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PROGRESS REPORT ON IMPROVING WATER RESOURCE DATA FOR THE ARARAT VALLEY

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Advanced Science and Partnerships for Integrated Resource Development Project

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Introduction

The purpose of the Advanced Science & Partnerships for Integrated Resource Development (ASPIRED) Project of the United States Agency for International Development (USAID) is to support sustainable water resource management and sustainable practices of water users in the Ararat Valley through the use of science, technology, innovation and partnership initiatives. The ultimate goal is to reduce the rate of groundwater extraction in the Ararat Valley to the sustainable levels.

As defined in the ASPIRED Project Task Order, the ASPIRED assists the Government of Armenia (GOA) in establishing a comprehensive up-to-date data and information system on water resources of the Ararat Valley, developing and calibrating decision-support tools for generating hydrologic, hydrogeologic, environmental datasets for informed decisions on groundwater resources of the Ararat Valley. The Project also collaborates with the Ministry of Nature Protection (MNP) on enhancing the State Water Cadaster Information System, which is a warehouse of comprehensive datasets on water resources of Armenia.

This report provides progress made by the ASPIRED Project during its 2nd year of operation in improving water resource data and technical analytical tools for supporting decisions on water resources of the Ararat Valley. It focuses particularly on progress achieved in the following areas:

1. Finalizing the inventory of natural springs, groundwater wells and fish farms in the Ararat Valley
2. Introducing an automated online system for groundwater use monitoring
3. Strengthening the SWCIS
4. Applying remote sensing technologies for data analysis
5. Enhancing the decision support tools for the Ararat Valley:
    - Decision Support System
    - Hydrologic Framework for the Ararat Valley and Groundwater Model.

1. Finalizing the inventory of groundwater wells, natural springs and fish farms in the Ararat valley

After completing field measurements in March-September 2016, the Hydrogeological Monitoring Center State Non-Commercial Organization of the MNP – ASPIRED Subcontractor for inventory of groundwater wells, natural springs and fish farms in the Ararat Valley, worked on organization of collected data in a comprehensive database on MS Excel format, and analysis of the field measurements results which are summarized in the final report on inventory of groundwater wells, natural springs and fish farms in the Ararat Valley[1].

Database contains the results of field measurements for 2807 groundwater wells, including geographic coordinates, measured water level and discharge, temperature and level of mineralization, type of ownership (private, community-owned, etc.), status of the well (operational or non-operational) and water use permit. It provides description of technical conditions of each well (type and state of the capitation structure, availability and state of the casing, regulation valve, pump, etc.). Field survey data is combined with lithological structure of the wells, which is summarized using archive data.

Database provides data on 235 fish farms in the Ararat Valley, describing location, ownership and status of each farm, number and total volume of the fish ponds, number of groundwater wells used, total volume of groundwater use and discharge per year. It also provides volumes of groundwater abstraction and discharge as defined by the water use permits.

Analysis of the survey results and description of the surveyed 14 groups of the natural springs, findings on current status of the groundwater wells and fish farms, volumes of permitted and actual groundwater abstraction for use for various purposes, etc., were summarized in the final report. The report and database were submitted to the Armenia's President Office, Government and National Assembly, and made publicly available at the ASPIRED web-site.

In December 2017, the results of the effective collaboration between the ASPIRED Project and MNP were presented to about 70 stakeholders (Figure 1).

Figure 1: The main findings of the inventory presented to the stakeholders, which open dialogue on acute issues

[1] Armenian and English versions of the Final Report are available at the ASPIRED Project website, Library section: www.aspired.wadi-mea.com/en

Representative of the Ministries of Nature Protection, Agriculture, Energy Infrastructures and Natural Resources, the President's office, representatives of international organizations, NGOs and academic institutions were present at the event. The findings of the inventory served a basis for a constructive dialogue between the government and civil society representatives on acute issues, such as the environmental and strategic importance of groundwater resources of the Ararat Valley, the balance between the resource conservation priorities and the economic development challenges of the country, the responsibilities for illegal use and anti-corruption measures to be taken by the Government.

The GOA accepted the results of the inventory as a baseline data on state of groundwater resources and use in the Ararat Valley as of 2016 for formulating its new, more stringent policy and measures on more effective management of groundwater resources in the Ararat Valley. The ASPIRED assisted the Government to this end, serving as the data source on the groundwater issues for the Prime Minister established Interagency Task Force created in January of 2017 to work on evidence- based rigorous program of measures for improving ground water management in the Valley. The program was adopted on May 6, 2017, consisting of regulatory, legislative, institutional and technical measures to be implemented by the GOA in 2017-2021 for achieving a more rational use of water in the Ararat Valley for fish farming, irrigation, drinking. The Program also refers to the ASPIRED Project, which will be supporting the Government in the implementation of a number of measures. These include improved monitoring of groundwater use in the selected fish farms and data management system for the Ararat Valley - as a part of enhanced State Water Cadaster Information system; preparation of a digital hydrogeological map and groundwater model for the Ararat Valley to be used by the Government for re-assessing renewable groundwater resources in the aquifers of the Ararat Valley; introducing water and energy efficient technologies in the selected fisheries, etc.

2. Introducing an automated online system for groundwater use monitoring in the selected fish farms

Installation of an automated online system for groundwater use monitoring in the fish farms of the Ararat Valley is amongst the priority measures of the Government Program for year 2017. The Program of measures for effective management of groundwater resources in the Ararat Valley adopted by the Prime Minister of Armenia in May of 2017 establishes the following requirements and timeline for installing the online groundwater use monitoring system in the fish farms:

- Large farms using 150 liters/second and more by September 1, 2017
- Medium size fisheries, using from 100 to 150 liters/second by December 31, 2017
- Small fisheries, using less than 100 liters/second by April 1 2018.

According to the Government plans, large and medium-size fisheries must install the monitoring system at their expense, while assistance of USAID and other donors must be channeled to the small farms.

The USAID ASPIRED Project, jointly with Coca-Cola Hellenic Bottling Armenia, within the framework of the Memorandum of Understanding signed in July 2016 by the USAID, Coca-Cola Hellenic Bottling Armenia and MNP, planned installing an automated online groundwater use monitoring system on 20 groundwater abstraction points of the selected large fisheries in 2017. The large fisheries are using up to 60 % major part of groundwater in the valley, and USAID and the ASPIRED team strongly support the installation of the monitoring systems in these fisheries.

The MNP conducted two meetings with the representatives of the fish farms in February and June of 2017 to discuss measures adopted by the GOA on improving groundwater use by the fish farms and installing online system for groundwater use monitoring in the fisheries. During the both meetings fish farmers opposed strongly to the GOA requirement to install monitoring system at their expense, with arguments that they cannot afford the additional high costs for installing and maintaining the system, and having their wells already equipped with the mechanical water meters. At the time of preparing this report, there were no online monitoring systems installed in the large and medium size fisheries, as requested by the Government.

The GOA changed its approach and in August-September requested USAID to assist the large fisheries in installing the automated online groundwater use monitoring system. Data from the real-time monitoring will be transferred to a newly established entity within the Ministry, which will be equipped with hardware and software with assistance of Coca-Cola Hellenic Bottling Armenia and ASPIRED.

The ASPIRED team will collaborate with the MNP in finalizing the bidding documents for an open tender for procurement and installation of the automated online system for the groundwater use monitoring in the selected large fisheries. A list of the fish farms will be provided by the MNP.

Working online, the new system will allow for the real-time monitoring of the groundwater abstraction by the fisheries vis-à-vis allowable limits. This will improve the overall compliance and enforcement mechanism of water use permits. The data will be publicly accessible.

3. Strengthening the SWCIS

At the beginning of Year 2, the ASPIRED team and the WRMA discussed the issue of the SWCIS upgrade and improvements. The working group, consisting of the representatives of the WRMA and ASPIRED project, initiated preparation of the technical Terms of Reference describing the technical features and the data requirements for the future SWCIS.

In February 2017 a new Government Resolution on procedures for maintenance of the State Cadaster of Water Resources was adopted. However, comments provided by the ASPIRED team to the MNP on the draft resolution in October-November 2016 were only partially included into the final version of the legal act, such as several provisions on mechanisms of information dissemination through the Cadaster. In addition, the team believes that the frequency of data and information entry in the information system is not sufficient for timely and effective management of water resources. A verbal agreement was reached between the ASPIRED and WRMA on addressing these concerns by amending the Government Resolution when the SWCIS is enhanced and tested.

In February-March 2017, the ASPIRED technical team convened three working meetings with the representatives of WRMA on discussing the content and format of tabular information in the enhanced SWCIS. ASPIRED also discussed the list and structure of the new tables and reports proposed for design by WRMA. In March, the ASPIRED recruited an expert on database programming is working with the WRMA on enhancement of the SWCIS in accordance with requirements of the newly adopted government resolution.

During the period from March to September 2017, the following enhancements of the SWCIS Data Warehouse were made:

- A new design of the main window of the Data Warehouse has been developed (Figure 2 below). According to the agreed structure of the Data Warehouse, the following thirteen components will function in the Data Warehouse:
  (1) *Water Object Codes*: will be transferred from the old structure;
  (2) *Water Quantity*: to store monitoring data on surface water quantity - new table design is needed according to the new requirements;
  (3) *Water Quality*: to store monitoring data on surface water quality - new table design is needed according to the new requirements;
  (4) *Water Use*: existing Water Use Permitting database will be migrated into this item;
  (5) *Lake Sevan*: a new component to be design according to the new legal requirements;
  (6) *Reservoirs*: a new component to be design according to the new legal requirements;
  (7) *Water lines*: a new component to be design according to the new legal requirements;
  (8) *HPPs*: a new component to be design according to the new legal requirements;
  (9) Groundwater resources: to store monitoring data on groundwater quantity and quality - *new table design is needed according to the new requirements*
  (10) *Water balance*: to store the calculated values of annual water balance for 14 main river basins of Armenia - a new component to be designed;
  (11) *Water supply and demand balance*: to store the calculated values of annual water supply and demand balance for 14 main river basins of Armenia - a new component to be designed;
  (12) *Messages and alerts*: to inform on the shortcomings in the system, if necessary;
  (13) *Services*: to generate queries and State Water Cadastre monthly, quarterly and annual

reports, as required by the legislation.

Figure 2: The main window of the SWCIS Data Warehouse (in Armenian).

- The ERICA codes (unique identifiers) for the rivers longer than 5 km, their catchment areas, lakes, reservoirs and canals were migrated from the previous version of the Data Warehouse into a separate component called “Water Object Codes” (Figure 3 below). These identifiers serve as a key tables to link datasets from different components into a single Database Management System (DBMS). The codes will also be used to generate linkages between the tabular data in the Data Warehouse and geospatial datasets under the GIS environment.

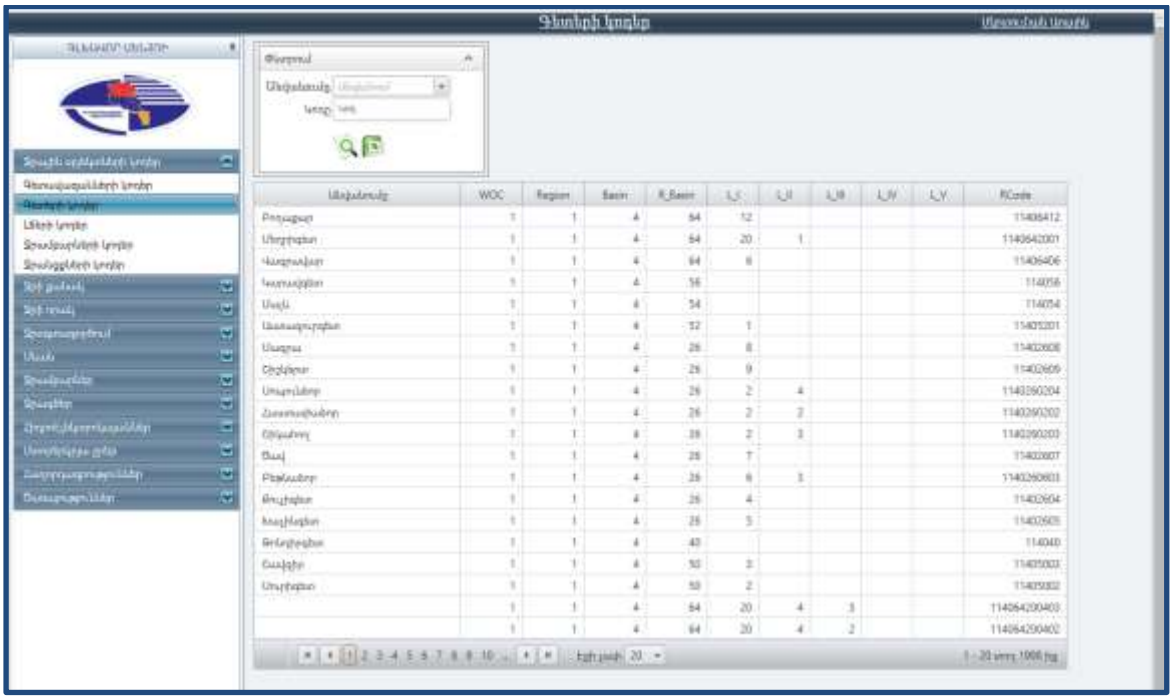

Figure 3: Sample print-screen of *Water Objects Codes* component of the Data Warehouse.

- Two new subcomponents on spring flooding and ecological flow were added into the Water Quantity component of the Data Warehouse,. They will complement the tables on the list of hydrological gauging stations (static data) and time-series of monitoring data on water level and water discharge at hydrological gauging stations (see Figure 4 below).

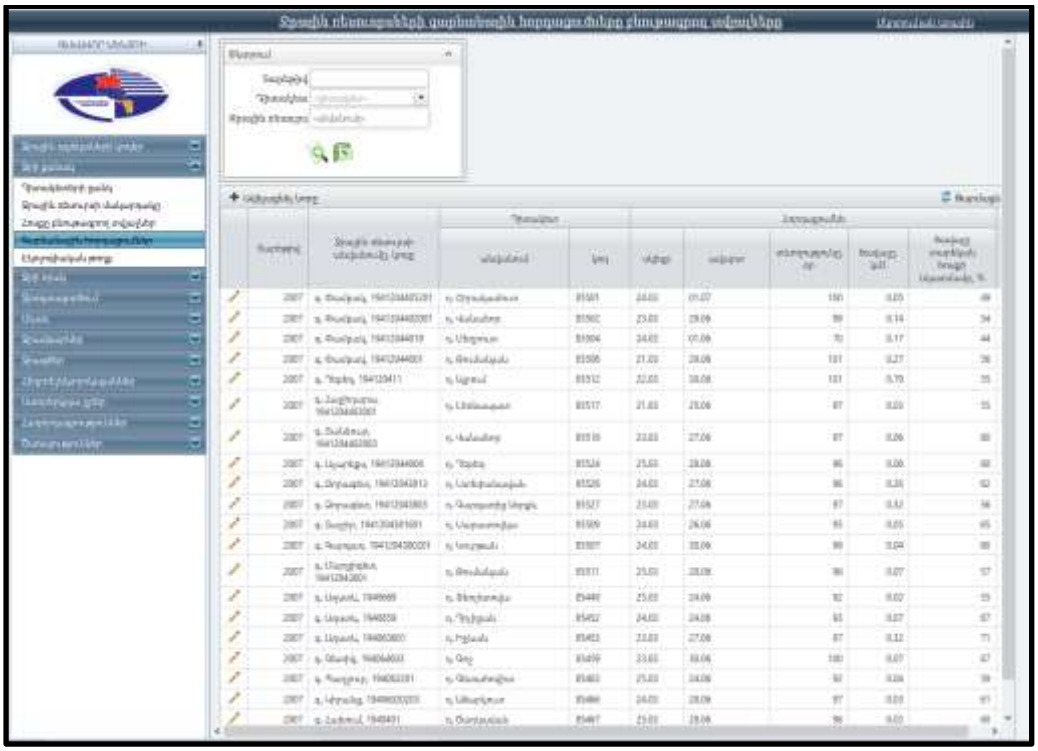

Figure 4: Sample print-screen of *Water Quantity* component of the Data Warehouse.

- The water quality monitoring tables were migrated from the existing Data Warehouse. In addition two separate tables were designed to maintain the data on annual and monthly pollution from the 131 water quality sample points throughout the country (see Figure 5).

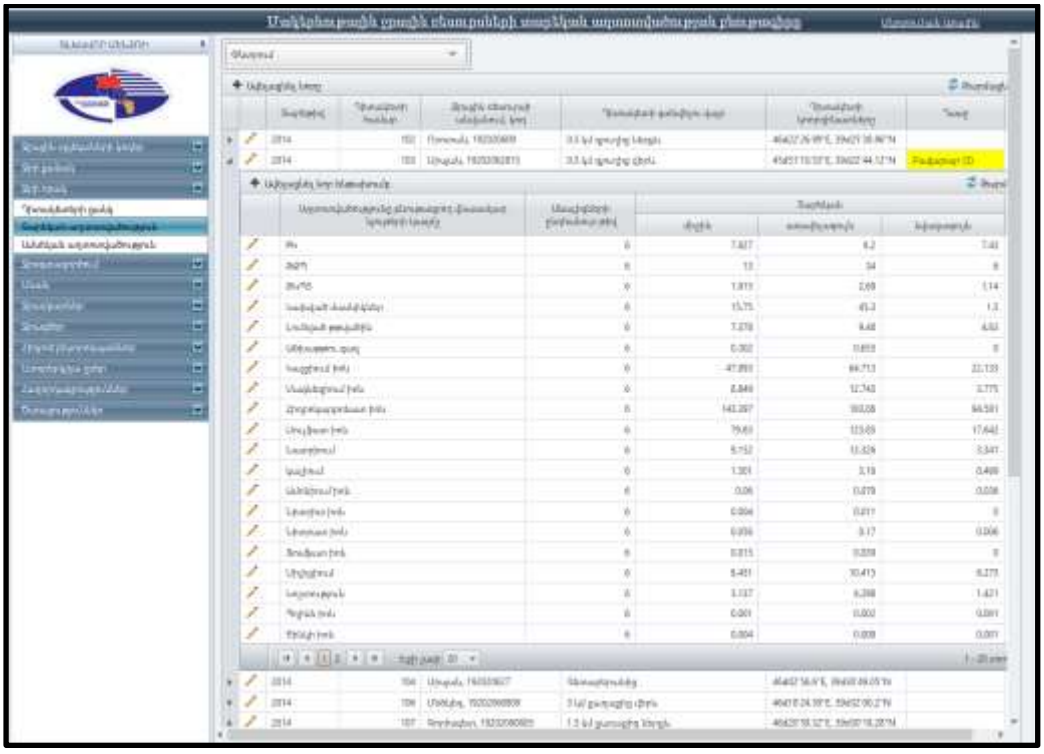

Figure 5: Sample print-screen of *Water Quality* component of the Data Warehouse.

- The Water Use Permitting database of WRMA was entirely integrated into the new Data Waterhouse as a separate component. It contains 3 sub-components on (a) water users; (b) WUP application; and (c) follow-up of the process of WUP issuance (see Figure 6).

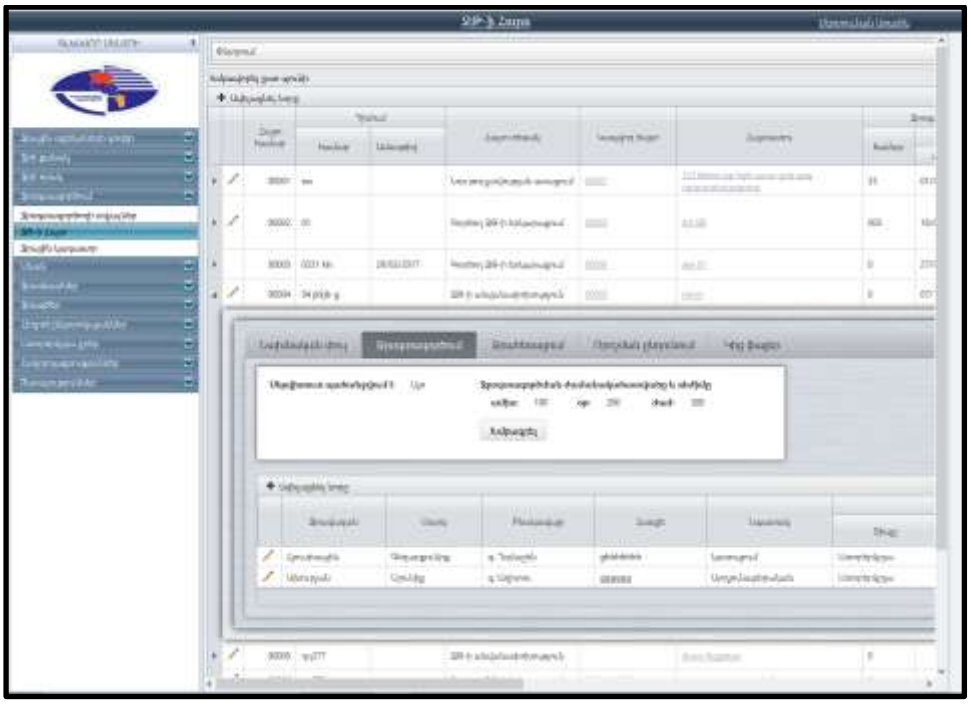

Figure 6: Sample print-screen of *Water Use Permitting* component of the Data Warehouse.

- An entirely new component of the Lake Sevan was programmed and designed according to the new requirement of the legislation. The component stores daily values of the level in the Lake as well as provide comparative analysis between the level values of the given day in the current year and the same day for any years after 2006. The is a possibility also to compare the actual level value with one set by the “Law on Lake Sevan” and corresponding by-laws. The tables in the component are A number of graphical were complemented by a number of built-in graphs to show the comparisons (Figures 7-8).

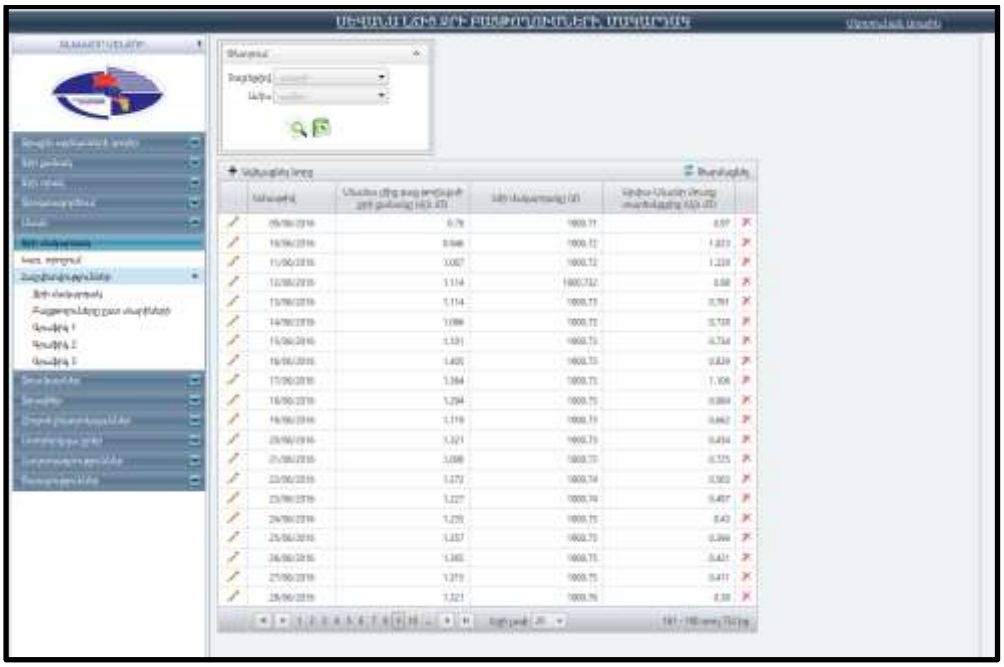

Figure 7: Sample print-screen of *Lake Sevan* component of the Data Warehouse.

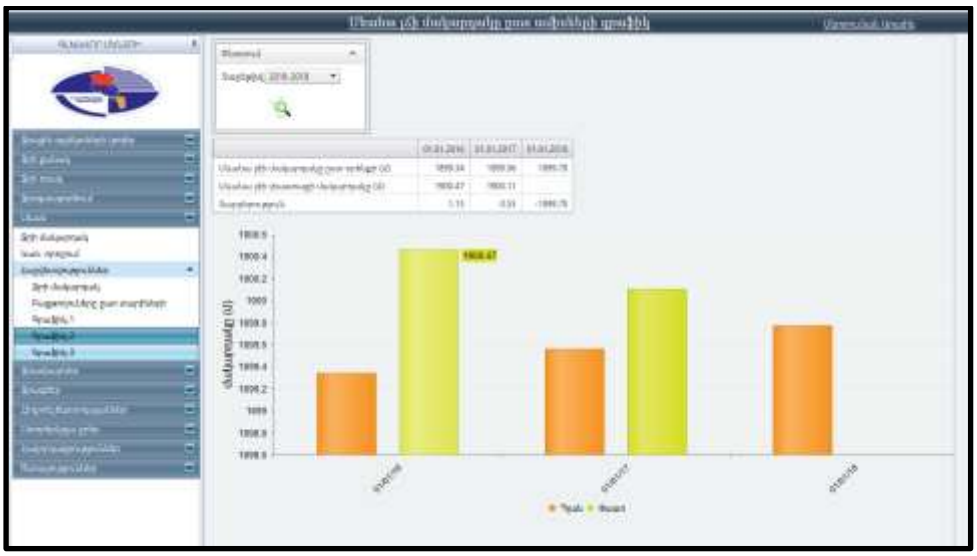

Figure 8: Comparative graphs for water level in the Lake Sevan.

- Two new components on the reservoirs and hydropower plants (HPP) were programmed and designed according to the new requirement of the legislation. Those components are supposed to store and maintain time-series data on the water level in the main reservoirs of Armenia and water use data on the HPPs respectively (Figures 9-10).

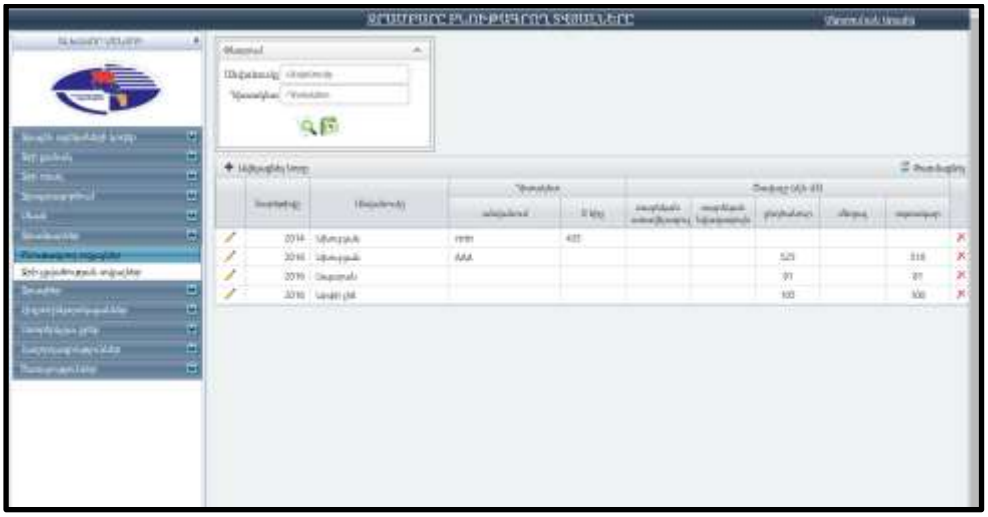

Figure 9: Sample print-screen of *Reservoirs* component of the Data Warehouse.

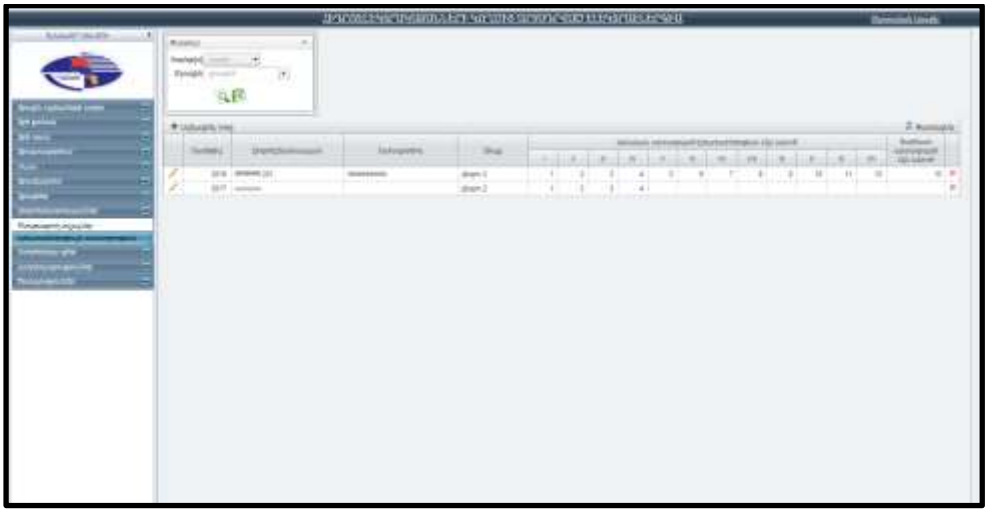

Figure 10: Sample print-screen of *HPP* component of the Data Warehouse.

The ASPIRED team intends to continue the technical improvements of the SWCIS in the Y3.
The following activities will be implemented:

- Reprogramming and redesign of the "*Groundwater Resources"* component of the Data Warehouse, including integration of additional tables for the quantitative and qualitative monitoring implemented in 128 observation wells of the national reference network.
- Programming and designing two new components of the Data Warehouse: (1) Water Balance component and (2) Water Supply and Demand Balance component;
- Definition of the relationships among the tables of all the components of the Data Warehouse;
- Development of data import/export tools for the surface and groundwater monitoring components to ensure automatic data transfer from the MsExcel sheets;
- Construction of new queries and design of new reports based on those queries for each component as well as improvement of the existing queries and reports;
- Improvement of the linkages between the tabular and spatial components of the Data Warehouse;
- Installation, testing and debugging of the final version of the SWCIS Data Warehouse in WRMA Server;
- Preparation of the User Manual in Armenian language;
- Conduction of training for WRMA staff

In addition, the ASPIRED team plans to provide additional training programs to WRMA on the GIS to enhance the capacities on data analysis and linkages between the Cadaster's various components. These trainings are anticipated for the beginning and throughout the Y3 and will serve as on-the-job training for the WRMA personnel, enhancing their skills and capacities on database design, management, and data sharing.

4. Applying remote sensing technologies for data analysis

At the beginning of Year 2, the ASPIRED Project initiated land cover/use classification of the Ararat Valley. In November-December 2016, the ASPIRED team collaborated with SatAgro Polish Company, the World Bank's project implementer, on acquisition and processing of high resolution satellite imagery for the Ararat Valley, including a part of the valley on Turkish territory. The World Bank experts also expressed their commitment to share the SENTINEL-2 imagery for the Ararat Valley to the ASPIRED team in a format suitable for the Project analysis, as well as to further collaborate in performing the land cover and land use analysis.

The SENTINEL-2 high-resolution satellite imagery of the European Space Agency was used to perform the land cover/use classification according to the EU CORINE methodology. The imagery has 0% of cloudiness and is orthorectified. Both the RGB and NDVI images of the Ararat Valley are used (Figure 11). The CORINE methodology was used up to Level 2 to provide data for generating the precipitation/run-off curves for the Ararat Valley. This will allow obtaining more accurate values of the natural, surface and deep flows in the Ararat Valley. Those parameters will serve as major inputs in calculation of water balance for the Ararat Valley.

Figure 11: The SENTINEL-2 imagery of the Ararat Valley.

During Year 2, the ASPIRED Project team conducted the first two of the three phases of the land cover/use classification in the Ararat Valley. First, the unsupervised classification was performed using high resolution multi-spectral satellite imagery for the Ararat Valley based on the CORINE methodology. The mosaic of the image was obtained with 50 classes and the gradual regrouping of the classes was performed to reach the 10 classes of the CORINE Level 2. In addition, the team came up with a georeferenced database with approximately 630 conflict sites to be surveyed in the field (groundtruthing) during the summer months (Figure 12).

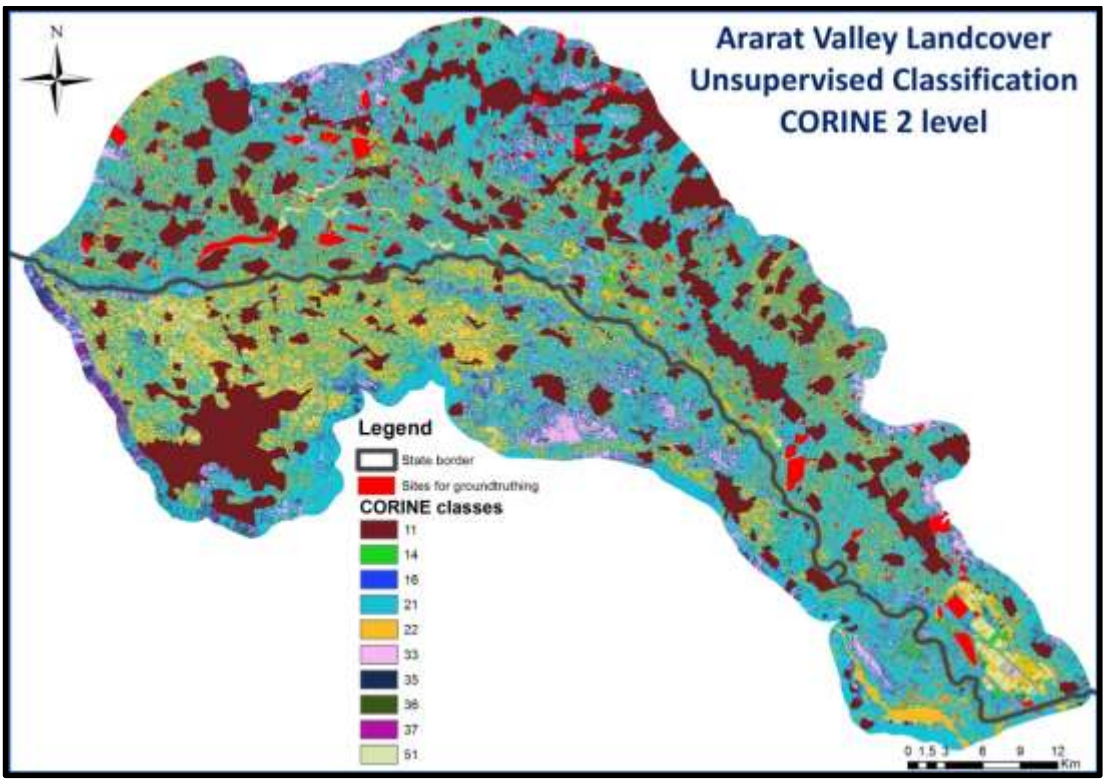

Figure 12: Results of unsupervised classification of the Ararat Valley.

In June-August 2017, field survey (groundtruthing) was performed in the Armenian section of the Ararat Valley to clarify the land cover classes for the unclear sites. Total 674 sites were visited and GPS-ed. In addition, representative photos were taken for each site (Figure 13).

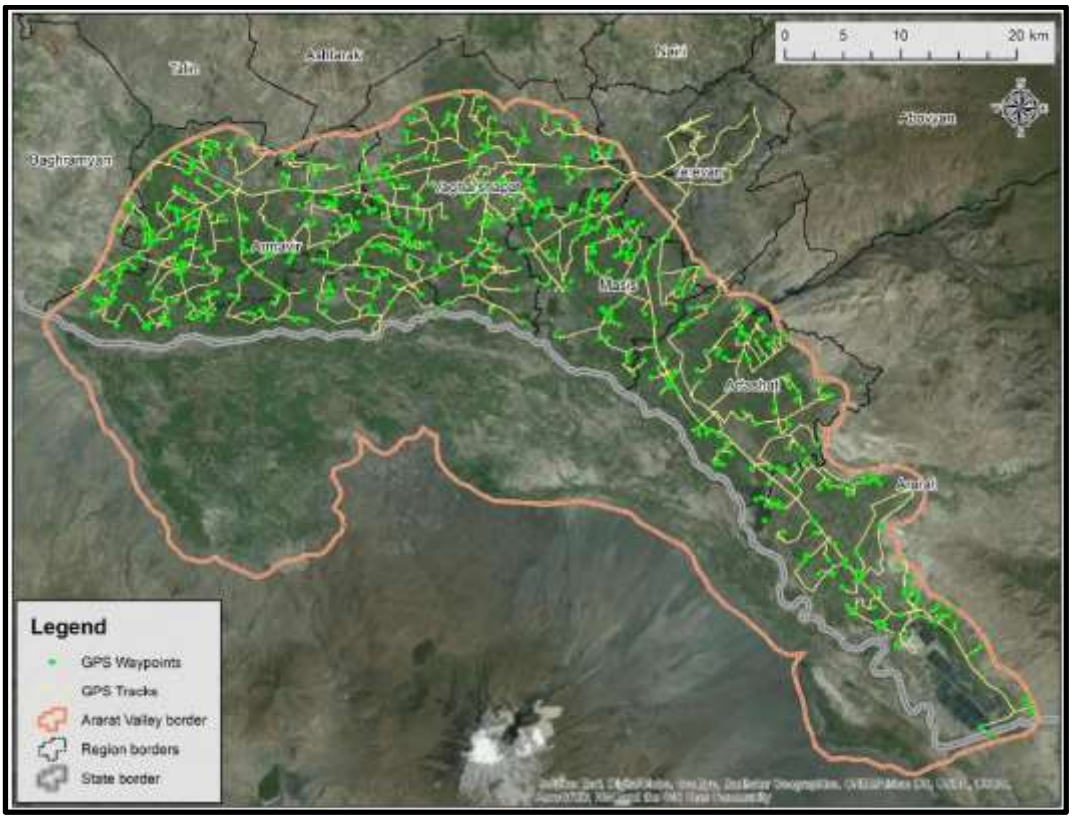

Figure 13: Locations of the waypoints and tracks GPS-ed during the groundtruthing.

The following issues were resolved during the groundtruthing:

- identifying 3-rd level classification for permanent crops
- distinguishing between permanent crops and heterogeneous agricultural areas
- distinguishing between pasture/grasslands and arable lands;
- distinguishing between pasture/grasslands and open spaces;
- distinguishing between mining areas and open spaces;
- identifying mining and industrial areas;

As a main output of the groundtruthing, a geo-references database with the clarified status of the sites were provided. In addition, a report was prepared with the clarified CORINE class, geographic coordinates, and representative picture for each site (Figure 14).

The geodatabase obtained based on the results of the groundtruthing will be used during Year 3 to perform the supervised classification of the land cover/use in the Ararat Valley, leading to:

- generating precipitation/runoff curve for the Ararat Valley for further use in the DSS;
- designing and publishing big-scale Ararat Valley land cover classification maps for the stakeholders;
- presenting and providing a single geodatabase on the Ararat Valley land cover/use classification to the main stakeholders.

Waypoints / Tracks	*Latitude*	*Longitude*	*CORINE class*	*Photo IDs*	*Representative photo*
050	39° 43' 25.126" N	44° 48' 15.426" E	2.3 Pasture/Grasslands	040-041	
051	39° 47' 34.971" N	44° 47' 39.322" E	2.2 Permanent crops *(2.2.2 Fruit trees and berries plantations - apricot)*	042-043	
052	39° 47' 14.093" N	44° 47' 2.594" E	2.2 Permanent crops *(2.2.2 Fruit trees and berries plantations - apricot)*	044-045	

Figure 14: Sample print-screen of a page from the final report on groundtruthing.

5. Enhancing the decision support tools for the Ararat Valley

5.1 DSS

Since the beginning of the Year 2, the ASPIRED team initiated developing decision support tools for the Ararat Valley through customizing the DSS (developed within the framework of the USAID CEWP) for the Ararat Valley catchment area. The team considered a two-directional approach, which includes revising and reprogramming the DSS; and calibrating the DSS for the river basins of the Ararat Valley catchment area, namely the Akhuryan, Metsamor, Hrazdan, Vedi and Azat river basins.

Calibration of the tool for the 5 river basins of the Ararat Valley catchment area started with organization of the required input datasets received from the government agencies and calculation of the multi-annual mean values of precipitation and evaporation under the Water Balance component of the Hydrological Model. For that purpose the time-series data on precipitation and evaporation obtained from the meteorological stations were inputted into the model and raster images were generated through interpolation of those datasets throughout the Ararat Valley (Figures 15-16). The respective annual raster images for precipitation and evaporation for the year 2015 were also obtained.

The next steps of the calibration of the Hydrological Model of the DSS will be implemented in the next year and will include:

- generating annual raster images of the natural flow and natural surface flow for 2015 and 2016;
- generating annual raster image of the deep flow for the year of 2015 and 2016;
- obtaining the water balance equation for the 5 river basins of the Ararat Valley catchment;
- generating precipitation/run-off curves for the Ararat Valley catchment area for 2015 and 2016;
- obtaining the water supply and demand balance for the 5 river basins for the year of 2015 and 2016.

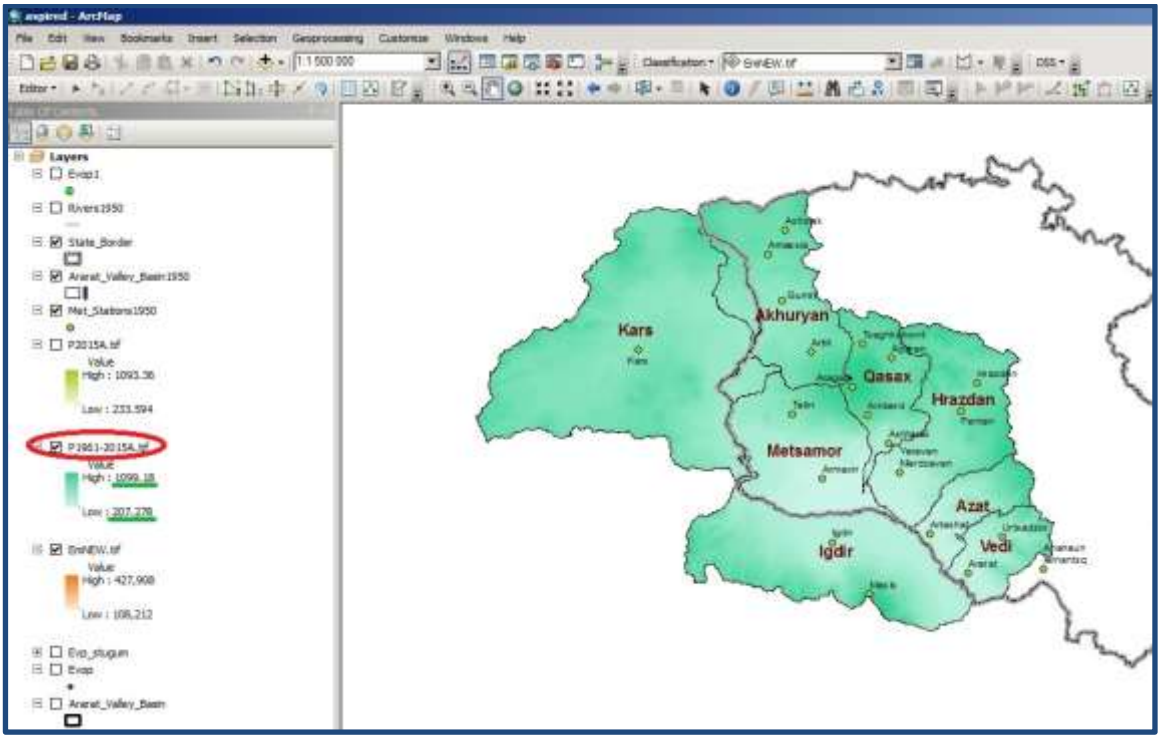

Figure 15: Multi-annual precipitation raster image for the Ararat Valley catchment area.

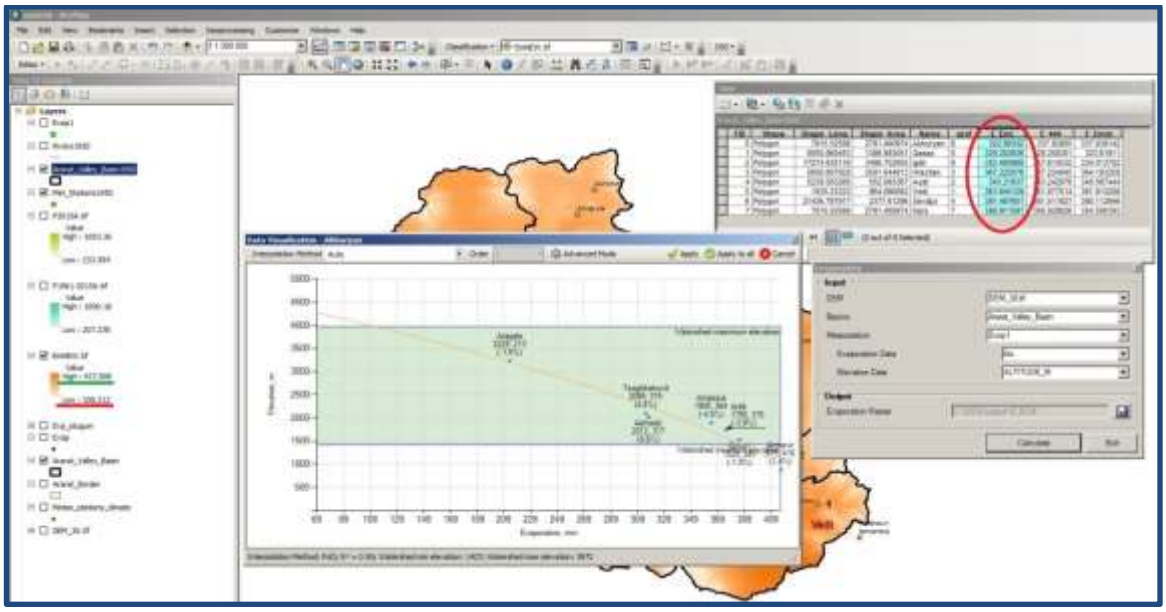

Figure 16: Multi-annual evaporation raster image for the Ararat Valley catchment area.

The activity on revising and reprogramming of the DSS was mainly related to simplifying the Hydrological Model so that it would allow calculation of various components by using default values (automatic selection by the DSS). The print-screen below demonstrates the automatic selection of the method for data interpolation while calculating the annual precipitation patterns under the Water Balance component of the Hydrological Model (Figure 17).

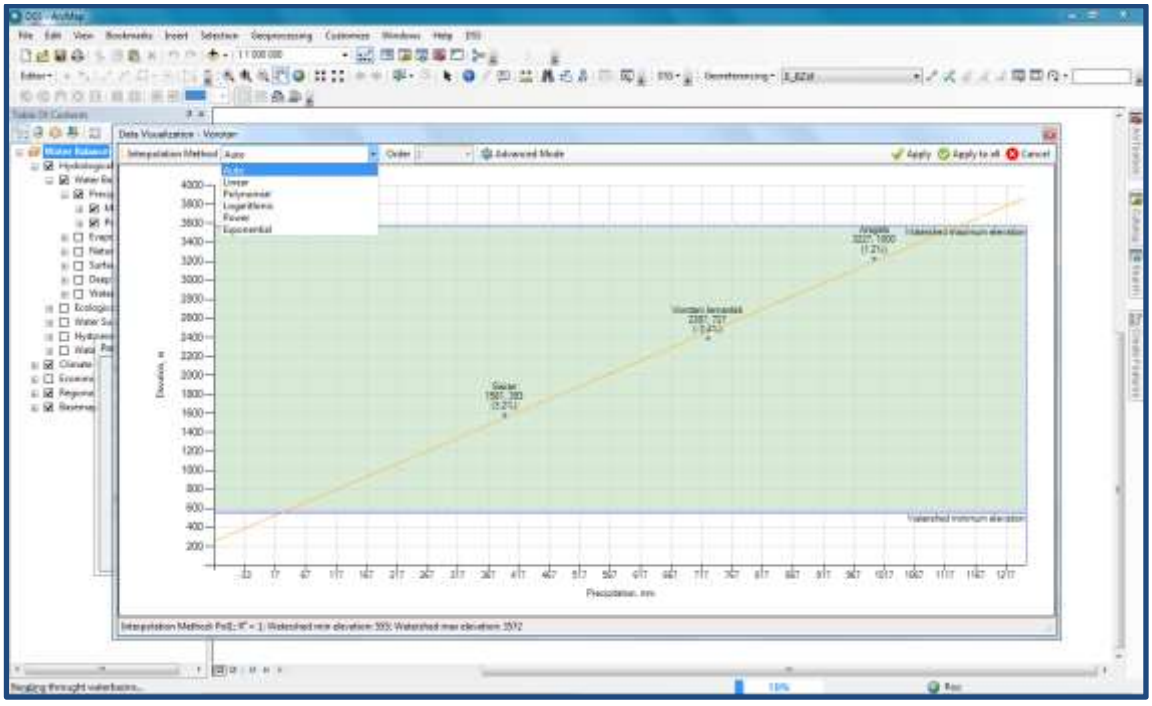

Figure 17: Print-screen of the Water Balance component of the Hydrological Model.

At the meantime, there is an option for the user to define own method for interpolation in the “advanced mode” section (Figure 18).

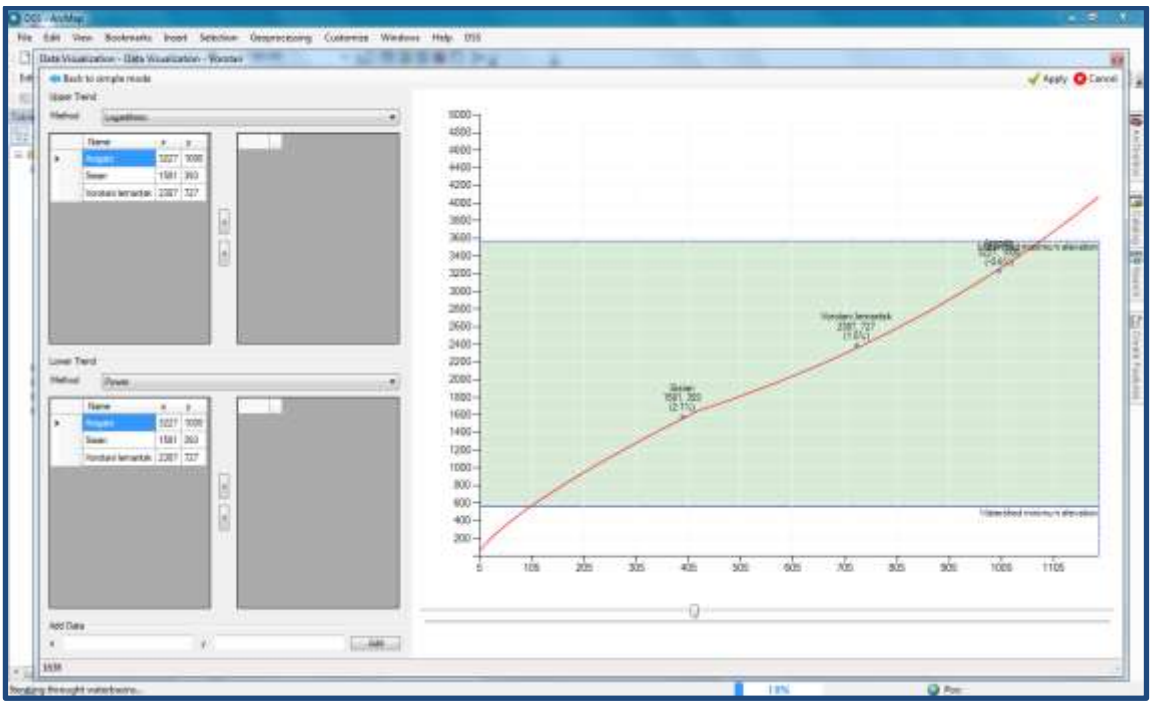

Figure 18: Print-screen of the Advanced Mode section to define the interpolation method.

In addition, the following changes in the functionality of the system were done during the Year 2:

- the new version is made completely compatible with the latest versions of ArcGIS 10.x;
- the regression calculation user interface was completely redesigned to be more user friendly. An automatic method for the regression type selection was added, which allows choosing the best suitable regression method for the given dataset.
- For the all modules of the DSS we have added new filter to the shapefile selection based on the input data type. This will help the user to select the input data easily.
- Some of the input data sheets templates were improves.
- To monitor the status of the calculation all modules of the DSS were reprogrammed to have their progress showing at the bottom of the ArcGIS software.
- The overall performance of the DSS was improved by changing some core functions algorithms. There were some minor bugs in various modules of the DSS, which has been fixed during the improvement process.

The revisions in the programming code of the DSS will continue during the next year, in parallel with calibrating the Hydrological Model with data from 5 river basins of the Ararat Valley catchment.

5.2 Hydrogeologic framework for the Ararat Valley and groundwater model

Another significant milestone in the collaboration of the USAID and USGS aimed at strengthening groundwater management capacities for Armenia was reached. ***The Ararat Valley hydrogeologic framework*** was developed by the USGS Dakota team. The framework, which characterizes the hydrogeologic structure and conditions of groundwater resources in the Ararat Valley, is a foundation for developing groundwater model for the aquifers of the Ararat Valley.

The ASPIRED team contributed vast amount of data to USGS, including available geologic maps, lithologic data from wells, well records and logs, groundwater-level measurements and other

information collected and complied by the ASPIRED Project through the 2016 inventory of wells, natural springs and fish farms. As noted by Janet Carter, Deputy Director for Studies of USGS Dakota Water Science Center, *"Data from inventory is phenomenal in a sense of detailed description of groundwater levels and groundwater use in the Ararat Valley." "We were able to use most of the datasets provided by the Armenian partners in our study, which is exceptional. For other countries we would be able using from 2 to 8% of datasets available,"* Joshua Valder, Hydrologist, Groundwater Specialist of the USGS Dakota Water Science Center said.

A webinar on detailed presentation of the hydrological framework was conducted by the USGS for the ASPIRED team and stakeholders on August 29 and 30, 2017. Over these two days, the USGS experts described in details the step-by-step process to build the complex hydrogeologic framework of the Ararat Valley by using data and information available and applying sophisticated tools and methods. Groundwater management options and next steps toward development of the groundwater flow model for the Ararat Artesian Basin were also presented to the Armenian specialists, representing the ASPIRED Project, Water Resources Management Agency and Environmental Monitoring and Information Center of the MNP (Figure 19).

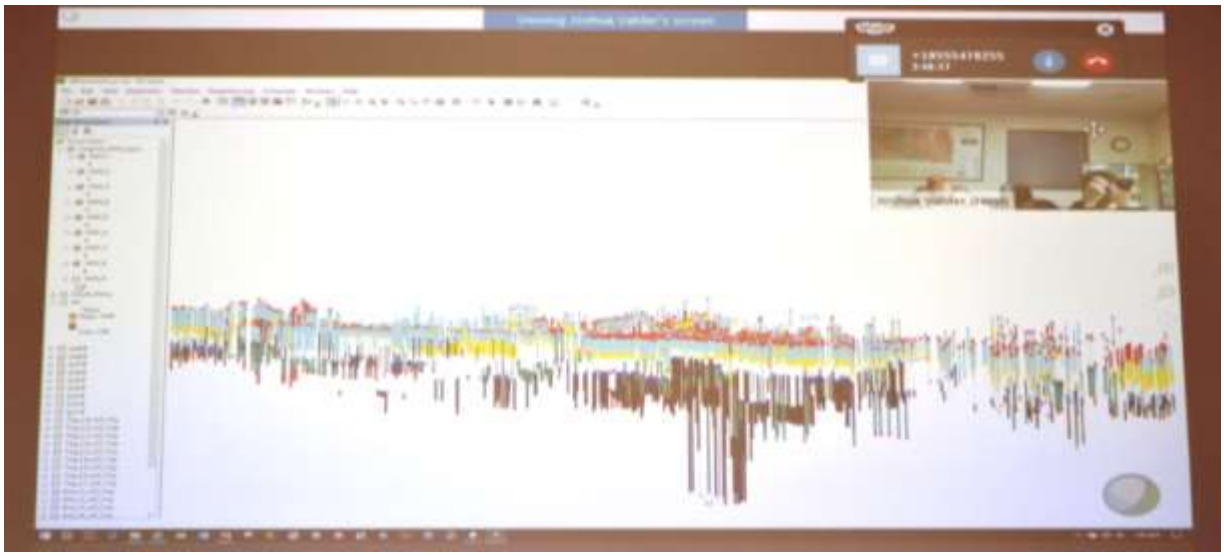

Figure 19: USGS Dakota team presents the hydrologic framework of the Ararat Valley to the Armenian specialists

Presented outcomes and opportunities for building the generated a substantial interest among the MNP specialist in further enhancement of their skills in GIS and groundwater modeling tools, which will allow them generating data to inform decisions made by the Government of more effective management of groundwater resources.

The hydrogeologic framework provides the areal extent, thickness, depth, water levels, and groundwater flow directions of the artesian aquifers basin based on the existing geologic maps, remote sensing imagery and groundwater wells field inventory conducted by the ASPIRED team. When the hydrogeologic framework is finalized and report is published in November-December, 2017, the ASPIRED team will use the framework of the Ararat Valley for developing a groundwater flow model (Figure 20).

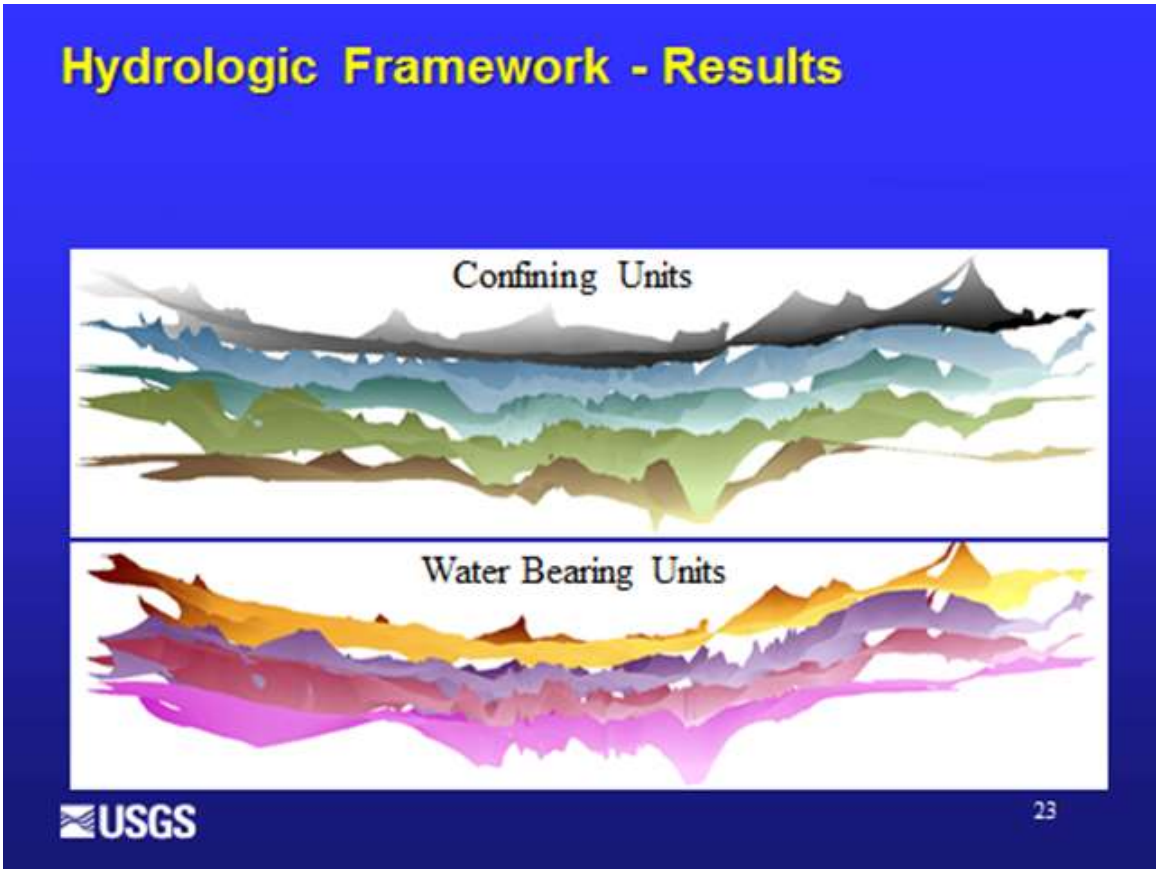

Figure 20: Capture from the USGS presented results on hydrogeologic framework

At the same time, the ASPIRED will update the digital hydrogeological map for the Ararat Valley developed by the Project team, using historical/archive data and results of inventory of groundwater wells, natural springs and fish farms from 2016. First in its nature, the map includes GIS layers on boundaries of the Ararat Valley and Ararat artesian basin, tectonic structure, geological formations, aeration zone, drainage network of the Ararat Valley, directions and volumes of groundwater inflow into the valley, directions and volumes of groundwater outflow out of the valley, as well as the piezo-lines of groundwater pressure. This will be discussed and shared with the stakeholders.

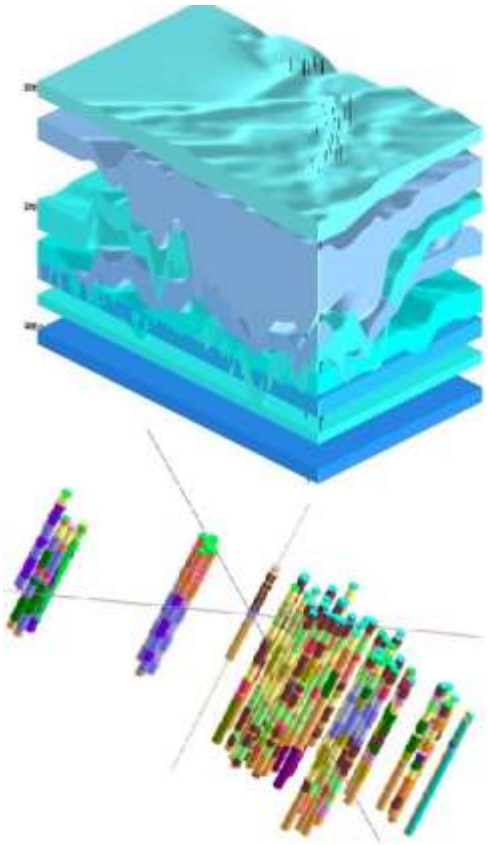

Figure 21: Preliminary lithology of wells and aquifers of the Ararat Valley: testing phase of the groundwater modeling.

This year the ASPIRED team reviewed the available ***groundwater modeling tools*** developed by USGS – specifically MODFLOW with its front-end and back-end extensions (i.e. GMS, Modelmuse, etc.) – as well as other software, which could be used for modeling the Ararat artesian basin. Among those are the RockWorks with its RockWare, which generates the GIS compatible results.

The ASPIRED team completed the first round of testing the RockWorks groundwater modeling tool. The ASPIRED team constructed preliminary two- and three-dimensional images of the Ararat Valley aquifers, with cross sections, using data of about 60 groundwater wells (Figure 21). The project team will continue testing the groundwater modeling tool, using data of additional representative wells from the 2016 inventory.

In its 3rd year of operation, the ASPIRED Project will work with a selected trainer on the design and content of a customized training program for the Project team and selected technical staff from the WRMA, EMIC, and academia on the ArcGroundwater (ArcGW) tools and MODFLOW package, using the hydrogeologic framework developed in cooperation with USGS. The Project team and selected technical staff from WRMA, EMIC and Yerevan State University, Agribusiness Teaching Center, American University of Armenia and others are expected to participate in the course, starting December 2017. The purpose of the training is to enhance participants' practical skills in refining the 3-D model of the aquifers developed by the USGS, creating numerical groundwater model for the aquifers of the Ararat Valley.

Afterwards, the ASPIRED project team will work on enhancing hydrogeologic framework of the Ararat Valley into a numerical groundwater model so that in addition to visualizing the 3D model of the aquifers, the model also (a) determines recharge rates in the groundwater basin; (b) simulates the actual water volume in each aquifer; and (c) simulates groundwater dynamics in the Ararat Valley.