMD	6.5 mln. AMD	192	88	4%

Incremental revenues have also been estimated for each scenario. The next table shows the incremental revenues for each scenario compared to the current fee structure as well as the expected fee structure based on the adopted New Tax Code. Incremental revenues generated by the proposed block tariff water abstraction fee scheme are higher than those of the fee scheme recently adopted in the Tax Code by approximately 530-780 million drams.

Table 5-4: Incremental fiscal revenue analysis (million drams)

Fiscal revenue (In mln. AMD)			Current regulation and adopted changes			
			2016-2017	**Starting 2018**	**Starting 2019**	**Starting 2020**
			335	**368**	**402**	**435**
Representative scenarios	Scenario 1	**1,005**	670	637	603	570
	Scenario 3	**1,018**	683	650	616	583
	Scenario 8	**1,120**	785	752	718	685
	Scenario 10	**745**	410	377	343	310
	Scenario 13	**894**	559	526	492	459
	Scenario 14	**965**	630	597	563	530

Note: Estimated fiscal revenues are in blue cells, and incremental fiscal revenues are in the middle white cells.

6. Water Management Recommendations and Tools, and Estimated Impact

The report offers the following key recommendations.

Recommendation 1: A combination of instruments

A number of policy and regulatory tools and measures are applied worldwide for sustainable management of water resources. Among those are:

- Command and control instruments: Water use permits; Water use standards, quotas, restrictions; Administrative measures; and
- Economic instruments: Tradeable water use permits; Water use fee structure;

The management effectiveness is best achieved when the systemic approach is implemented using a combination of command and control, and economic instruments. The key advantage of economic instruments is that they provide incentives for users to change water consumption behavior. However, economic instruments alone are unlikely to be sufficient for effective water use management. In addition to economic instruments the potential use of water abstraction quotas cannot be discarded.

Recommendation 2: Water use pricing

There are various ways to price water abstraction. A two-part structure with an increasing block tariff is most capable to support achieving the sustainable use of groundwater resources satisfying the criteria of ecological sustainability, economic efficiency, financial sustainability, and equity.

Recommendation 3: Additional activities

In addition to the resource fee recommendation presented above, a number of other activities need to be implemented to achieve sustainable groundwater sustainable use in the Ararat Valley. These are presented below.

Focus Area: Prudent Water Sector Management Policy in the Ararat Valley

Observation:

- Science-based research and assessment of the groundwater recharge rate is key to water management policy in the Ararat Valley. The ASPIRED Project, jointly with the US Geological Survey, will work with key stakeholders on groundwater analysis in the Ararat Valley, using modeling tools. This may provide a basis for further thorough assessment of the Ararat Artesian Basin groundwater recharge rate and water abstraction limits.

Recommendation:

- It is recommended that a prudent policy limiting overall water abstraction to the assessed threshold be implemented, along with clear definitions of water abstraction limits by sector in accordance with strategic priorities.

- Before a new assessment is completed, strict measures must be implemented to reduce the level of groundwater abstraction to the defined sustainable rate - 1.1 billion cubic meters per year.

Result:
- Implementation of these efforts will provide a foundation for more sustainable use of groundwater resources and the opportunity for groundwater aquifer recovery.
- These efforts will minimize the probability of future ecological and economic crises and risks caused by water shortages.

Timing of implementation: Short-term (up to 3 years).

Focus area: Enhance Transparency, Reliability and Consistency of Data

Observations:
- In the course of this study, significant problems were encountered regarding data availability and accuracy, particularly on fishery performance and water usage. Databases received from the Ministry of Agriculture and Ministry of Nature Protection are not consistent with one another (the names of lists of fisheries are up to 40% incompatible). One of the important actions is thus to clear up data inconsistency.
- Another issue is transparency and reliability of information found in the databases of different Governmental agencies. Metering and surveillance is critical to effective management of actual water used by the fisheries. Installation of a system of real time water use monitoring will thus represent a much needed tool in these efforts.
- Despite water use meters being installed in fish farms following the requirements of the 2011 GOA Decision N: 1071-N, the preliminary results of field observations show that water meters on many groundwater abstraction points are out of order and that many wells are not equipped with meters. Many of the water meters installed were tampered with to show low volumes of abstraction. In addition, there is a lack of capacity (including human and financial resources) to conduct regular groundwater use compliance monitoring and supervision in the Ararat Valley.
- Automated, online groundwater use monitoring using the SCADA system was piloted in three groundwater abstraction wells in three fish farms in Armavir Marz under the EU EPIRB Project. Additionally, similar systems will be installed in 10 fish farms by the ASPIRED Project.
- All data must be incorporated into the SWCIS.

Recommendations:
- Development of a georeferenced database on fish farms in the Ararat Valley with data on permitted and actual volumes of groundwater abstraction, production volumes, etc. for the use of relevant agencies.
- Online groundwater usage monitoring systems using SCADA need to be installed in all operational fisheries in Ararat Valley.

Results:
- Concise, up-to-date, reliable and transparent data will allow better analysis and more informed decision-making.

- Installation of this technology will preclude the possibility of groundwater over-abstraction, corruption, or fraud and will generate reliable data for analysis of the sector. This will facilitate effective implementation of an increasing block fee structure and allow for reliable analysis of its impact as well as any need for further adjustment and fine tuning.

Cost of the action:

- There are about 336 wells in the Ararat Valley used by the fisheries. The average price for installing a water meter with online connectivity is about AMD 1.75 million. Thus, overall investments required for 100% coverage of fisheries with real time groundwater use metering and online data transfer is about AMD 588 million, or USD 1.24 million. Annual maintenance costs are estimated at USD 70.7 thousand per well per year, which overall will be AMD 33.6 million.

Timing of implementation: Short-term (up to 3 years).

Focus area: Closure of Abandoned Wells

Observations:

The GOA's efforts toward temporary or permanent closure of abandoned groundwater wells in the Ararat Valley (belonging to communities and fish farms) from 2014-2016 need to be continued. As of September 15, 2016, about 2,807 groundwater wells (with a depth of more than 50 meters) were measured as a part of the field inventory being conducted with support of the USAID ASPIRED Project. Statistics on the inventory are presented in the tables below:

Table 6-1: Statistics on wells measured as of mid- September 2016

Status	Number of wells	Discharge, liters/sec	Estimated MCM/year
Used/Operational	1,775	64167.7	2,023.0
Not used, including those with leakage	831, including 128 with leakage	1,096.4	34.6
Temporarily closed	118	33.0	1.0
Permanently closed in 2016	3	0	0
Sealed	27	0	0
Monitoring wells	53	0	0
Total	**2807**	**65,297.1**	**2,058.6**

Data Source: Interim results of field inventory of groundwater wells and fish farms in the Ararat Valley, the ASPIRED Project

While the inventory is still underway, initial assessment reveals that there are 831 groundwater wells currently not in use, including 128 that are filled with stone and garbage and have discharge. The total discharge of these wells is 1,096.4 liters/second or 34.6 MCM/year.

Table 6-2: Statistics on abandoned wells

Status	Number of wells	Discharge, liters/sec	Estimated MCM/year
Not used at the moment of field measurements	545	0	0
Not used, filled with stones, sand, garbage	158	0	0
Not used and have discharge	128	1,096.4	34.6
Total	**831**	**1,096.4**	**34.6**

Data Source: Interim results of field inventory of groundwater wells and fish farms in the Ararat Valley, the ASPIRED Project

Recommendations:

Efforts taken by the Government toward temporary or permanent closure of unused groundwater wells in the Ararat Valley from 2014-2016 need to be continued. 128 wells need to be closed or valve regulated.

Results:

It has been estimated that this measure could save approximately 34.6 MCM of groundwater annually.

Cost of the action:

According to the MNP, the average actual cost per well closure (permanently of temporarily) is AMD 2.5 million. Valve regulation installation may cost on average AMD 1.2 million per well. More thorough assessment is needed to determine which wells need to be closed and which ones are better to put under valve regulation. However, an approximate estimate of required funding for this measure is AMD 231 million.

Timing of implementation: Short-term (up to 3 years).

Focus Area: Piloting Water Saving Technologies and Knowledge Transfer

Observations:

- As previously mentioned, a pilot project has been underway in cooperation with the FAO to introduce water saving technology in an Ararat Valley fishery. However, according to the FAO report, the cost for building a complete new outdoor recirculating aquaculture system (RAS) for trout farming in Armenia is estimated to be roughly in the range of USD 500 thousand per 100 tons/year of production capacity. In the case of existing farms, paddle-wheels, airlifts for aeration and moving water, water pumps for return-pumping, and sludge sedimentation/sludge traps would need to be installed. Investment in water-saving equipment to cut down water intake by two thirds for 100 tons/year of production is roughly estimated at a cost ranging between USD 50-150 thousand depending on the amount of home-made equipment, pre-existing equipment, locally-produced equipment, local farm conditions, and the level sophistication of the solution chosen. The smaller the scale of the production more investments per kg will be required (form 10 to 30%). It is therefore understood that only larger producers will be able to implement this technology in the cost efficient manner.

- As a part of the ASPIRED Project, a pilot project is currently underway on re-using discharged water from a fish farm for the irrigation of community lands. The project is designed for the irrigation of 40 hectares of arable land in the community of Hayanist.

Recommendations:

- The results of the pilot projects' implementation need to be continually observed and reported by the Ministry of Agriculture. Lessons learned must also be transferred to other fisheries in the region.
- For the large scale implementation of secondary water use, a technical and economic feasibility assessment must be conducted, including assessment of institutional, infrastructure and regulatory factors.

Results:

- If the pilot is successful, the fish production process can become up to three times more water-efficient than current production practices in Ararat Valley. As a result, the impact of a resource fee on fisheries' production costs will be significantly reduced. Considering the required investments, it is estimated that only larger fisheries will be able to implement this technology in a cost efficient manner, assuming the Government provides concessional support for adoption of the technology.
- Successful and effective technological solutions will reduce water abstraction volumes and increase overall production output.

Timing of implementation: Short-to-long term (3-10 years)

Focus Area: New Technologies Financing Options

Observations:

Even if the best technology is readily available and tested in many fisheries in the Ararat Valley, a business will not implement it without affordable financing options for the required capital investments.

Recommendations:

It is recommended that the Ministry of Agriculture, the Ministry of Economic Development and the Ministry of Finance explore the possibility of providing financing options to fisheries that want to implement new water saving technologies. These can include, inter alia:

- Subsidized loans
- Direct financing
- Tax privileges
- Leasing options
- Special guarantees

Another option can be to direct a portion of fiscal revenues generated from increased water fees to support water saving technology investment. This can be done with a special fund or with annual budget items, based on the predicted fiscal revenues from resource fees.

Results:

- Diminished financial pressure on fisheries in the adoption of the new technologies.

Timing of implementation: Short-to-medium (3 to 5 years)

Key Message

A key message from the analysis is that regardless of the tools or combination of tools selected to achieve sustainable water abstraction in the Ararat Valley, resources, staffing, and capacity are needed to achieve effective implementation. In particular up-to-date reliable data and information is needed to (1) assess the status of implementation of the selected tools; (2) to estimate the impacts of the selected tools on water users and on water use; and (3) to facilitate the review of the tools as socio-economic conditions change over time.

Selected Priorities

In addition to the recommendations offered above, a number of next steps would appear to be of immediate, and arguably urgent, importance. Three such steps are briefly presented below for purpose of pursuing the on-going discussion. These (and other) actions would have to be further detailed and developed perhaps in the context of the development of an *Ararat Valley Groundwater Conservation Action Plan*. Such action plan should provide details of: (1) the appropriate timing and sequencing of the implementation of the various recommendations presented in this report, including the selected priorities mentioned below; (2) the roles and responsibilities of various stakeholders, including those of the selected implementing entity; and of (3) the nature and role of Armenia's development partners in support of the overall objectives of the action plan.

<u>Selected Priority 1</u>

In the course of this study, various water abstraction datasets were used. These were found to be of varying reliability and consistency. A *first priority* is to put in place a comprehensive and reliable data collection and management system for groundwater resource use in the Ararat Valley. Among other components, this will include:

- Data collection (metering) system to monitor water abstraction, recognizing that the nature and degree of sophistication of the water abstraction monitoring system need not be the same across all groundwater users;
- Centralized database management system;
- Adequate and appropriate staffing and resources, along with strong data analysis capacity.

This is a no-regret priority: It must be put in place regardless of the nature of the actions or activities selected by government to conserve the groundwater resources of the Ararat Valley.

It should be noted that the data collection and management system should target all users of the groundwater resource, and not solely the fisheries sector. The timing of implementation of this priority should be such as to allow estimating the impacts of the selected actions and activities on water users and on water use against an estimated baseline without actions.

Selected Priority 2

In order to protect the groundwater resources of the Ararat Valley, water abstraction (demand) must not exceed the natural recharge rate of the resources (supply). Monitoring demand (as indicated above) is a key component for achieving this purpose. Simultaneously, reliably establishing the resource recharge rate is the other key component.

Hence the second priority is to scientifically review the existing sustainable water abstraction consumption established in 1984, and adopted in 2015. The implementation of this priority may involve:

- Discussion with experts to determine the reliability of the existing sustainable water abstraction estimate; and then
- If needed, to conduct a scientific study to review the existing estimates.

Once the above two activities are implemented, demand and supply will be known and assuming that demand (in the baseline scenario) exceeds supply, it will be possible to establish a target in terms of desired reductions in groundwater resources abstraction in the Ararat Valley.

Selected Priority 3

Assuming the adoption of a water pricing approach along the lines recommended in this report, a key issue will pertain to the use of the incremental revenues generated by the revised pricing structure.

Water users are in a unique position to understand the nature and characteristics of their production processes, and should therefore be in best position to determine ways, means, and technologies to respond to the various measures selected by government to conserve Ararat Valley's groundwater resources.

As shown in this report, the adoption of a block tariff structure will generate incremental fiscal revenues. These may be deposited into government general revenues. However, without a clear mechanism allowing for the earmarking of a proportion of the incremental revenues to provide financial support (limited in size and limited in time) for the adoption of approaches and technologies to reduce groundwater resources abstraction, support for the recommended water abstraction pricing approach may be lacking.

Hence, a third priority is to set in place a transparent and accountable financial mechanism complying with the laws and regulations of the Republic of Armenia to facilitate the earmarking of (some or all) revenues (or incremental revenues) which will be generated with the adoption of the revised groundwater pricing approach.

Annex 1: List of Nominated Interagency Task Force Members

No.	Name	Position
RA President Office		
1.	Karen Mukhsyan	RA President Office
RA Government of Armenia Office		
2.	Armenak Khachatryan	Expert of Financial and Economic Department of the RA Government Staff
3.	Rafik Antonyan	Deputy Head of Territorial Development and Environmental Department of the RA Government Staff
RA National Assembly		
4.	Hermine Poghosyan	Expert of the NA Standing Committee on Agriculture and Environment
RA Ministry of Nature Protection		
5.	Ashot Harutyunyan	Head of Environmental Strategic Programs and Monitoring
6.	Artyom Mkhitaryan	Deputy Head of the Water Resources Management Agency
RA Ministry of Finance		
7.	Hrayr Yesayan	Head of Division of Financial Planning of Current Budget Expenditures on Agriculture, Food Safety, Nature Protection and Water Economy Sectors
8.	Ori Alaverdyan	Head of Income Policy Division of Revenues Policy, Assessment and Disciplinary Programs Department
RA Ministry of Agriculture		
9.	Tigran Aleksanyan	Head of Fish Breeding and Bee Keeping Division
RA Ministry of Justice		
10.	Aharon Khachatryan	RA Ministry of Justice, Deputy Head of Legal Acts Inspection Agency
Union of Fish Producers and Exporters of Armenia, NGO		
11.	Arthur Atoyan	Chairman
Association of Young Environmental Lawyers and Economists		
12.	Erik Grigoryan	President
Union of Armenian Fish Farmers		
13.	Armen Buniatyan	President

Annex 2: Ararat valley community survey results summary

#	Name of the community	Number of wells	Number of households	Water reduction was observed	Reduction was significant or not	Are there fisheries near the community?	Number of fisheries indicated	Number of households interviewed	Number of households indicated water reduction
1	Nizami	13	300	Yes				3	3
2	Zorak	10	530	Yes		yes	6	3	3
3	Dashtavan	6	650	Yes		yes	2	3	1
4	Darakert	3	650	Yes				3	3
5	Darbnik	19	360	Yes	yes	yes	1	3	0
6	Hovtashat	67	870	Yes	yes	yes	23	3	2
7	Sayat-Nova	17	520	Yes	yes	yes	3	3	3
8	Gai	30	710	Yes	yes	yes	7	3	2
9	Haykashen	12	380	Yes	yes			3	2
10	Griboyedov	17	130	Yes				3	3
11	Jrarat	22	700	Yes	yes			3	3
12	Arevabuyr	3	254	Yes	yes	yes	2	3	2
13	Hovtashen	6	300	Yes				3	1
14	Araqsavan	0	215	N/A				3	2
15	Burastan	0	580	N/A				3	3
16	Azatavan	3	840	No				3	3
17	Baghramyan	2	455	Yes	yes			3	3
18	Dalar	5	750	Yes	yes			3	3
19	Artashar	6	297	Yes	yes			3	3
20	Yeraskhahun	15	425	Yes	yes			3	3
	Total	**256**	**9916**				**44**	**60**	**48**

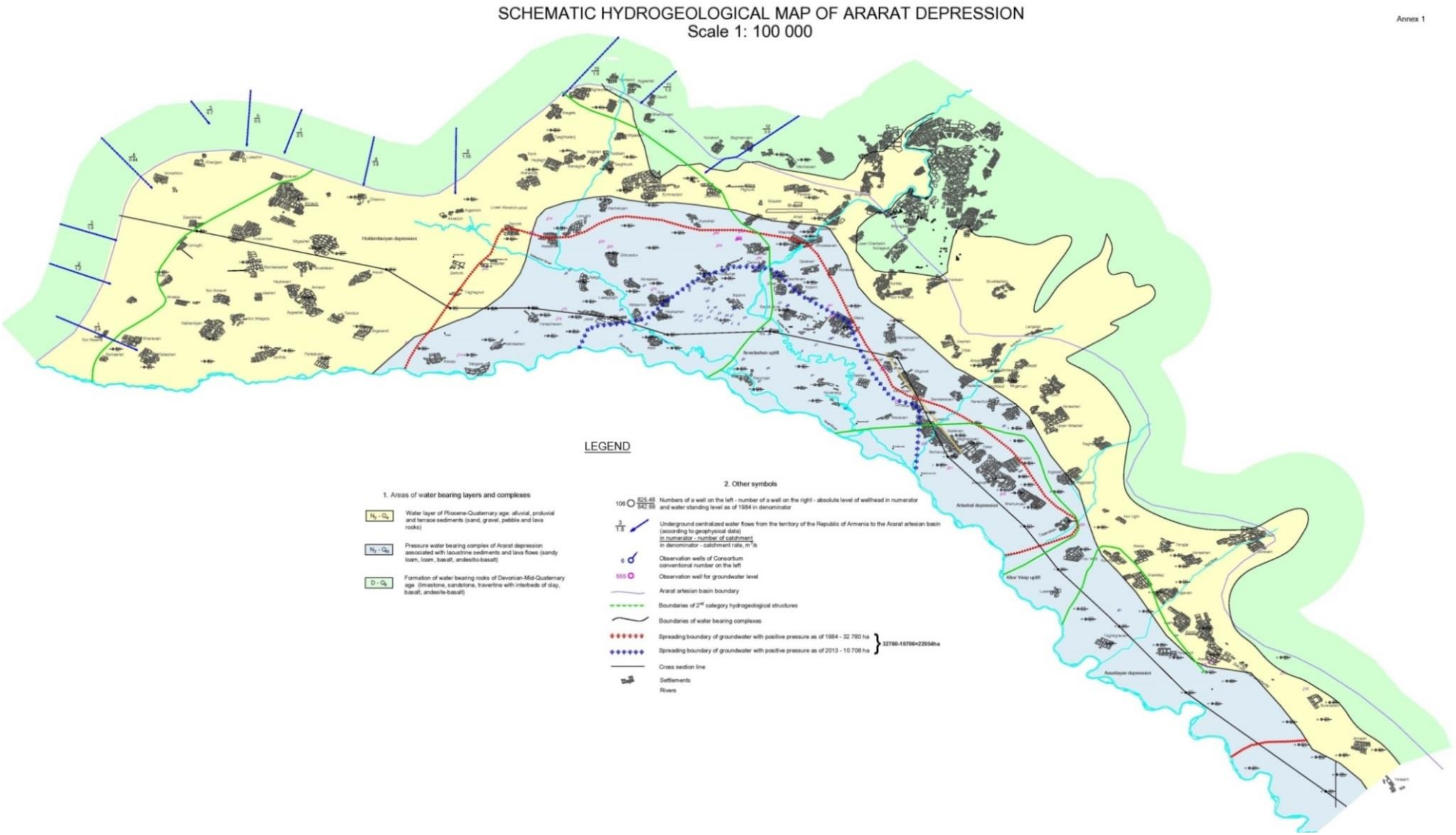
Annex 3: Ararat valley water user association survey summary

WUA Name	*Number of wells*	*Total number of water users (households)*	*Number of households using water from wells*	*Is there decrease of water (Yes/No)*	*When the decrease started (year)*
Masis	132	7500	300	Yes	2013
Azat	24	7500	1200	Yes	2013
Sev Jur Aghtamar	44	1700	250	Yes	2007
Artashat	29		1000	Yes	2011
Vagharshapat	129	5715	3000	Yes	2007
Total	**358**	**22415**	**5750**		

Taking measures by WUAs and cost of impact

WUA	*Wells (Units)*	*Depth (Meter)*	*Measure*	*Number of wells deepened*	*Total cost for deepening (mln. AMD)*	*Number of upgraded pumps*	*Total cost for upgrading (mln. AMD)*	*Total expenditures (mln. AMD)*
Masis	132	70-120	N/A					
Azat	24	25-40	Deepening of wells and replacing or upgrading the pumps	6	1,5	15 (in 2016)	7,5	9
Sevjur-Akhtamar	44	80-120	N/A					
Artashat	29	40-50	N/A			29	0.2	5.8
Vagharshapat	129	100-170-	Deepening of wells for 5-10 m and replacing or upgrading the pumps	129	10,3	129	38,7	49.

Annex 4: Schematic hydrogeological map of Ararat depression: artesian zone



Source: Assessment Study of Groundwater Resources in the Ararat Valley, USAID Clean Energy and Water Program, 2014.

Annex 5: Template of questionnaire for survey

Արարատյան դաշտի ստորերկրյա ջրային ռեսուրսի բնօգտագործման վճարի օպտիմալ դրույքաչափը վերլուծելու նպատակով՝ Արարատյան դաշտում ջրօգտագործման, ձկնարտադրության ծավալների, ձկնարտադրության մեջ ընդգրկված միջոցների և ծախսերի վերաբերյալ իրական պատկեր ունենալու համար, ԳԱՏՕ ծրագրի կողմից իրականացվող հարցում:

Հարցաշար

		Ընտրել ցուցակից	Լրացնել	
Ընդհանուր հարցեր				
1 Կազմակերպության անվանումը				
2 Կազմակերպության գտնվելու վայրը				
3 Լրացնողի անուն, ազգանուն				
4 Լրացնողի պաշտոնը կազմակերպությունում				
5 Լրացման ամսաթիվը				
Արտադրություն և վաճառք				
6 Բուծվող ձկնատեսակները և այլ արտադրանքը				
Իշխանազգիներ	☐			
Սաղմոնազգներ	☐			
Թառափազգիներ	☐			
Կարպազգիներ	☐			
Խավիար	☐			
Խեցգետին	☐			
Այլ ջրային կուլտուրաներ	☐			
7 Օգտագործվող ջրավազանի մակերեսը				**մ2**
8 Օգտագործվող ջրավազանի ծավալը				**մ3**
9 Ընդհանուր ջրավազան(ներ)ի ծավալը				**մ3**
10 Տարեկան ջրառը				**մ3**
11 Օգտագործվող ջրային ռեսուրսը	☐ Մակերևութային		☐ Ստորերկրյա	
12 Առկա ձկների և այլ կուլտուրաների քանակը	2013	2014	2015	
Իշխանազգիներ				**կգ**
Սաղմոնազգներ				**կգ**
Թառափազգիներ				**կգ**
Կարպազգիներ				**կգ**
Խավիար				**կգ**
Խեցգետին				**կգ**
Այլ ջրային կուլտուրաներ				**կգ**
13 Արտադրության ծավալը ըստ տարիների	2013	2014	2015	
Իշխանազգիներ				**կգ**
Սաղմոնազգներ				**կգ**
Թառափազգիներ				**կգ**
Կարպազգիներ				**կգ**
Խավիար				**կգ**
Խեցգետին				**կգ**
Այլ ջրային կուլտուրաներ				**կգ**
14 Ընդհանուր վաճառքի ծավալները ըստ տարիների	2013	2014	2015	
Իշխանազգիներ				**կգ**
Սաղմոնազգներ				**կգ**
Թառափազգիներ				**կգ**
Կարպազգիներ				**կգ**
Խավիար				**կգ**
Խեցգետին				**կգ**
Այլ ջրային կուլտուրաներ				**կգ**
15 Արտահանման ծավալները ըստ տարիների	2013	2014	2015	
Իշխանազգիներ				**կգ**
Սաղմոնազգներ				**կգ**
Թառափազգիներ				**կգ**
Կարպազգիներ				**կգ**
Խավիար				**կգ**
Խեցգետին				**կգ**
Այլ ջրային կուլտուրաներ				**կգ**
16 Ինքնարժեքը ըստ տարիների	2013	2014	2015	
Իշխանազգիներ				**ՀՀ դրամ**
Սաղմոնազգներ				**ՀՀ դրամ**
Թառափազգիներ				**ՀՀ դրամ**
Կարպազգիներ				**ՀՀ դրամ**
Խավիար				**ՀՀ դրամ**
Խեցգետին				**ՀՀ դրամ**
Այլ ջրային կուլտուրաներ				**ՀՀ դրամ**
17 Վաճառքի եղանակները տեղական շուկայում				
մատակարարում վերամշակող ձեռնարկություններին	☐			
մատակարարում միջնորդներին	☐			
մատակարարում մանրածախ և մեծածախ ցանց	☐			
ուղղակի վաճառք վերջնական սպառողներին	☐			
18 Արտահանման եղանակները				
Միջնորդների միջոցով	☐			
Ուղղակի արտահանում	☐			
19 2016 թ. դրությամբ գործող վաճառքի գինը	**Ներքին շուկա**	**Արտահանում**		
Իշխանազգիներ				**ՀՀ դրամ**
Սաղմոնազգներ				**ՀՀ դրամ**
Թառափազգիներ				**ՀՀ դրամ**
Կարպազգիներ				**ՀՀ դրամ**
Խավիար				**ՀՀ դրամ**
Խեցգետին				**ՀՀ դրամ**
Այլ ջրային կուլտուրաներ				**ՀՀ դրամ**
20 Բուծման մեթոդ				
21 Արտադրության մեթոդ				
22 Արտահահանման հիմնական ուղղությունները	**Առաջին**	**Երկրորդ**	**Երրորդ**	
Իշխանազգիներ				
Սաղմոնազգներ				
Թառափազգիներ				
Կարպազգիներ				
Խավիար				
Խեցգետին				
Այլ ջրային կուլտուրաներ				
Ֆինանսական տվյալներ				
23 Ներքին շուկայում ընդհանուր իրացման ծավալը	2013	2014	2015	
Իշխանազգիներ				**ՀՀ դրամ**
Սաղմոնազգներ				**ՀՀ դրամ**
Թառափազգիներ				**ՀՀ դրամ**
Կարպազգիներ				**ՀՀ դրամ**
Խավիար				**ՀՀ դրամ**
Խեցգետին				**ՀՀ դրամ**
Այլ ջրային կուլտուրաներ				**ՀՀ դրամ**
24 Արտաքին շուկայում ընդհանուր իրացման ծավալը	2013	2014	2015	
Իշխանազգիներ				**ՀՀ դրամ**
Սաղմոնազգներ				**ՀՀ դրամ**
Թառափազգիներ				**ՀՀ դրամ**
Կարպազգիներ				**ՀՀ դրամ**
Խավիար				**ՀՀ դրամ**
Խեցգետին				**ՀՀ դրամ**
Այլ ջրային կուլտուրաներ				**ՀՀ դրամ**

Annex 6: Block structure scenarios impact estimation based on WUPs

Scenario name	Block name	% of fisheries	Fiscal revenue generated (000 AMD)	Average resource fee per fishery in the block (000 AMD)	Maximum resource per fishery in the block (000 AMD)
Scenario 1	Block 1	*93%*	428,302	3,426	15,768
	Block 2	*4%*	173,076	28,846	39,420
	Block 3	*2%*	898,200	299,400	433,355
	Total	*100%*	**1,499,578**	**11,191**	**433,355**
Scenario 2	Block 1	*93%*	428,302	3,426	15,768
	Block 2	*2%*	62,482	20,827	25,702
	Block 3	*4%*	1,128,847	188,141	442,816
	Total	*100%*	**1,619,632**	**12,087**	**442,816**
Scenario 3	Block 1	*84%*	301,349	2,691	7,758
	Block 2	*14%*	335,911	17,680	43,362
	Block 3	*2%*	874,548	291,516	425,471
	Total	*100%*	**1,511,808**	**11,282**	**425,471**
Scenario 4	Block 1	*84%*	301,349	2,691	7,758
	Block 2	*12%*	213,492	13,343	29,644
	Block 3	*4%*	1,081,543	180,257	434,932
	Total	*100%*	**1,596,384**	**11,913**	**434,932**
Scenario 5	Block 1	*84%*	301,349	2,691	7,758
	Block 2	*10%*	139,184	10,706	19,710
	Block 3	*7%*	1,291,655	143,517	449,123
	Total	*100%*	**1,732,188**	**12,927**	**449,123**
Scenario 6	Block 1	*31%*	42,076	1,026	1,577
	Block 2	*63%*	513,113	6,108	22,864
	Block 3	*7%*	1,234,891	137,210	442,816
	Total	*100%*	**1,790,080**	**13,359**	**442,816**
Scenario 7	Block 1	*31%*	42,076	1,026	1,577
	Block 2	*65%*	596,882	6,861	32,797
	Block 3	*4%*	1,043,700	173,950	428,624
	Total	*100%*	**1,682,659**	**12,557**	**428,624**
Scenario 8	Block 1	*31%*	42,076	1,026	1,577
	Block 2	*67%*	728,762	8,097	46,516
	Block 3	*2%*	855,627	285,209	419,164
	Total	*100%*	**1,626,465**	**12,138**	**419,164**
Scenario 9	Block 1	*93%*	214,151	1,713	7,884
	Block 2	*4%*	99,616	16,603	23,652
	Block 3	*2%*	827,244	275,748	409,703
	Total	*100%*	**1,141,011**	**8,515**	**409,703**
Scenario 10	Block 1	*93%*	214,151	1,713	7,884
	Block 2	*2%*	33,771	11,257	14,507
	Block 3	*4%*	1,005,857	167,643	422,317
	Total	*100%*	**1,253,779**	**9,357**	**422,317**
Scenario 11	Block 1	*84%*	150,675	1,345	3,879
	Block 2	*14%*	198,975	10,472	27,594
	Block 3	*2%*	815,418	271,806	405,761
	Total	*100%*	**1,165,068**	**8,695**	**405,761**
Scenario 12	Block 1	*84%*	150,675	1,345	3,879
	Block 2	*12%*	121,304	7,582	18,449
	Block 3	*4%*	982,205	163,701	418,375
	Total	*100%*	**1,254,184**	**9,360**	**418,375**
Scenario 13	Block 1	*84%*	150,675	1,345	3,879
	Block 2	*10%*	75,707	5,824	11,826
	Block 3	*7%*	1,185,221	131,691	437,297
	Total	*100%*	**1,411,603**	**10,534**	**437,297**
Scenario 14	Block 1	*31%*	21,038	513	788
	Block 2	*63%*	320,000	3,810	14,980
	Block 3	*7%*	1,156,839	128,538	434,143
	Total	*100%*	**1,497,877**	**11,178**	**434,143**
Scenario 15	Block 1	*31%*	21,038	513	788
	Block 2	*65%*	375,058	4,311	21,602
	Block 3	*4%*	963,283	160,547	415,222
	Total	*100%*	**1,359,379**	**10,145**	**415,222**
Scenario 16	Block 1	*31%*	21,038	513	788
	Block 2	*67%*	462,189	5,135	30,748
	Block 3	*2%*	805,957	268,652	402,607
	Total	*100%*	**1,289,185**	**9,621**	**402,607**

Annex 7: Block structure scenarios impact estimation based on inventory data

Scenario name	Block name	% of fisheries	Fiscal revenue generated (000 AMD)	Average resource fee per fishery in the block (000 AMD)	Maximum resource per fishery in the block (000 AMD)
Scenario 1	Block 1	*91%*	365,905	3,552	17,313
	Block 2	*6%*	176,649	25,236	33,696
	Block 3	*3%*	667,358	222,453	423,541
	Total	*100%*	**1,209,912**	**10,707**	**423,541**
Scenario 2	Block 1	*91%*	365,905	3,552	17,313
	Block 2	*5%*	142,953	23,825	27,689
	Block 3	*4%*	756,826	189,206	433,002
	Total	*100%*	**1,265,684**	**11,201**	**433,002**
Scenario 3	Block 1	*83%*	264,391	2,813	7,884
	Block 2	*14%*	322,881	20,180	37,638
	Block 3	*3%*	643,706	214,569	415,657
	Total	*100%*	**1,230,978**	**10,894**	**415,657**
Scenario 4	Block 1	*83%*	264,391	2,813	7,884
	Block 2	*13%*	285,243	19,016	31,631
	Block 3	*4%*	725,290	181,322	425,118
	Total	*100%*	**1,274,924**	**11,283**	**425,118**
Scenario 5	Block 1	*83%*	264,391	2,813	7,884
	Block 2	*8%*	128,147	14,239	31,536
	Block 3	*9%*	1,067,960	106,796	439,309
	Total	*100%*	**1,460,497**	**12,925**	**439,309**
Scenario 6	Block 1	*29%*	34,413	1,043	1,577
	Block 2	*62%*	443,137	6,331	25,229
	Block 3	*9%*	1,004,888	100,489	433,002
	Total	*100%*	**1,482,438**	**13,119**	**433,002**
Scenario 7	Block 1	*29%*	34,413	1,043	1,577
	Block 2	*67%*	628,616	8,271	34,784
	Block 3	*4%*	700,061	175,015	418,810
	Total	*100%*	**1,363,090**	**12,063**	**418,810**
Scenario 8	Block 1	*29%*	34,413	1,043	1,577
	Block 2	*68%*	669,408	8,694	40,792
	Block 3	*3%*	624,785	208,262	409,350
	Total	*100%*	**1,328,605**	**11,758**	**409,350**
Scenario 9	Block 1	*91%*	182,953	1,776	8,657
	Block 2	*6%*	99,370	14,196	19,836
	Block 3	*3%*	596,402	198,801	399,889
	Total	*100%*	**878,725**	**7,776**	**399,889**
Scenario 10	Block 1	*91%*	182,953	1,776	8,657
	Block 2	*5%*	79,534	13,256	15,831
	Block 3	*4%*	674,832	168,708	412,503
	Total	*100%*	**937,319**	**8,295**	**412,503**
Scenario 11	Block 1	*83%*	132,195	1,406	3,942
	Block 2	*14%*	194,230	12,139	23,778
	Block 3	*3%*	584,576	194,859	395,947
	Total	*100%*	**911,002**	**8,062**	**395,947**
Scenario 12	Block 1	*83%*	132,195	1,406	3,942
	Block 2	*13%*	170,452	11,363	19,773
	Block 3	*4%*	659,064	164,766	408,561
	Total	*100%*	**961,712**	**8,511**	**408,561**
Scenario 13	Block 1	*83%*	132,195	1,406	3,942
	Block 2	*8%*	73,605	8,178	19,710
	Block 3	*9%*	949,700	94,970	427,483
	Total	*100%*	**1,155,500**	**10,226**	**427,483**
Scenario 14	Block 1	*29%*	17,206	521	788
	Block 2	*62%*	277,029	3,958	16,556
	Block 3	*9%*	918,164	91,816	424,329
	Total	*100%*	**1,212,399**	**10,729**	**424,329**
Scenario 15	Block 1	*29%*	17,206	521	788
	Block 2	*67%*	399,105	5,251	22,927
	Block 3	*4%*	646,450	161,612	405,408
	Total	*100%*	**1,062,761**	**9,405**	**405,408**
Scenario 16	Block 1	*29%*	17,206	521	788
	Block 2	*68%*	426,037	5,533	26,932
	Block 3	*3%*	575,115	191,705	392,793
	Total	*100%*	**1,018,358**	**9,012**	**392,793**