

# **Valuing Nature for Better Basin Management**

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# 1. Background

Water is a critical resource for the Republic of Armenia (RA), supporting livelihoods as well as important sectors such as agriculture, including horticulture, fruit cultivation, cattle breeding, aquaculture (good for more than 25% of the country's economy<sup>1</sup>), and hydropower generation. Additionally, water is critical for maintaining Armenia's natural landmarks, such as Lake Sevan, sites of great cultural and touristic importance to the country. As Armenia's climate is dry and continental, water resources are limited, with most of the country receiving around 500 mm of precipitation per year. Great dependence on water resources, ambitions to grow water-dependent sectors of the economy, and imminent global climate change create an urgent need to understand and manage the country's water resources and water-dependent sectors<sup>2</sup>.

A more strategic management of the RA's water resources is also codified in the 2022 update to RA's Water Code, which aims to not only improve the management of RA's water resources but also support the alignment between RA and key European directives set up by the Comprehensive and Enhancement Partnership Agreement<sup>3</sup>, such as the Water Framework Directive<sup>4</sup>. Such, the new water code aims to reform the water sector and lays a stronger focus on the ecological status of water bodies, notably aiming to develop a more holistic perspective (including social, economic, and ecological aspects) of RA's water resources<sup>4</sup>. One central element of the updated water code is the development of Basin Management Plans (BMPs) for Armenia's six major basins<sup>5</sup> (Figure 1). This aspect is important because acknowledging natural basins as core spatial units on which water resources are generated by hydrologic processes and benefit human users is at the core of the WFD.

While of critical importance for water resource management, BMPs mainly focus on water quality and water consumption by different economic sectors and how to allocate limited water resources to those sectors and water-dependent ecosystems. However, BMPs typically overlook the contribution of upstream ecosystems to the hydrologic cycle<sup>6</sup> and the important role of these ecosystems and upstream watersheds for providing water resources of sufficient

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<sup>1</sup><https://link.springer.com/article/10.1007/s10668-013-9483-8&sa=D&source=docs&ust=1723489484321936&usg=AOvVaw1C6KKINvxSm004b5u7TbeK>

<sup>2</sup>[https://climateknowledgeportal.worldbank.org/sites/default/files/2021-06/15765-WB\\_Armenia%20Country%20Profile-WEB\\_0.pdf](https://climateknowledgeportal.worldbank.org/sites/default/files/2021-06/15765-WB_Armenia%20Country%20Profile-WEB_0.pdf)

<sup>3</sup>[https://www.mfa.am/filemanager/eu/CEPA\\_ENG\\_1.pdf](https://www.mfa.am/filemanager/eu/CEPA_ENG_1.pdf)

<sup>4</sup><https://www.eu4environment.org/news/new-water-code-adopted-legal-reforms-in-armenia-progress-towards-better-preservation-of-water-resources/>

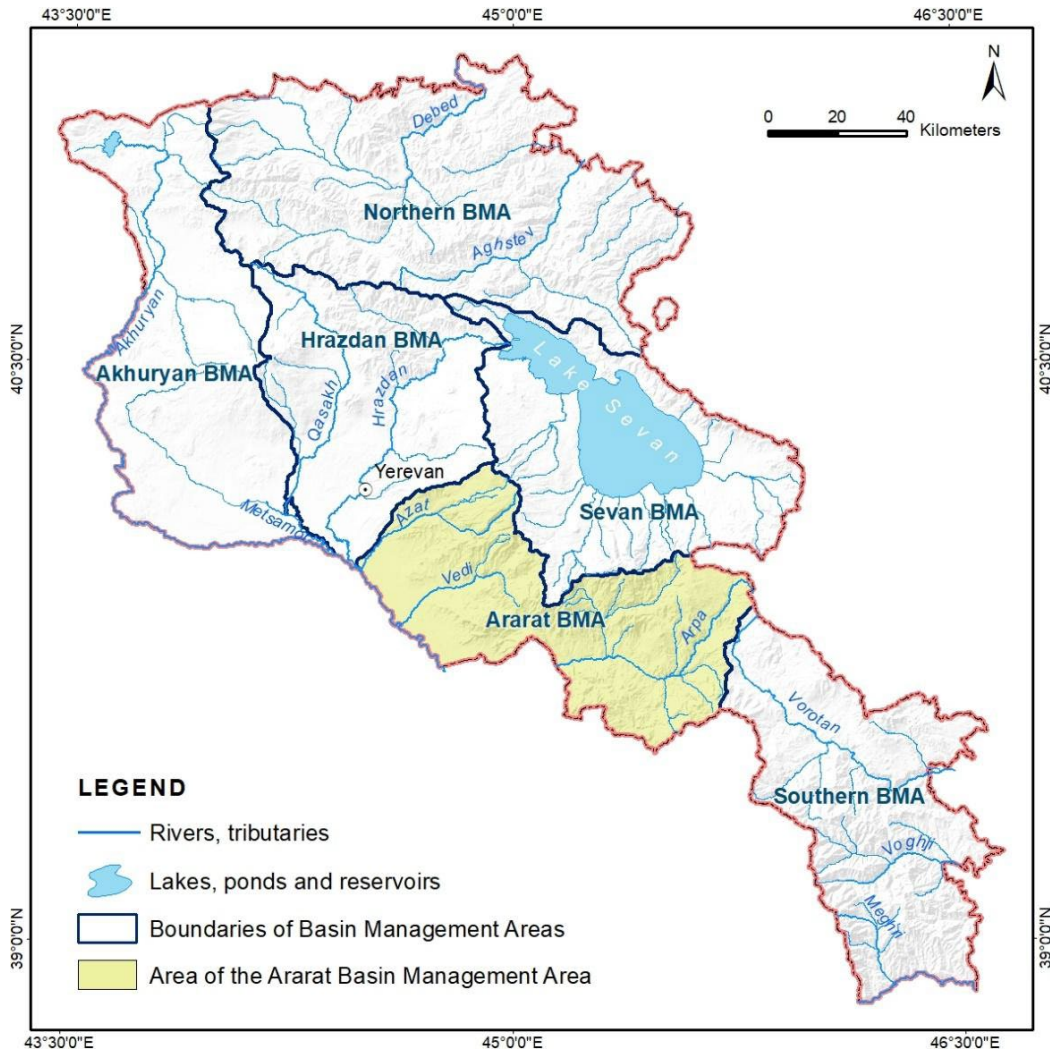
<sup>5</sup><https://www.eu4waterdata.eu/en/where-we-work/armenia/water/river-basin-management.html#:~:text=Armenia%20has%20prepared%20management%20plans,plan%3A%20the%20Northern%20River%20Basin>

<sup>6</sup><https://besjournals.onlinelibrary.wiley.com/doi/pdf/10.1111/1365-2664.12613>

quality and quantity for human uses. A better understanding of these linkages would enable to not only manage water resources (as enshrined in current BMPs) but also the natural terrestrial and aquatic ecosystems from where water resources originate; eventually leading to a perspective on basins that highlights the importance of ecosystems for managing water resources in the 21st century.

This gap can be filled by Natural Capital Approaches and Assessments (NCAAs). NCAAs aim to provide holistic information about how nature, in terms of ecosystem services, contributes to human societies. By highlighting these interdependencies, NCAAs aim to provide decision makers with quantitative evidence for how to manage nature in a way that maintains ecosystems and maximizes benefits for human beneficiaries. Combining BMP's with NCAAs would thus open the door to develop new environmental objectives for BMPs and highlight the need to conserve upstream areas to maintain benefits for downstream water users. In turn, BMPs could become an important use case and multiplier for NCAAs.

Herein, we use the example of the Ararat BMPs (Figure 1) as an example for how strategic alignments between NCAAs and BMPs open new opportunities for managing water resources and nature, particularly in the face of climate change. The BMP for the Ararat basin is due in 2025 and will be renewed 6 years in the future (2031). Beyond informing the Ararat BMP, our work also serves to underscore which additional science is required to further integrate NCAAs in BMPs (the next BMPs due are: Sevan and Hrazdan basins in 2027), and which opportunities arise from such an integration.



**Figure 1.** Republic of Armenia (RA), and the 6 basin management areas, for which Basin Management Plans are being developed, including Ararat BMA.

## 2. Methods and Approaches

Upstream watersheds contribute to downstream water users in many ways. Vegetation and soils modulate the hydrologic cycle, controlling the availability of water resources by governing which fraction of precipitation is released slowly to rivers (baseflow) and which fraction runs off more rapidly (quickflow). These processes are thus critical to control the availability of water resources, but also natural hazards such as floods and droughts. The role of ecosystems goes beyond water quantity, as vegetation retains sediment and nutrients and controls downstream water quality with benefits for users such as hydropower or municipal water users.

There is increasing recognition that water resources problems need to be addressed with a holistic perspective on water quality and quantity, and the same rings even more true for NCAAs. However, we focus our analysis on the role of upstream watersheds in providing sufficient water.

The reason for that is threefold:

- Firstly, as per Armenia's water code, BMPs are focused on water quantity and allocation.
- Secondly, impacts of upstream land use and climate change might be felt most immediately through changes and water quantity.
- Thirdly, data on water quantity are most readily available, making studies around water quantity a good use case for a first linkage of BMPs and NCAAs.

Thus, we focus on one key ecosystem service: the regulation of water (water yield) as the sum of quick flow and baseflow. This ecosystem service is modeled using the [“Seasonal Water Yield” model](#) from the InVEST toolbox developed by the Natural Capital Project.

The integrated inter-institutional team conducted a set of related analyses to increase understanding of the sources of baseflow in the Ararat basin and the economic values derived from it. These included:

- developing an updated land use and land cover map for the Ararat Basin;
- assessing water use permits across sectors for the Ararat Basin;
- conducting a socio-economic study on the value of water resources provided by the Ararat basin
- modeling of the Ararat basin management area's basins to develop a synthetic understanding of the watershed areas where baseflow is produced, the sectors who derive the most value from baseflow, and how these values might be impacted with climate change.

All these activities were executed by the Natural Capital Project-Stanford in close collaboration with the Institute of Botany after A. Takhtajyan of the National Academy of the Sciences of the RA (IoB), local consultants, and in coordination with the “Hydrometeorology and Monitoring Center” SNCO of the Ministry of Environment.

**Developing an updated land use land cover map.** An updated land use map for Ararat Basin was developed, combining cadastral data and other secondary information to derive a spatial overview over where water users (e.g., farms, fish farms) and natural ecosystems (e.g.,

protected areas). The cadastral land use geospatial data was obtained from the Cadastre Committee of the RA.

**Assessment of water use permits:** This assessment used data from the Ministry of Environment database of water use permits to characterize the location of water use permits across key sectors including hydropower, irrigated agriculture, and fish farming.

**Sociological surveys and economic valuation of the value of water resources in the Ararat Basin:** Aiming to understand which sectors benefit most from water resources, structured interviews were conducted with stakeholders in water-dependent sectors. Interviews included questions regarding the value of water in a sector, issues related to water quality and quantity, and the sensitivity of economic activities to water scarcity. Secondly, an economic valuation was performed to calculate the economic value that is generated for around 114 beneficiaries across 3 sectors: fish farms, agriculture, and hydropower.

**Putting it all together:** Sources and values of baseflow in the Ararat under current and future climate.

The [“Seasonal Water Yield” \(SWY\) model](#) was deployed from the InVEST toolbox developed by the Natural Capital Project to model where water resources originate in the Ararat BMP area, and how climate change will impact water resources users. The SWY model for the Ararat Basin was validated with local data, observed at nine gauging stations (each with around 40 years of data). The water yield under current climate conditions, as well as for two future time horizons (2041-2070, 2071-2100) was evaluated according to the IPCC SSP585 scenario (CMIP6).

### 3. Economic valuation of water provision

Through the assessment of the strengths, weaknesses, opportunities, and limitations of three methods - Gross Production, Total Economic Valuation, and Comparative Assessment the economic value of one cubic meter of water in the Hydropower, Fish Farming, and Horticulture sectors has been evaluated. These methods aim to quantify the monetary value of water as Natural Capital and align with the study’s objectives.

Valuing water resources in the Ararat Basin faced challenges due to the lack of a standardized methodology and limited data on sector revenues and costs. Three approaches were used:

1. **Economic Value:** Benefits directly obtained from water users of economic sectors.

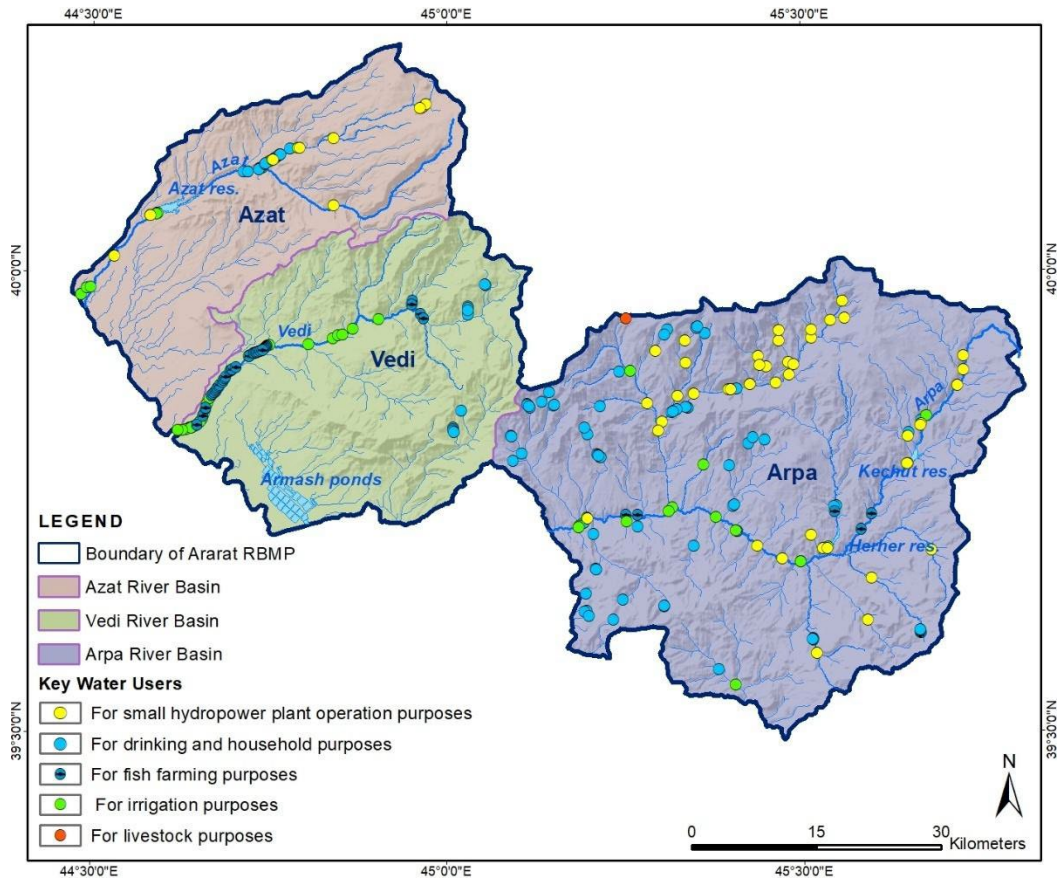
2. **Gross Product (GP):** Assesses water's economic contribution.
3. **Comparative Advantage:** Evaluates sector efficiency in water use.

Based on the aforementioned methodological approaches, the main results obtained in the fields of hydropower (53), fish farming (22), and agriculture (39), according to 114 water users (Figure 2) are presented in Table 1.

These methods assign a monetary value to water, reflecting its role as Natural Capital. Due to insufficient data, the assessment relies mainly on Water Use Fees, Total Volume, and Gross Product. Data collection was hindered by the lack of a unified database for the Ararat Basin and the region's separation from local communities. The Hydropower sector's pricing structure, as a natural monopoly, also complicates valuation.

<b>Sub-sector</b>	<b>Fee for 1m<sup>3</sup> water, AMD</b>	<b>Total water used per sub sector, m<sup>3</sup>/year</b>	<b>Total Value (Cost) from Water use Fees, AMD</b>	<b>Gross Product of water (AMD/m<sup>3</sup>)</b>	<b>Total value (revenue) created by sub-sector, AMD/year</b>
HPPs	0,1	15,942,961,728	1,594,296,173	0,348 AMD/m <sup>3</sup>	5,554,344,853
Fish Farming	0,975	43,191,705	42,111,913	159 AMD/m <sup>3</sup>	6,873,063,943
Agriculture/ Horticulture	9,6	197,376,419	1,894,813,625	469 AMD/m <sup>3</sup>	92,641,421,040

**Table 1.** Results of the economic valuation of the Ecosystem Services (Hydropower, Fish Farming and Agriculture/Horticulture sectors) in the Ararat Basin Management Area (Ararat and Vayots Dzor regions), 2023.



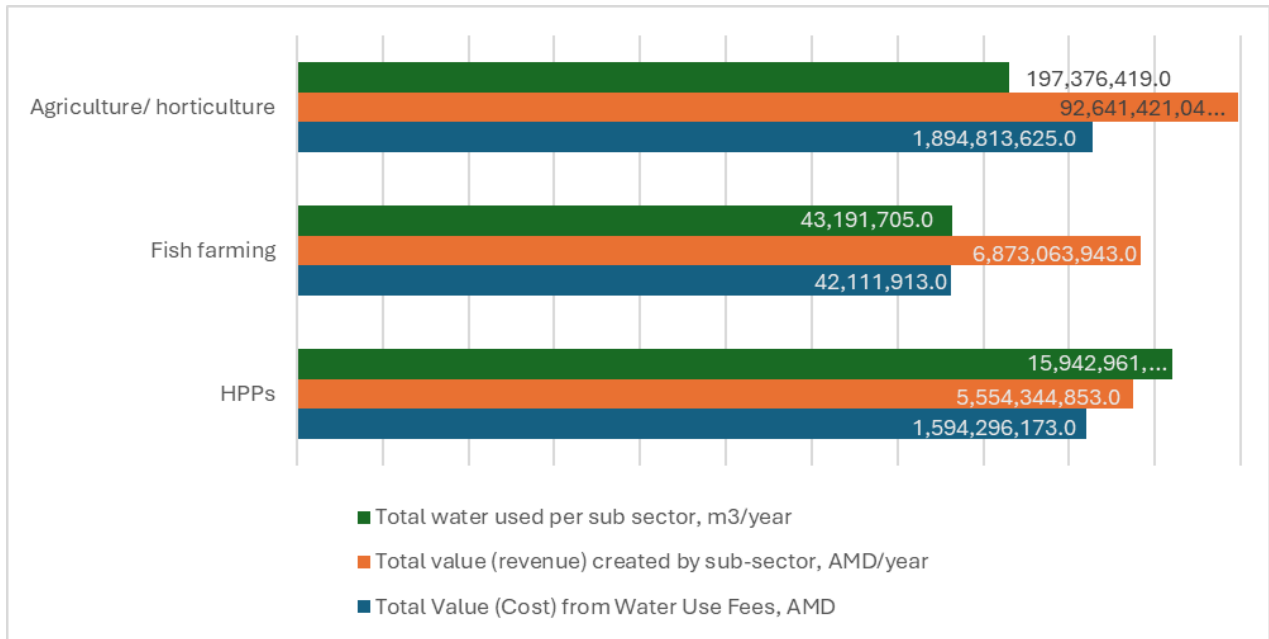
**Figure 2.** Map of key water users in the Ararat BMP area. Shown are permit holders from key economic sectors, as reported in the most recent update of water permits. <sup>7</sup>

For **Fish Farming**, the evaluation uses fish production per cubic meter and market prices. In **Agriculture**, it uses gross agricultural product and water fees for the Ararat and Vayots Dzor regions. These sector-wide estimates may overstate individual farm-level values.

The analysis of the **Hydropower** sector is based on state pricing and energy production data; fisheries focus on fish prices; and agriculture uses regional product and water fees.

The **Comparative Assessment Method** is an analytical approach used to evaluate the economic viability of sectors such as Hydroelectricity Production, Fish Farming, and Horticulture by comparing the value generated per cubic meter of water with the respective Gross Value Added in the country (Figure 2).

<sup>7</sup> The data presented in Figure 2. “Map of key water users in the Ararat BMP area” is sourced from official requests to the Ministry of Environment of the Republic of Armenia and supplemented by open access data from the official webpage of the Public Services Regulatory Commission of the Republic of Armenia



**Figure 3.** Total water use, fees, and economic viability for each sector.

The Total Value of the Hydropower sector (53 water users) was calculated using electricity sales tariffs and production capacities, resulting in a value of **5,554,344,853 AMD**. Water usage fees were set in 2024, these fees were set at **0,1 AMD**, totaling **1,501,990,317 AMD**. The cost of one cubic meter of water from energy production is **0,348/m<sup>3</sup>AMD**. This reflects environmental investments in the Ararat Basin to maintain ecosystem services.

In the **Fish Farming** sector 22 water users were assessed based on their surface water use at a fee of **0,975 AMD/m<sup>3</sup>**. The Total Value of the sector from Water Use Fees is **42,111,913 AMD**. Fish farming water users created **6,873,063,943 AMD Total Value**. This value could be higher in secondary and export markets, taking into account minimal profit margins.

In the **Agriculture/Horticulture** sector water is essential for irrigation, where 39 water users are involved in the study. The water supply service Fee is **9,6 AMD** per cubic meter, which totals **1,894,813,625 AMD**. The Horticulture sector, by moving to intensive agriculture, has created a **Total Value** of **92,641,421,040 AMD**. The value of the segment highlights its importance for food security, despite the risks associated with running costs and water conservation benefits.

The economic valuation of ecosystem services in the Ararat BMP area shows significant contributions from the Hydropower, Fish Farming and Horticulture sectors. The economic value of each sector is influenced by specific pricing structures and market dynamics, with Horticulture showing the highest economic benefit.

In all three sectors **Fish Farming, Hydropower Production, and Agriculture / Horticulture**, indicating that investments within the Ararat and Vayots Dzor Marzes are economically viable and beneficial. These calculations offer valuable insights into the profitability and resource efficiency of each sector, which can guide policymakers and investors in making informed decisions regarding the allocation of resources and the design of targeted programs. **Agriculture/horticulture** exhibit the highest economic value despite having the highest water fees per cubic meter. The Gross product per cubic meter is the highest among the three sectors, driven by intensive agricultural practices and significant regional output. Agriculture/horticulture contributes the most to water use fees, accounting for 54.76%, and has the highest gross product of water at 91.01%. At the same time it generates the majority of the revenue at 87.80%, followed by fish farming and hydropower production.

**Fish farming**, with a relatively lower water usage compared to hydropower, produces a significantly higher gross product per cubic meter. This sector benefits from higher market prices for fish, resulting in substantial total revenue, with potential increases in secondary and export markets.

**Hydropower** sector uses the highest volume of water but generates a lower gross product per cubic meter due to the regulated pricing structure. Despite the extensive water use, the Total revenue is significantly affected by the natural monopoly status and state-regulated prices. Hydropower production dominates water use with 98.66% of the total.

These findings are crucial for shaping strategic initiatives related to **water resource management** in the region. They provide a foundation for revising **water pricing structures and rates**, ensuring that the economic value of water is adequately recognized across sectors. Such adjustments would help align resource costs with their value in fostering economic growth, optimizing sectoral performance, and supporting sustainable development in the Ararat and Vayots Dzor Marzes.

## 4. Surveys on socio-economic dependence on water provision, and emerging problems

Considering the aim of the current study, firstly we shortlisted the sectors of the economy where water is the main input for production, which are: **land cultivation, fish farming, and hydroelectric power plants (HPP) operation.**

In land cultivation, there is a wide range of sub-sectors, such as cultivation of technical crops, forage, melon crops, leguminous crops, potato, vegetable crops, melon crops, fruit orchards, berry fields and vineyards, etc.

Three indicators were used for further shortlisting of the crop groups for this study:

1. Share of the area under cultivation of each crop group in the total area of land cultivation in the Marz.
2. Share of agricultural output in weight of each crop group in the total agricultural output of the sector for Armenia.
3. Share of gross output for each crop group in AMD in the total gross output of land cultivation in AMD.

After having these calculations, the rating of the crop groups of the study was summarized, and as a result of the analysis, for further study three crop groups of land cultivation were selected: **vegetable crops, fruits and berries, and grapes.**

The second stage of the survey was conducting the sociological survey with different stakeholders from target marzes. In order to ensure the full geographical coverage of the survey, different stakeholders representing all the enlarged communities of Ararat and Vayots Dzor Marzes were engaged in the interviews considering all of the main sectors of study.

The conducted interviews indicate that the situation is very different in Ararat and Vayots Dzor Marzes in regard to the quality and accessibility of water and is similar in terms of inefficient use of water.

### **The key findings of the survey**

Feedback of the respondents regarding the quality and accessible quantity of water was the main difference among the Marzes. For Ararat Marz, almost all the respondents have complained on the quality of water, in particular littering of water with solid waste, domestic wastewater and wastewater generated from animal husbandry (pig farming, cattle breeding and poultry) and are seriously to be anxious about the future accessibility of water, while in Vayots

Dzor Marz, the respondents are mainly happy with the quality of water and don't see any reason to worry about potential shortage of water. In Ararat marz some respondents have mentioned that at the beginning of the irrigation system during the first hours of receiving water, the water has dark color and is very ugly smelling. The locals call it "dark water".

One of the main similarities among the regions is that many respondents in Horticulture have mentioned one fact that depending on the location of the village the accessibility of water is tangibly different.

Fish Farming in Ararat basin and in Hrazdan basin is tangibly different. Hrazdan basin is used basically for production of high value fish breed as trout and sturgeon, while the Ararat basin is used for production of low value fish breeds such as different breeds of carp.

The surveys also indicate that the density of fish per cubic meter of water is lower in the Ararat basin, rather than in the Hrazdan basin.

In the case of fish farms, the farmers complain not only about the reduced quantity but about the reduced quality of water because of the activity of fish farms. The respondents consider that the water used in fish farms becomes saturated with microbes and bacteria from fish feed. Because of this the irrigation infrastructure gets mossy. Besides that, the farmers consider that using water from fish farms causes an increase of salination of water, which harms the soil. In some cases, the water turns to become fish-smelling and they believe that this fact dramatically impacts the quality of agro products, especially vegetables.

The interviews conducted with different stakeholders in Vayots Dzor Marz indicate that despite the fact that the HPP has the approval of Environmental Impact Assessment, actually, the activity of the HPP has a very serious negative impact on the water ecosystems of the region.

The three sub-sectors of agriculture, fruits, grapes, and vegetables were analyzed in scopes of the sociological surveys based on such indicators as:

- Water consumption per ha/ AMD
- Harvest from 1 ha. AMD
- Value of GDP produced with 1 m<sup>3</sup> water
- Potential decrease of harvest in the case of water shortage, %
- Potential to reduce water consumption/ %

### **The importance of water for different sectors of study**

Fish Farming is very sensitive to the quality of the water, in particular the temperature of the water and the oxygen content. Shortage of water may dramatically impact on the both characteristics of the water leading to tangible drop down of the productivity of a fish farm.

HPP is very sensitive to the littering of ware with solid waste. On the other hand, the efficiency of the HPP depends a lot on the speed of flow of water.

The findings of the sociological survey indicate that most of the respondents consider that land irrigation takes place significant losses of water, and 40-60% of water is lost on the way to the source of water to the garden. These significant losses accrue because of poor condition and lack of relevant infrastructure. The water flows in open ground because of which a significant amount of water is absorbed in the land and does not reach the water users.

The sociological surveys indicate that in the case of a shortage of water resources, out of three observed sectors of agriculture most vulnerable are the old fruit gardens, as the potential of this sector to adapt to a shortage of water resources is very limited. On the other hand, it is likely that in the case of shortage of water resources, the farmers engaged in vegetable cultivation are more likely to suspend their further activity because of which the turnover of this sector may be decreased significantly.

The most drought resistant sector is grape growing, on the other hand the wine gardens start to bring profit in 2-3 years after establishment of the garden, while the fruit gardens start to bring profit in 5-6 years after establishment of the garden.

**The sociological surveys indicate that the estimated value of GDP produced with 1 m3 water is 300, 360, and 364 AMD respectively for vegetable gardens, fruit orchards, and wineries.**

The findings of the sociological survey also support the BMP for the development of scenarios of management of water resources in case of a decrease in the accessibility of water resources.

The findings may be used as well for designing initiatives to reduce conflict of interest among different sectors and stakeholders. Especially, according to the findings of the survey, different sectors of agriculture have different vulnerabilities towards the accessibility of water and different potentials to decrease the dependency on the accessibility of water. Based on this information the BMP may include a section on planning actions to decrease the dependency of different sectors on accessibility of water.

The findings of the sociological survey include such information as actual and potential problems related to the quality and accessibility of water for different sectors and stakeholders.

The BMP may include a section on planning of actions for mitigation of existing key problems and prevention of potential problems identified by the respondents.

## 5. Biophysical modeling of water provision under climate and ecosystem change

Biophysical modeling of ecosystem services is a key component of **Natural Capital Accounting Assessments (NCAAs)**. These models provide quantitative data to identify which areas of a landscape are most critical for delivering specific ecosystem services and who benefits from them. This information is vital for informing policy and investment decisions that optimize these services while balancing competing interests. Additionally, biophysical models can predict how ecosystem service provision will change under future scenarios, such as shifts in land use or climate, helping to assess risks and identify opportunities for mitigation. They support the development of strategies that enhance ecosystem services and deliver benefits to both people and nature.

In this context, this NCAA focuses on **water yield** as a crucial ecosystem service in the **Ararat Basin**. To quantify water yield, we use the **InVEST Seasonal Water Yield (SWY)** model, which is set up with a combination of global and regional data. The model incorporates global digital elevation model (DEM) data, land use from the **ESA**, climate data (temperature and precipitation) from recent studies. It operates at a high spatial resolution of 90m. In addition to current conditions, we project water yield for two future periods (2041-2070 and 2070-2100) based on **SSP8-5.8** scenarios. Model results for current conditions are validated using discharge data from nine gauging stations across the basin.

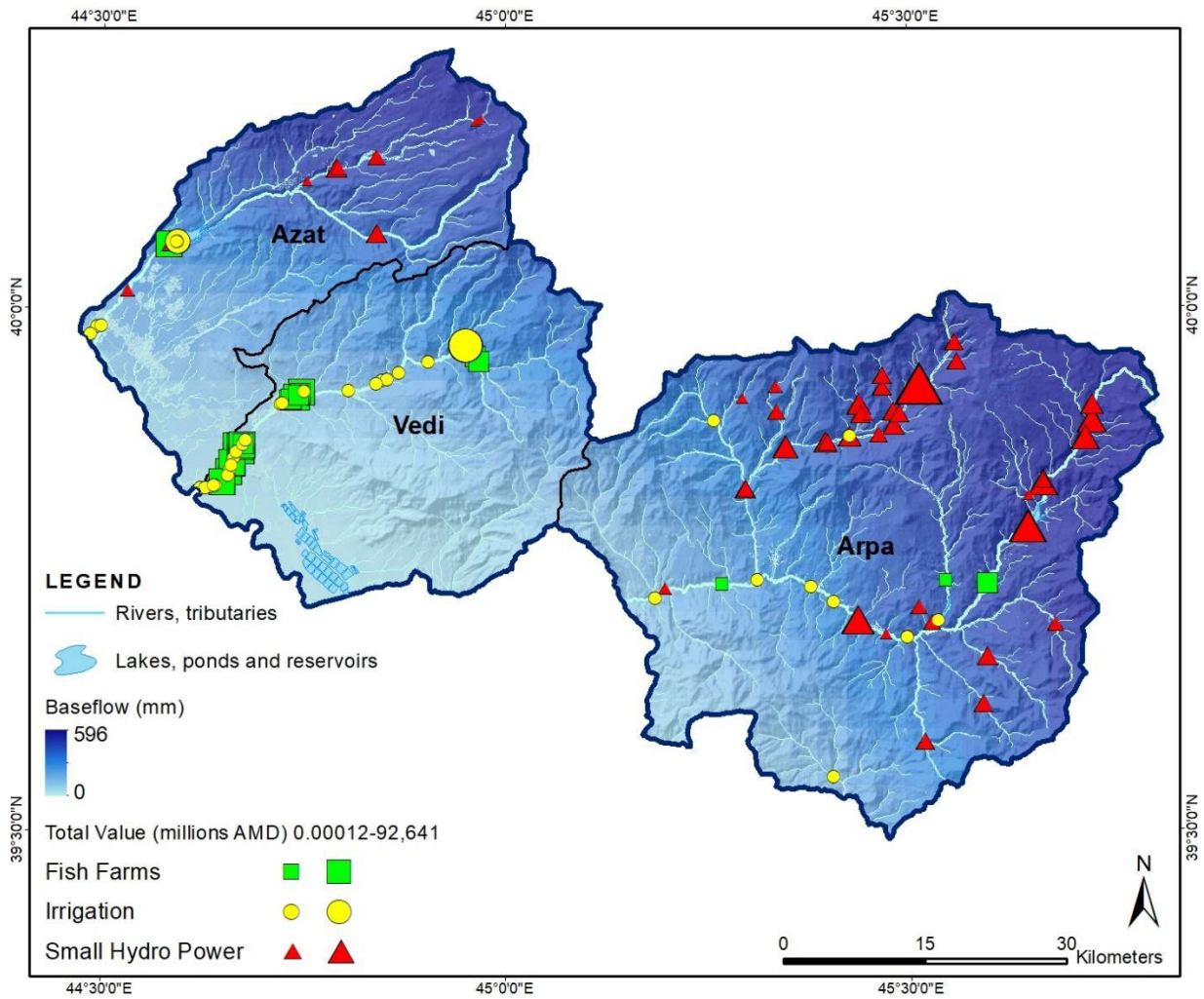
### Conclusions and Key findings

InVEST integrated biophysical modeling with economic assessment to provide stakeholders in the Ararat Basin with a comprehensive understanding of how fisheries, agriculture, and hydropower demand and impact water resources. The model generated visual results that effectively communicated the quantitative interdependence of water resources among these sectors. As a result, stakeholders can visualize the effects of different management strategies, such as pricing structures, on water availability and ecosystem health. This multifaceted approach supports informed decision-making that balances economic development with ecological sustainability, delivering long-term benefits for both the

environment and local economies. By evaluating the ecosystem services provided by water resources within these interconnected sectors, the InVEST model fosters sustainable practices that promote better resource management.

Some key findings are:

- 1) **Water use in irrigation, hydropower, and fish farming sectors creates a total value of 105.1 billion AMD per year.** Most of that value is from irrigation. Figure 4 shows where most water originates in the basin and how it relates to downstream water users.
- 2) **Climate change will threaten water yield in the Ararat Basin, with some areas, particularly in the upper basin, experiencing up to an 18% reduction by the end of the century (2070-2100).** On average, water yield will decrease by 5% (Figure 5). Notably, regions supplying most of the water, especially the northern mountainous areas, will see the greatest reductions. While this analysis focuses on baseflow, our additional assessment of surface runoff shows an increase in quickflow relative to baseflow (Figure 4). This shift suggests not only reduced water availability but also a potential rise in natural hazards, as increased quickflow may heighten flood risks.
- 3) **Analyzing water values and hydrologic changes reveals key connections between protected areas, natural ecosystems, and future hydro-economic risks.** We introduce a novel indicator that combines the value of water in specific parts of the Ararat BMP area with hydroclimatic risks. This indicator shows the greatest changes in water value in the **Vedi River** and **Azat River**, as these areas generate the most value from water and are also the most vulnerable to climate change impacts. (Figure 6). Improving watershed conditions - such as reducing soil erosion and restoring natural ecosystems - could help mitigate these climate impacts. Maintaining or enhancing hydrologic conditions in these areas could be integrated into the mandate of existing or new protected areas and forest lands, particularly in regions facing the greatest loss in water value. This strategy would help preserve both ecosystem services and the economic value of water in the face of climate change.

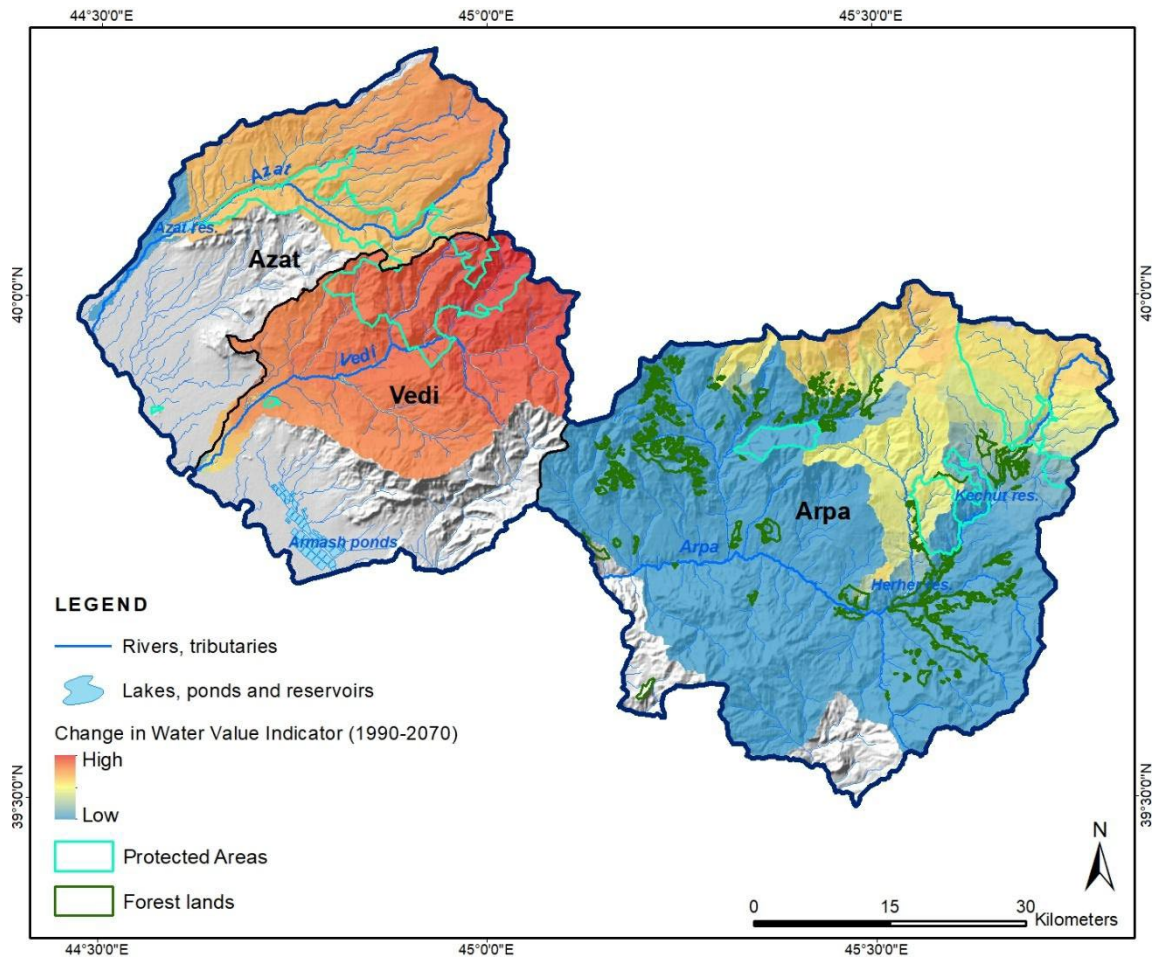


**Figure 4.** Modeled water yield in the Ararat BMP areas. Markers indicate locations of users (agriculture, fish farming, hydropower) that depend on that water yield for their business (marker size proportional to the value created by each user).

1961-1990 to 2041-2070



**Figure 5.** Climate change analysis for the Ararat Basin. Results for two future time periods (2041-2070, 2071-2100) compared to a historical baseline (1961-1990) are shown. Colors indicate the percent change in baseflow compared to the historical baseline.



**Figure 6.** Climate-induced changes in water yield and associated economic value are greatest in the Azat and Vedi Rivers. This map shows the value of a semi-quantitative indicator measuring how changes in water yield will impact downstream economic activities. Most negative changes in the Water Value Indicator are projected in the Azat and Vedi basins, where important water-related sectors are concentrated and where climate change will most impact water yield. Protected areas (turquoise) and forest lands (green) could help buffer future impacts.

## 6. Recommendations and Outlook

### Limitations & Outlook

- **BMPs primarily focus on water quality and quantity, which may overlook more complex relationships.** BMPs focus primarily on maintaining adequate water quantity and quality. However, these plans often fail to address the more

intricate relationships between human water users (e.g., agriculture, industry, households) and ecosystems. For instance, an BMP might not fully account for how water scarcity or pollution affects local wildlife, biodiversity, or ecosystem services, like water purification or flood control.

- **NCAAs offer high-level spatial mapping of ecosystem services but lack the detailed sectoral focus needed for BMPs.** NCAAs are useful for mapping out ecosystem services (such as clean water, flood regulation, etc.) across a broad region. However, they provide a general overview without the detailed, sector-specific information needed for effective Basin Management Plans. For example, NCAAs might not provide the fine-grained data required for managing agricultural water use, hydropower needs, or urban water demands in a way that aligns with both ecological health and human requirements.

**We propose a three-pronged approach:**

- **Inclusive BMPs:** Expand the content of BMPs (regulated by the decree of the RA Minister of Environment No. 26, dated 27.01.2023) with information on the interconnections between key ecosystems, landscapes, protected areas, and the specific characteristics of water use.
- **Broader Ecosystem Services:** Include catchment functions and ecosystem services beyond water supply (e.g., freshwater biodiversity, sediment and nutrient regulation).
- **Downscale NCAAs:** Adapt NCAA approaches to smaller spatial and temporal scales to better model sub-annual water yield dynamics, aligning with sub-sectoral water needs and vulnerabilities.

**Additionally, develop key scenarios for each BMP, such as:**

- Maintaining current land use
- Expanding protected areas
- Degrading natural ecosystems.