



European Union Water Initiative Plus for Eastern Partnership Countries (EUWI+): Results 2 and 3

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WATER MONITORING ASSESSMENT REPORT – ARMENIA



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The assessment in Armenia was carried out during the second and third quarters of 2017 and its Final Draft Report (Version 2.0) had been agreed in December 2017. The current final version does not include any new assessments or additional findings, but reflects the new visibility requirements of the project only.

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Abbreviations

ASPIRED	Advanced Science and Partnerships for Integrated Resource Development
DOA	Description of action
EC	European Commission
EaP	Eastern Partnership
EECCA	Eastern Europe, Caucasus and Central Asia
EMIC	Environmental Monitoring and Information Centre
EU	European Union
EUWI+	European Union Water Initiative Plus
EPIRB	Environmental Protection of International River Basins
EQS	Environmental Quality Standards
GW	Groundwater
GWB	Groundwater body
ISO	International Standards Organisation
IWRM	Integrated Water Resources Management
MNP	Ministry of Nature Protection
NPD	National Policy Dialogue
QA	Quality assurance
QC	Quality control
QM	Quality management
RBMP	River Basin Management Plan
SW	Surface water
SCWS	State Committee on Water Systems
USAID	United States Agency for International Development
USGS	United States Geological Survey
WB	World Bank
WFD	Water Framework Directive
WRMA	Water Resource Management Agency
WSS	Water supply and sanitation
WTP	Water treatment plant
WUA	Water Users Association

Country Specific Abbreviations Armenia

EIMC	The Environmental Impact Monitoring Centre
HMC	Hydrogeological Monitoring Centre
MNP	Ministry of Nature Protection
SCWS	State Committee on Water Systems
SWCIS	State Water Cadastre Information System of Armenia
WRMA	Water Resources Management Agency

1 PROJECT SUMMARY

The Eastern Partnership (EaP) is a policy initiative launched at the Prague Summit in May 2009. It aims to deepen and strengthen relations between the European Union and its six eastern neighbours: Armenia, Azerbaijan, Belarus, Georgia, Moldova and Ukraine.

In recent years, the countries of the Eastern Partnership have demonstrated a willingness to align their water policies and practices with the general principles and specific requirements of the EU Water Framework Directive (WFD), as well as other thematic and sectoral water directives and UN Multilateral Environmental Agreements (MEAs). Moreover, Georgia, Moldova, and Ukraine have assumed commitments to reform water policies and implement the EU water *acquis* as part of the Association Agreements signed with the EU in 2014.

It is within this context that the *European Union Water Initiative Plus for the Eastern Partnership* (EUWI+) for Eastern Partnership Countries was initiated by the Directorate-General for Neighbourhood and Enlargement Negotiations (DG NEAR) of the European Commission.

The *European Union Water Initiative Plus for the Eastern Partnership* (EUWI+) was launched in September 2016 to assist the six Eastern Partnership countries to approximate to the EU Water Framework Directive and its associated directives. Its objective is to improve the sustainable management of water resources with a focus on trans-boundary river basin management.

EUWI+ focuses on five thematic areas:

1. Legislation, policy development and institutional consolidation
2. Laboratory and monitoring system enhancement
3. River Basin Management Plan development
4. River Basin Management Plan implementation
5. Public awareness, communications, and data/information management

The OECD and UNECE are implementing activities under thematic area 1. Thematic areas 2–5 are being undertaken by a consortium of EU member states comprised of the Environment Agency Austria (UBA) and the International Office for Water (OIEau/IOWater) of France. Experts from other EU member states will also be involved in project activities.

The budget for these thematic areas for all six countries amounts to a total of EUR 24.6 million and is financed by the European Union with contributions from the governments of Austria and France. Its planned period of operation is from September 2016 until August 2020 (48 months).

A website has been created (<http://euwipluseast.eu/en/>) for the publication and dissemination all the data, information and services developed and used within the framework of this project.

2 EXECUTIVE SUMMARY

The *European Union Water Initiative Plus for the Eastern Partnership* (EUWI+) was launched in September 2016 to assist the six Eastern Partnership countries to approximate to the EU Water Framework Directive and its associated directives. Its objective is to improve the sustainable management of water resources with a focus on trans-boundary river basin management.

This assessment report summarises the current state of knowledge regarding the existing water monitoring and management systems in Armenia and takes into account the findings of the forerunner EPIRB project and existing River Basin Management Plans. It indicates the needs identified for capacity building in Armenia, which are necessary in order to bring the country's water management into line with the Water Framework Directive (WFD).

Assessment focused primarily on the current status of ground- and surface water (identification and delineation of water bodies and preliminary identification of main pressures) and gaps in the light of the requirements of the WFD. The secondary focus was on the current situation of the quantitative and chemical groundwater monitoring network, as well as the monitoring of the biological quality elements in surface and coastal waters, and some general indications of areas of improvement.

The main institution in Armenia with responsibility for ground- (qualitative and quantitative) and surface (qualitative) water monitoring is the Environmental Monitoring and Information Centre (EMIC). In 2018, an additional staff member (a hydrobiologist) will be employed at the EMIC water lab. According to EMIC, a monitoring strategy for groundwater is lacking and therefore a new strategy, including groundwater monitoring, is currently under development. The current groundwater monitoring network consists of 50 chemical and some 80 quantitative monitoring sites. The existing monitoring network does not cover the upper groundwater horizon and in order to establish a representative monitoring network for groundwater and all categories of surface water, human resources and budgets for operation and maintenance are needed.

An assessment of surface water monitoring was completed during the fourth quarter of 2017 (assessment mission in October 2017). A surface water monitoring strategy was introduced by the EU Tacis project KURA-II (Trans-boundary river management for the Kura River, phase II, 2008-2011) and the EU ENPI project KURA-III (Trans-boundary river management for the Kura River, phase III, 2012). Field sampling and training activities have been extended with the support of the latter EPIRB project. Monitoring of the two basins of Lake Sevan is conducted at 28 monitoring stations along transects. At present, basic fish parameters such as biomass, size and weight are assessed. The equipment available at the Science Centre of Zoology and Hydroecology of the National Academy of Science of Armenia is operational, however additions are required. Hydrobiological monitoring has yet to be established in Armenia and the limited number of experienced staff for surface water monitoring will limit the development of ecological assessment systems and delay the implementation of River Basin Management Plans.

Advancement of the groundwater monitoring strategy in Armenia requires the delineation of groundwater bodies, as these constitute the groundwater management units used under the Water Framework Directive. In the absence of a groundwater assessment system, there is a significant need for training on matters that include available quantities and quality.

An essential improvement of the surface water monitoring would be the introduction of hydrobiological monitoring.

In order to facilitate the development of River Basin Management Plans and build respective capacity in the Armenian administration, a clear and pragmatic step-by-step procedure regarding the delineation of water bodies and the development of monitoring networks (based on the existing guidance of the Common Implementation Strategy of the Water Framework Directive and of the EPIRB project) is under development. This procedure will include draft templates for water body characterisation and a template for the characterisation of monitoring sites (based on the EPIRB Water Body at Risk Report and EU and Austrian experience). These will be introduced in a series of workshops and via work packages completed in the interim periods, which will be complemented by theoretical and practical training on sampling in close coordination with field surveys.

3 INTRODUCTION

The European Neighbourhood Policy (ENP) provides a framework for closer relations between the EU and its neighbouring countries Armenia, Azerbaijan, Belarus, Georgia, Moldova and Ukraine. The European Union Water Initiative Plus for Eastern Partnership Countries project (EUWI+) aims to furnish these states with further support in improving their water quality and has a special focus on trans-boundary river basin management in the light of the WFD principles.

The EUWI+ action is built on the lessons learned from several development initiatives of the European Union in the water sector in Armenia, consisting primarily of the EUWI EECCA and EPIRB projects.

This overall project objective addresses existing challenges in both the development and implementation of efficient water resource management.

One key, outstanding challenge is the further enhancement of water monitoring capacity through the geographical coverage of monitoring networks, laboratory infrastructure and the methodological basis for sampling and biological and (physico-)chemical analyses. In view of limited resources and the necessity for effectiveness and efficiency, ground- and surface water monitoring must be carried out where it is most urgently required. The data generated has to be transformed into the information needed to acquire and use the knowledge necessary for risk-based and targeted water management, as stipulated by the WFD. A second key challenge is therefore the strengthening of water management capacities within the framework of River Basin Management Planning and its implementation.

Groundwater is often a major source of drinking water and an important resource for industry (food processing etc.), agriculture (e.g. irrigation, fish farming) and thermal water supply (balneology, heating purposes). Furthermore, it plays a vital role in the hydrological cycle, as it is critical for the maintenance of wetlands and feeding of river flows. It acts as an important buffer during dry periods and provides the base flow to many surface water systems.

Restricted water quantity is one of the many threats posed to surface waters and therefore aquatic organisms. Pollution ranging from chemicals and pesticides (e.g. agricultural runoff) to organic waste, and morphological alterations can impact water quality and ecological status.

Surface water systems are amongst the most threatened but precious habitats, as they are subject to multiple pressures. They account for less than 0.01% of the planet's total surface area, but support more than 100,000 species. Continuous monitoring of the ecological status of rivers and lakes that takes pressure-impacted relationships into account represents a platform for sustainable water management and thus provides a basis for many human lives.

The WFD aims to achieve good chemical status of all water bodies, good ecological status or potential of all surface waters, and good quantitative status of groundwater bodies. Achieving these objectives requires the implementation of various steps and both the identification and delineation of water bodies, and targeted and cost-efficient monitoring are essential. These basic steps subsequently help to focus the implementation of the most appropriate measures in a cost-efficient manner and thereby achieve the greatest possible benefit from the resources available.

This report covers the water-related aspects of the following activities:

- Activity 2.1.1 Assessment of monitoring and laboratory infrastructure, capacities and needs;
- Activity 2.1.2 Purchase of equipment, including hydrological and water quality monitoring stations and rehabilitation and upgrade of existing equipment and existing laboratories;
- Activity 2.2.1 Preparation of training plans and organisation of hands-on training and training of trainers with regard to monitoring and laboratory analyses and to support laboratories for accreditation;

- Activity 2.3.1 Assessment of the needs and identification of priorities in implementation of the RBMPs;
- Activity 2.3.2 Technical Support in the elaboration and implementation of the pilot RBMPs.

These activities are closely related to Activity 2.2.1 regarding capacity building in the laboratories (equipment, analytics, QA/QC, accreditation) and Activities 2.3.1 to 2.3.7, which involve the development and implementation of RBMPs.

In order to define and target the exact water-related steps to be taken within each activity of Result 2 of the EUWI+ project, it was necessary to conduct a thorough assessment of the status quo and the related trajectories of the partner country administrations. This ground- and surface water management assessment report summarises the current state of knowledge on the existing water monitoring and management systems. It indicates the needs identified for capacity building along with the step-by-step approach of the WFD to cyclical ground- and surface water management. This extends from the delineation and characterisation of water bodies, including the anthropogenic pressures to which they are subjected, to the resultant risk to the achievement of the WFD's environmental objectives, the definition of a suitable and feasible monitoring network, sampling at the monitoring sites, the analysis of the generated data, the assessment of water body status, the definition of measures to ensure the adequate protection of water resources and biological quality elements, and the required implementation of these steps.

This report also has links to the rehabilitation and/or procurement and installation of monitoring equipment. The assessments presented in this report are preliminary, information having been gathered and elaborated through meetings between the responsible technical and management staff in the Armenian administration and the UBA water team. The assessments are subject to constant revision, as the teams working in the Armenian administration and the member state consortium continue to develop the activities foreseen under the EUWI+ project.

4 ASSESSMENT OBJECTIVES

4.1 Objectives

In order to establish project priorities and targets, an assessment of the current state of ground- and surface water management and the monitoring situation was carried out with the aim of identifying potential gaps and areas of support via the project. According to the step-by-step approach of the WFD, as management units water bodies have first to be identified and delineated before a monitoring network can be developed in line with the directive's principles.

The WFD typology for surface waters (Annex II, section 1) is organised by initially classifying water bodies in broad categories (rivers, lakes, transitional, coastal waters, artificial water bodies, heavily modified water bodies) and secondly, by differentiating water body types within these categories. This is achieved using fixed typologies: System A, which is based on an eco-region, altitude, catchment area and geology, and an alternative typology, System B, which consists of a mixture of obligatory and optional factors.

Due to this dependency, at this stage the assessment focused primarily on the current status of ground- and surface waters (identification and delineation of water bodies and preliminary identification of the main pressures), and the gaps in the light of WFD requirements.

The secondary focus was on the current situation of the groundwater monitoring network and the monitoring of biological quality elements, as well as some general indications of areas of improvement. The detailed assessment of the groundwater monitoring infrastructure and capacities will be completed once the groundwater bodies are established. The following aspects required assessment:

- The need for a review of existing delineation methodology and groundwater bodies in EPIRB pilot basins (feeds into Activity 2.3.1);
- The need for hands-on training to delineate groundwater bodies in the river basin districts newly included in the EUWI+ project (feeds into Activities 2.2.1 and 2.3.2);
- The current status of groundwater monitoring and initial indications with respect to training, infrastructure and equipment requirements (feeds into Activities 2.1.1 and 2.1.2).

The assessment of the surface water monitoring infrastructure was completed during six missions. Corresponding questionnaires in the respective countries were prepared with a focus on:

- The current status of surface water monitoring (feeds into Activity 2.1.1):
 - Qualified staff numbers and their respective fields of expertise
 - The existing monitoring of biological quality elements and available expertise
 - Monitoring and reference sites
 - Data availability
- Equipment needs (feeds into Activity 2.1.2):
 - On-site assessment of sampling/monitoring equipment
 - Identification of equipment needs
- Training needs (feeds into activity 2.2.1):
 - Initial indication of training needs for sampling and identification
 - Sampling and identification training for additional biological quality elements

This assessment report summarises the findings described in detail in the mission reports, which are an essential part of the assessment activities. Moreover, the assessment report identifies gaps and proposes steps aimed at the sustainable implementation of the WFD within the EUWI+ project, as well as providing a strategic outlook on the further needs for action beyond the time frame of the EUWI+ project.

4.2 Assessment methodology

During the inception phase and the assessments at the beginning of the implementation phase of the EUWI+ project, meetings were held with representatives of the responsible administration and relevant international projects. The key Armenian institution working in groundwater management and involved in the current project is the Environmental Monitoring and Information Centre (EMIC) under the Ministry of Nature Protection (MNP). In order to gather the required information, meetings took place with both management and technical staff from the Centre.

The following aspects were discussed:

- Existing EPIRB methodologies, e.g.
 - Guidelines on identification, characterisation and delineation of groundwater bodies
 - Guidelines on sampling
- The existing (draft) River Basin Management Plan(s)
 - The identified, delineated and characterised groundwater bodies
 - The pressure analysis methodology for groundwater
 - The pressure data employed
 - The risk and status assessment methodology and the results
- The existing and planned groundwater monitoring activities:
 - The legal basis, existing rules and responsibilities
 - The distribution and location of monitoring points
 - The monitored parameters and monitoring frequency

The administration's experts were asked to provide their opinions regarding the following:

- Are the EPIRB methodologies understandable, logical, tailored to the local situation and easily applicable in other areas? What needs to be improved? What should be better explained? Who are the readers/users?
- Have gaps or problems with regard to the groundwater aspects of the existing (draft) RBMP(s) already been identified. Is there a need for updates?
 - Are you happy with the identified groundwater bodies, or might a re-delineation be necessary and helpful?
 - Are you happy with the methods and procedures applied in the RBMPs? Are they clearly explained, understandable and logical? Can they be easily applied to other river basins?
 - Have all pressures been considered (e.g. land use, urban areas, forests, location of industrial sites, dump sites, groundwater abstractions, ...)? Have all potential pollutants been identified and considered?

- According to your instincts and experience does the RBMP identify those areas, which should be prioritised for action?
- Do you think that the results of the risk and status assessment reflect the actual situation? If not, is this because of the assessment methodology or the fact that certain data is incomplete or completely missing?
- Who is responsible for groundwater monitoring network/sampling? What kind of quality assurance is considered? Who receives the monitoring data results and what is the data used for?

The aim of these discussions with the national administration was to understand:

- Who will actually be responsible for the various steps of WFD implementation and who will be our counterparts for the single aspects.
- Which aspects of the EPIRB methodologies need to be improved in order to become more user-friendly and better tailored to the national situation/needs, as well as what needs to be improved for alignment with the WFD.
- Which additional (pressure) data needs to be explored and compiled for the next working steps.
- What are the next steps and who is doing what.

The Armenian institutions currently working on surface water issues and monitoring are the Institute of Zoology and Hydroecology, the National Academy of Sciences and the EMIC water lab.

A questionnaire was sent to and completed by our Armenian partners after the surface water mission in order to summarise and supplement the knowledge gathered.

The most significant ongoing international undertaking with groundwater-related links to EUWI+ is the USAID Advanced Science and Partnerships for Integrated Resource Development (ASPIRED) technical assistance project, which is being carried out together with the US Geological Survey (USGS).

4.3 Chronology

The aforementioned assessments were completed during the following missions:

- 1st groundwater assessment mission 27-30.6.2017
- 1st surface water assessment mission 2.-5.10.2017
- A questionnaire on surface water monitoring was sent in August 2017 to the institutions visited
- The Environmental Monitoring and Information Centre returned the questionnaire on 30.1.2018

5 ACTIVITIES

In conjunction with the review of the deliverables from the previous EPIRB project, the discussions with representatives of the responsible administration revealed the following current status and areas for support through the EUWI+ project.

5.1 Activities regarding groundwater

5.1.1 Activity 2.1.1 Assessment of monitoring and laboratory infrastructure, capacities and needs

Discussions concerning the current status of the monitoring infrastructure, capacities and needs were held with the technical and management staff of the Environmental Monitoring and Information Centre. At present, there is no monitoring strategy. EMIC explained that a new monitoring strategy, including groundwater monitoring, is currently under development. It will cover responsibilities, budgets and the schedule of implementation. It is of note that the outline of the model RBMP for Armenia, which contains a section on the monitoring network, has recently been adopted. Adaptations of this outline for the Sevan, Hrazdan and Debed/Northern basins are undergoing preparation as part of the EUWI+ project.

The current groundwater monitoring network consists of 50 chemical and around 80 quantitative monitoring sites. The upper groundwater horizon is not covered by the monitoring network.

5.1.2 Activity 2.1.2 Purchase of equipment, including hydrological and water quality monitoring stations and rehabilitation and upgrade of existing equipment and existing laboratories

Decisions on the rehabilitation and upgrading of existing monitoring sites, and the purchasing and installation of equipment for new groundwater monitoring sites will be taken on the basis of a sound understanding of the groundwater bodies and once the planning of the groundwater monitoring network has been finalised and the monitoring frequency and parameters determined.

Some groundwater bodies have already been identified and delineated in the EPIRB pilot basin. Under Activity 2.3.2, this work will be continued in the EUWI+ pilot basins. Once the existing monitoring infrastructure is fully assessed in all the pilot basins and can be assigned to the newly identified, delineated and characterised groundwater bodies, and in addition the gap between the status quo and the newly developed plan for the monitoring network is known, it will be possible to determine if, where, and how the rehabilitation of existing sites and the installation of new sites will be necessary, most suitable and possible with the resources available in order to implement the revised groundwater monitoring network. The selected equipment will influence the content of the training to be carried out under Activity 2.2.1. For further details see the groundwater roadmap for Armenia in chapter 7.2.

5.1.3 Activity 2.2.1 Preparation of training plans and organisation of hands-on training and training of trainers with regard to monitoring and laboratory analyses and to support laboratories for accreditation

Centre staff were already involved in the EPIRB project, which worked on the Akhuryan basin. Nonetheless, there is a need for and a desire for external input regarding groundwater management and monitoring. The Armenian experts expressed an interest in monitoring concept papers and strategies from Austria.

The preliminary training plans for groundwater monitoring will be based on the insights obtained during the stepwise implementation of the groundwater roadmap for Armenia in chapter 7.2. Similarly, the individual training and the field survey(s) will be developed over the course of the EUWI+ project in order to allow maximum targeting on the needs of the Armenian administration. Training material and the groundwater survey manual will be based on EPIRB manuals, which will be revised if necessary. Sampling training and field survey(s) will be carried out once groundwater bodies have been identified, delineated and characterised, and after the design of the monitoring network, including frequencies and parameters as part of Activity 2.3.2. The surveys will serve the validation of conceptual understanding and the gathering of the data necessary for enabling risk and status assessment. The exact content of training will also depend upon the equipment purchased, or to be purchased under Activity 2.1.2. Possibilities for conducting some of the monitoring training and the field surveys as regional workshops and trans-boundary exercises, and thereby fostering an exchange of experience between administrations and the establishment of working relations on a technical level, will be evaluated with all the stakeholders involved. For further details see the groundwater roadmap for Armenia in chapter 7.2.

5.1.4 Activity 2.3.1 Assessment of the needs and identification of priorities for implementation of the RBMPs

The general working approach of the EUWI+ project and the difference to a technical assistance project were explained. The step-by-step nature of WFD groundwater management, including the importance of groundwater bodies and the related concept, were also clarified and discussed. It was stressed that it is important to assign and assume responsibilities on an individual level.

The UBA GW team underlined the fact that the WFD is ideal for focusing effort where it is needed most. In addition, it was pointed out that shallow GW is one highly important aspect that is considered by the WFD because of the risks to which it is subject and its potential relevance for drinking water supplies, particularly in rural areas.

In the absence of a groundwater assessment system, there is a significant demand for training on the assessment of groundwater resources, including the available quantities. Groundwater status is currently assessed through a comparison of the measured values with drinking water standards and irrigation water standards. Exceedances are reported to the MNP. EMIC does not have a method for assessing aquifer vulnerability, or the impact of landfills as source pollution hotspots at its disposal. Hydrogeological information is available from the Republican Geological Fund, but the EMIC has to pay significant fees for access. Armenia's Ministry of Agriculture has some data on the anthropogenic pressures on water resources, but accessibility of this data for EMIC has yet to be clarified. It might be possible to arrange a free data exchange between the institutions.

The Centre considers Austria's experience with groundwater management in mountainous areas, as well as with the predominant use of groundwater for the provision of drinking water, as a valuable asset for the EUWI+ project.

5.1.5 Activity 2.3.2 Technical Support in the elaboration and implementation of the pilot RBMPs

This activity focuses on the revision and implementation of the existing Akhuryan RBMP completed during the EPIRB project, the development of plans for the Hrazdan and Lake Sevan river basin districts, and cooperation between Armenia and Georgia on the Debed/Northern basin.

The EPIRB project placed great emphasis upon the work of the international experts. Responsibility was insufficiently transferred to the Armenian specialists. Partner country institutions and their experts were not in a position to assume ownership of the previous project and its outcomes.

In order to facilitate the development of RBMPs and create related capacity in the Armenian administration, a clear and pragmatic step-by-step procedure on how to identify aquifers, delineate GWBs and design monitoring networks (based on existing CIS and EPIRB guidance) is currently undergoing completion. This procedure will include a draft template for GWB characterisation (based on the EPIRB Water Body at Risk Report and EU and AT experience) and a template for the characterisation of monitoring sites (based on EU and AT experience).

The UBA GW team provides input on important aspects for consideration when identifying, delineating and characterising groundwater bodies. Centre hydrogeologists will assemble relevant background information for the preliminary delineation and characterisation of GW bodies in the pilot basins. This will include an overview of the available geological and hydrogeological information and on the pressures to which GW is subject. EMIC hydrologists will draw up a preliminary list of the relevant pressures with the support of the UBA GW team. The resulting draft list of GW-relevant pressures will then be used by the IOW to collect pertinent data under Activity 2.3.6. Subsequently, a draft list of indicator parameters and monitoring frequencies related to these relevant pressures will be compiled.

There will be a kick-off workshop and three key hands-on workshops regarding the development of GWBs and the corresponding monitoring network. The workshops will represent joint efforts by the Centre hydrogeologists and the UBA GW team. They will feed into the RBMP work led by the IOW. Before and after the workshops, EMIC hydrologists (possibly with support from external consultants) will work through the clearly defined steps necessary for the preparation of the next event. This will allow continuous and well-paced progress towards the RBMPs with capacity being accumulated within the administration in order to ensure the institutional sustainability of WFD groundwater management. As in the EPIRB project, an Armenian consultant could contribute to groundwater body delineation and GIS mapping.

The kick-off workshop will deal with the:

- a. Presentation of the procedure and underlying principles
- b. Hands-on training on GWB delineation
- c. Hands-on training on groundwater monitoring network design

The first workshop will focus on the:

- a. Discussion of draft GWBs and hands-on revision
- b. Discussion of the template for GWB characterisation
- c. Discussion/finalisation of identified GW-relevant pressures
- d. Discussion of draft monitoring networks and hands-on revision
- e. Presentation and discussion of a characterisation template for monitoring sites
- f. Discussion/finalisation of monitoring frequency and relevant (chemical) indicator parameters
- g. Discussion of investment needs
- h. Planning of sampling training and potential surveys

The second workshop will consist of:

- a. Further discussion and hands-on training/finalisation of GWB delineation
- b. Further discussion and hands-on training/finalisation of GWB characterisation (template and description);
- c. Further discussion and hands-on training/finalisation of the monitoring network
- d. Further discussion and hands-on training/finalisation of the characterisation of monitoring sites (template)
- e. Further discussion/finalisation of investment needs including the specifications.

The focus of the third workshop will depend upon the progress made thus far:

- a. Finalisation of GWB delineation
- b. Finalisation of GWB characterisation
- c. Finalisation of the monitoring network
- d. Finalisation of monitoring site characterisation
- e. Finalisation of investment needs and specifications

These workshops will be followed by theoretical and practical training on sampling in close connection with the field survey(s), and possibly within a regional or trans-boundary context, as explained in chapter 5.1.3. For further details see the groundwater roadmap for Armenia in chapter 7.2.

5.2 Activities regarding surface water

5.2.1 Activity 2.1.1 Assessment of monitoring and laboratory infrastructure, capacities and needs

Discussions on chemical and biological monitoring were held at the Institute of Hydroecology and Ichthyology with Prof. Bardukh Gabrielyan, the Director of the Science Centre of Zoology and Hydroecology of the National Academy of Science of Armenia, and experts from the EMIC laboratory, who were part of the surface water assessment mission to Armenia.

During the laboratory assessment, in addition to laboratory information the Central Laboratory of Environmental Monitoring and Information Centre provided input regarding the equipment available for biological monitoring.

EMIC water lab

During the assessment mission, the possibilities for improving biological monitoring and a new measurement frequency within the monitoring system were discussed. A differentiation between sites was proposed, in order to focus on sites at risk as a priority. Regular monitoring needs to be in place for the identification of sites at risk.

Table 1: Existing monitoring expertise of EMIC water laboratory according to the questionnaire

Fields of expertise	Level of knowledge trainee/experienced/advanced	Nr. of staff
Fish		
Macroinvertebrates	Should be trained	1
Phytobenthos		
Phytoplankton		
Macrophytes		
Hydromorphology		
Hydrology		
Other, please specify		

An expert on hydrobiology will be reemployed at the beginning of January 2018.

Table 2: Existing assessment methods of EMIC water laboratory according to the questionnaire

Method	Parameter/s	Interval	Site type <ul style="list-style-type: none"> • Monitoring site • Reference site • Project-based site selection 	Number of samples	WFD compliance
-	Macroinvertebrates	2011-2015 during a project	<ul style="list-style-type: none"> • Monitoring site • Reference site 	About 50 samples annually	yes

The evaluation of the existing monitoring network will be the first important step towards identifying improvement and training potential.

Science Centre of Zoology and Hydroecology of National Academy of Science of Armenia

At the Science Centre, all classes of animals including invertebrates and fish are studied scientifically. The Institute of Hydroecology and Ichthyology, which is part of the Science Centre, focuses mainly on Lake Sevan, where monitoring has taken place since 1923.

The monitoring of Lake Sevan's two basins is conducted at 28 monitoring stations located along transects. At present, basic fish parameters such as biomass, size and weight are assessed. Poaching is still a major threat on Lake Sevan and the consequences of drastic water level changes in the past are still evident.

As all trophic levels are studied on Lake Sevan, including phytoplankton, macrophytes, zooplankton and phytobenthos, in terms of biological monitoring species identification, skills are in place. Plankton are studied in lakes and sometimes in reservoirs and the macroinvertebrates, macrophytes, microbiology and fish in rivers have been assessed occasionally.

The data is usually on paper, but some is already available in a database.

The equipment available at the Zoology and Hydroecology Science Centre of the National Academy of Science of Armenia is operational, but additions are still needed (see 5.2.2 Activity 2.1.2).

Table 3: Existing monitoring expertise of Science Centre of Zoology and Hydroecology according to the questionnaire

Fields of expertise	Level of knowledge trainee/experienced/advanced	Nr. of staff
Fish	Advanced	3
Freshwater crayfish	Advanced	2
Macroinvertebrates	Advanced	6
Phytobenthos	Advanced	6
Phytoplankton	Advanced	5
Macrophytes	Advanced	1
Hydromorphology /geographer	Advanced	1
Hydrology	Advanced	2
Other, please specify		

26 staff members with advanced identification skills for all of the aforementioned biological quality elements are currently working at the National Academy of Science of Armenia's Zoology and Hydroecology Science Centre.

Table 4: Existing assessment methods of Science Centre of Zoology and Hydroecology according to the questionnaire

Method	Parameter/s	Interval	Site type • Monitoring site • Reference site • Project based site selection	Number of samples	WFD compliance
Hydrochemical method	Hydrogen index, dissolved oxygen content	spring-autumn period	project based site selection	Once a month	compliance
Hydrochemical method	Index of organic matter content	spring-autumn period	project based site selection		compliance
Hydrochemical method	Concentrations of nutrients (NH ₄ ⁺ , NO ₂ ⁻ , NO ₃ ⁻ , PO ₄ ³⁻)	spring-autumn period	project based site selection		compliance
Hydrobiological method	Shannon diversity index	spring-autumn period	project based site selection		compliance
Hydrobiological method	Extended biotic index (EBI)	spring-autumn period	project based site selection		compliance
Hydrobiological method	Family Biological Index (FBI)	spring-autumn period	project based site selection		compliance
Hydrobiological method	Biological Monitoring Working Party Index (BMWP)	spring-autumn period	project based site selection		compliance
Hydrobiological method	Degree of species similarity by Sorensen-Chekanovsky index	spring-autumn period	project based site selection		compliance

The evaluation of the different methods in terms of WFD compliance has yet to be completed.

5.2.2 Activity 2.1.2 Purchase of equipment, including hydrological and water quality monitoring stations and rehabilitation and upgrade of existing equipment and existing laboratories

Final decisions on procurement are yet to be made, but wish lists of equipment needs were drafted in the questionnaires and will be assessed during procurement.

EMIC water lab

The EMIC water lab stated equipment needs in the questionnaire:

- Outwear for sampling
- Nets for sampling

In addition, EMIC's water laboratory stated in the lab questionnaire that a car for sampling would be needed.

Science Centre of Zoology and Hydroecology of National Academy of Science of Armenia

Table 5: Existing equipment at the Science Centre of Zoology and Hydroecology according to the questionnaire

Portable spectrophotometer	DR 1900
Centrifuge	Z 216 M
PCR machine	TC9610
BOD bottles	Wheaton 227497-08
Water sampler	11.004 Ruttner
Sediment sampler	12.210 Van Veen grab

A collaboration exists between the Institute of Hydroecology and Ichthyology and two scientists from the National Park. The latter are responsible for microbiology and fish monitoring in the park and mostly use an office in an old building in the city of Sevan. It was proposed that this could be renovated and established as a field laboratory, but this suggestion requires evaluation.

5.2.3 Activity 2.2.1 Preparation of training plans and organisation of hands-on training and training of trainers with regard to monitoring and laboratory analyses and to support laboratories for accreditation

The first step will involve the evaluation of the existing monitoring network in order to achieve adaptation to both Armenian and WFD requirements.

The preliminary training plans for surface water monitoring will be based on a detailed assessment of the needs of the institutions responsible for surface water monitoring in Armenia. Individual training and field survey(s) will be developed within the framework of the EUWI+ project in order to attain maximum targeting on the needs of the Armenian administration. Training materials and the development of a surface water survey manual will be based on EPIRB manuals, which will be revised if necessary. Sampling training and field survey(s) will be carried out for various body monitoring parameters. The surveys will serve to validate conceptual understanding and gather the data necessary for the ena-

bling of risk and status assessment. The exact content of training will also depend upon the equipment purchased or to be purchased under Activity 2.1.2. The fostering of exchanges of experience between administrations and the establishment of working relations on a technical level will be evaluated.

Initial regional workshops are planned in order to discuss the requirements of the WFD and develop a stepwise approach to implementation. Subsequently, individual training will be organised for the specific needs relating to the assessment of biological quality elements.

EMIC water lab

The questionnaire mentions that new staff need to be trained, but specific requirements are yet to be clarified.

Science Centre of Zoology and Hydroecology of National Academy of Science of Armenia

The Science Centre of Zoology and Hydroecology stated training needs in the questionnaire:

- Training courses on GIS
- Training courses on 1D hydrodynamic model
- Training courses on water management
- Training courses on climate change impacts and adaptation

5.2.4 Activity 2.3.1 Assessment of the needs and identification of priorities for RBMP implementation

The general working approach of the EUWI+ project and the difference to a technical assistance project were explained. The step-by-step and cyclical nature of WFD surface water management were also clarified and discussed. As was the case with GW, the UBA SW stressed that with regard to the WFD it is beneficial to focus effort where it is needed the most.

5.2.5 Activity 2.3.2 Technical Support in the elaboration and implementation of pilot RBMPs

This activity focuses on the revision and implementation of the existing Akhuryan RBMP developed during the EPIRB project, the drawing up of plans for the Hrazdan and Lake Sevan river basin districts, and cooperation between Armenia and Georgia on the Debed/Northern basin.

The EPIRB project placed great emphasis upon the work of the international experts. Responsibility was insufficiently transferred to the Armenian specialists. Partner country institutions and their experts were not in a position to assume ownership of the previous project and its outcomes.

In order to facilitate the development of RBMPs and create related capacity in the Armenian administration, a clear and pragmatic step-by-step approach (manual) for SWBs and the design of monitoring networks (based on existing CIS and EPIRB guidance) is currently in preparation. This procedure will include a draft template for SWB characterisation (based on the EPIRB Water Body at Risk Report and EU and AT experience) and a template for the characterisation of monitoring sites (based on EU and AT experience).

The UBA SW team provides input on the important aspects requiring consideration when identifying and delineating surface water bodies. Armenian experts will draw up a preliminary list of relevant pressures with the support by the UBA SW team. The resulting draft list of SW-relevant pressures will then be used by the IOW to collect data under Activity 2.3.6. Subsequently, a draft list of indicator parameters and monitoring frequencies related to these relevant pressures will be compiled.

6 RELATED ISSUES

6.1 Institutional reform

The Environmental Monitoring and Information Centre is a newly formed organisation within the Republic of Armenia's Ministry of Nature Protection. It incorporates the former Hydrogeological Monitoring Centre, the Environmental Impact Monitoring Centre, the Information-Analytical Centre and the Waste Monitoring Centre. EMIC's range of responsibilities include GW monitoring (qualitative and quantitative) and SW monitoring (qualitative). The new Director of the Centre was previously the First Deputy Minister of Nature Protection, and was therefore deeply involved in the EUWI+ inception phase.

6.2 Model RBMPs and monitoring strategy

The outline of the model RBMP for Armenia was adopted on 26 October 2017 under the terms of the Armenian government's protocol resolution 45. The related outline of the programme of measures of the RBMP contains a section on the monitoring network. Adaptations of this outline to the Sevan, Hrazdan and Debed/Northern basins are currently being prepared as part of the EUWI+ project.

A new monitoring strategy including groundwater monitoring is currently under development. It will cover responsibilities, budgets and the implementation schedule. EUWI+ work on groundwater management will tie into these developments.

6.3 Institutional sustainability of selected institutions

In order to establish a representative monitoring network for GW and for SW, human resources, and a basic budget for infrastructure maintenance and the purchase of essentials are needed. The very limited number of experienced staff for surface water monitoring will limit the development of ecological assessment systems and delay RBMP implementation.

7 NEXT STEPS

7.1 Linkage with laboratory assessment

The identification of the significant anthropogenic pressures on water goes hand-in-hand with the identification of the associated chemical substances and indicators, which should be part of the monitoring system. Precise adjustment in line with Activity 2.1.2 in terms of laboratory needs and capacities is recognised as a guarantee that these substances can be analysed in the relevant laboratories.

7.2 Programming

7.2.1 Groundwater programming

A clear and pragmatic step-by-step procedure on how to identify aquifers, delineate GWBs and design monitoring networks is currently being prepared.

If considered necessary by the member state consortium and the Armenian administration, a groundwater survey might be organised during the summer of 2018 in order to fill the gaps in the baseline data required for further steps in the RBMP process.

A regional workshop on the principle requirements of the WFD could be organised jointly for the Armenian institutions working on ground- and surface water.

See below for the groundwater roadmap for Armenia.

Table 6: Groundwater roadmap for Armenia

	Implementation steps	Armenian experts	MS-consortium	Timing (Location)
1.	<p>Preparatory (home) work by MS consortium experts:</p> <ul style="list-style-type: none"> • A clear and pragmatic stepwise procedure (terms of reference) on how to identify aquifers, delineate GWBs and design monitoring networks (based on existing CIS and EPIRB guidance). This will include a draft template for GWB characterisation (based on the EPIRB Water Body at Risk Report and EU and AT experience) and a template for the characterisation of monitoring sites (based on EU and AT experience). 		UBA (ToR)	
2.	<p>Kick-off workshop</p> <ol style="list-style-type: none"> a. Presentation and discussion of step-by-step procedure. Background and principles of: GWB delineation, characterisation and groundwater monitoring. b. Exemplified, practical hands-on training on GWB delineation for a selected case study. c. Exemplified, practical hands-on training on groundwater monitoring network design for a selected case study. 	Name/institute	UBA	
3.	<p>Preparatory (home) work by country experts:</p> <p>Groundwater bodies</p> <ol style="list-style-type: none"> a. First draft delineation of the GWBs following the stepwise procedure (in map 1:200,000): <ol style="list-style-type: none"> i. Compilation of hydrogeological information (maps, profiles ...). ii. Selection of aquifers of relevance from a WFD perspective (used, intended to be used, linked to ecosystems). iii. Compilation of available pressure information (maps, inventories). b. Compilation of a draft list of GW-relevant pressures for each GWB (that should be considered by IOW for data collection). <p>Monitoring</p> <ol style="list-style-type: none"> a. Inventory of existing monitoring sites and existing wells/springs, which could be potentially used as monitoring sites (consider multipurpose use). b. First draft monitoring network for each GWB in line with the principles of the step-by-step procedure. c. Compilation of a draft list of (chemical) indicator parameters related to the relevant pressures and monitoring frequencies. <p>Documentation of the applied methodology and considered information (extension and tailoring of the 'step-by-step procedure', inclusion of references and literature).</p>	Name/institute		

	Implementation steps	Armenian experts	MS-consortium	Timing (Location)
4.	<p>1st workshop with a focus on:</p> <p>Groundwater bodies</p> <ul style="list-style-type: none"> a. Discussion of draft GWBs and hands-on revision. b. Presentation and discussion of the characterisation template and the structure of the 'verbal' description of GWBs. c. Discussion/finalisation of the list of identified GW-relevant human pressures. <p>Monitoring</p> <ul style="list-style-type: none"> a. Discussion of draft monitoring networks and hands-on revision. b. Presentation and discussion of the characterisation template for monitoring sites. c. Discussion/finalisation of monitoring frequency and relevant (chemical) indicator parameters. d. Discussion of investment needs (e.g. new sites and those to be refurbished, additional infrastructure and sampling equipment). e. Planning of sampling training and potential surveys. 	Name/institute	UBA	
5.	<p>Preparatory (home) work by country experts:</p> <p>Groundwater bodies</p> <ul style="list-style-type: none"> a. Revision of GWB delineation according to the conclusions of the workshop. Inclusion in GIS. b. Modification of the GWB template and the description structure to national needs in accordance with the conclusions of the workshop. c. Characterisation of each GWB according to the template and the description structure. <p>Monitoring</p> <ul style="list-style-type: none"> a. Revision of monitoring networks for each GWB, based on the conclusions of the workshop. Inclusion in GIS. b. Adjustment of the monitoring site template to national needs according to the conclusions of the workshop. c. Characterisation of the monitoring sites according to the template. d. Elaboration of investment need specifications (e.g. new sites and those to be refurbished, additional infrastructure and sampling equipment). <p>Documentation of the applied methodology and considered information (extension and tailoring of the 'step-by-step procedure', inclusion of references and literature).</p>	Name/institute		
6.	<p>Preparatory (home) work by MS consortium experts:</p> <ul style="list-style-type: none"> a. Training material on sampling (if necessary update of the EPIRB manual with UA examples). b. Survey manual. 		UBA	

	Implementation steps	Armenian experts	MS-consortium	Timing (Location)
7.	<p>2nd workshop Depending upon the progress made between the workshops, the following activities could either be finalised, or progress and open questions discussed further:</p> <p>Groundwater bodies</p> <ol style="list-style-type: none"> Further discussion and hands-on training/finalisation of GWB delineation. Further discussion and hands-on training/finalisation of GWB characterisation (template and description). <p>Monitoring</p> <ol style="list-style-type: none"> Further discussion and hands-on training/finalisation of monitoring network. Further discussion and hands-on training/finalisation of monitoring site the characterisation (template). Further discussion/finalisation of investment needs including specifications. 	Name/institute	UBA	
8.	<p>Preparatory (home) work by country experts. Depending on the progress made thus far:</p> <p>Groundwater bodies</p> <ol style="list-style-type: none"> Completion of GWB delineation. Completion of GWB characterisation (templates and description). <p>Monitoring</p> <ol style="list-style-type: none"> Completion of monitoring network design. Completion of monitoring site characterisation. Completion of investment need specifications. <p>Documentation of the applied methodology and considered information (extension and tailoring of the 'step-by-step procedure', inclusion of references and literature).</p>	Name/institute		
9.	<p>3rd workshop – focus depends upon the progress made thus far:</p> <p>Groundwater bodies</p> <ol style="list-style-type: none"> Finalisation of GWB delineation. Finalisation of GWB characterisation. <p>Monitoring</p> <ol style="list-style-type: none"> Finalisation of the monitoring network. Finalisation of monitoring site characterisation. Finalisation of investment needs and specifications. 	Name/institute	UBA	
10.	Theoretical and practical training on sampling (e.g. in close harmony with field survey(s)).	Name/institute	UBA	
	The document regarding the step-by-step implementation procedure is a living document, which is continuously being supplemented with AM details and the literature used in order to finally achieve tailored AM guidance.	Name/institute	UBA	

7.2.2 Surface water programming

In accordance to the step-by-step approach of the WFD, the implementation of the following activities is planned for 2018 and 2019.

Training can be incorporated into surface water surveys. The goal is to ensure standardised sampling techniques and data collection as a basis for all monitoring activities. In order to maximise the outcome, field work will aim at the generation of valuable survey data and thus fill in the gaps in the baseline data required for further steps in the RBMP process.

Table 7: Surface water roadmap for Armenia

	Implementation steps	Armenian experts	MS-consortium	Timing (Location)
1.	<p>Preparatory (home) work by MS consortium experts:</p> <ul style="list-style-type: none"> • Assessment of the status quo: EPIRB documents regarding characterisation, typology and surface water body delineation • ToR for SW water body delineation • Review of existing characterisation, typology and surface water body delineation • Organisation and logistics of regional workshops 		UBA	
2.	<p>Delineation workshop One joint workshop covering water body delineation is planned Characterisation, typology and surface water body delineation</p> <ol style="list-style-type: none"> a. Background and principles b. Review of existing data/documents c. Presentation of examples 	Name/institute	UBA	25 – 26 April 2018 Kiev
3.	<p>Preparatory (home) work by country experts: Presentation of Water Framework Directive implementation/compliance steps containing information on:</p> <ul style="list-style-type: none"> • Pre-existing water body delineation • Selection of biological quality elements • Monitoring site selection • Pressure impact relation 	Name/institute		
4.	<p>Regional workshops A regional workshop is planned for the Caucasus region, AZ, GE & AM, focusing on:</p> <ol style="list-style-type: none"> a. Assessment systems <ol style="list-style-type: none"> i. Biological quality elements ii. Standardised sampling and indication potential b. Monitoring network <ol style="list-style-type: none"> i. Monitoring network design ii. Site selection 	Name/institute	UBA	11 – 15 June 2018 Tbilisi

	Implementation steps	Armenian experts	MS-consortium	Timing (Location)
	<ul style="list-style-type: none"> iii. Sampling frequency Interactive hands-on training <ul style="list-style-type: none"> a. Risk assessment and pressure impact relationships <ul style="list-style-type: none"> i. Presentation of the selected case study and general discussion ii. Two working groups for biological quality elements and hydromorphology possible 			
5.	Sharing workshop outputs with French team <ul style="list-style-type: none"> a. Preliminary risk assessment b. Preliminary SW WB delineation 		UBA/IOW	
6.	Evaluation of equipment list <ul style="list-style-type: none"> a. Preparation of procurement b. Confirmation of equipment list by countries 		UBA	
7.	Preparatory (home) work by MS consortium experts: Survey design <ul style="list-style-type: none"> a. Logistics b. Dates 		UBA	
8.	Preparatory (home) work by country experts: <ul style="list-style-type: none"> a. Site selection for training/survey activities based on interactive hands-on training (regional workshop) <ul style="list-style-type: none"> i. One site per country in pristine condition/ with little impact and one heavily impacted site within new EUWI+ river basins ii. Site selection considering logistics: max. of 4-hour drive between sampling sites b. Identification of main pressures <ul style="list-style-type: none"> i. Review of EPIRB documents and existing data ii. Finalisation of the list of the main pressures on different types of water bodies 	Name/institute		
9.	1st training/survey For the first training/survey, two suitable sampling sites (e.g. above and below an impoundment) should already be identified. <ul style="list-style-type: none"> a. Field work with a focus on standardised sampling techniques b. Macroinvertebrates will be investigated in all six countries c. As an additional biological quality element, phytobenthos is proposed in four countries, except for Georgia and Azerbaijan, where fish sampling will be conducted during joint training d. Species identification and data evaluation will be discussed, but can only be focused on additionally during specific in-depth training later in the year. 	Name/institute	UBA	Fourth week of September
10.	Preparatory (home) work by country experts: <ul style="list-style-type: none"> a. Species identification b. Data gathering 	Name/institute		

	Implementation steps	Armenian experts	MS-consortium	Timing (Location)
11.	Preparatory (home) work by MS consortium experts: a. Training material on sampling (if necessary update of the EPIRB manual) b. Draft manuals		UBA	
12.	2nd training/survey Depending upon the first fieldwork activities and the questionnaire on biological monitoring, the second round of training can be tailored to specific needs.	Name/institute	UBA	2019
13.	Linkage with French team Data management and delivery of training/survey data		UBA/IOW	
	The document regarding the step-by-step implementation procedure is a living document, which is continuously being supplemented with AM details and the literature used in order to finally achieve tailored AM guidance.	Name/institute	UBA	

8 STRATEGIC OUTLOOK AND RECOMMENDATIONS

The Environmental Monitoring and Information Centre and the UBA GW team will discuss and agree a groundwater roadmap for Armenia. The steps foreseen in this roadmap will then be implemented jointly, with ownership of the process lying with EMIC, and the UBA GW team providing support.

The involvement of significant numbers of junior staff in the exercises and training is highly recommended in order to facilitate the long-term transfer of hydrogeology and groundwater management knowledge. The gathering of such specific knowledge usually takes many years and intensive practice, and forms the basis for sustainable groundwater management, environmental protection and water supply security in the future.

This step-by-step procedure for the Armenian administration will ensure positive results, while adhering to the concept of institutional sustainability, i.e. the development of capacity within Armenia's administration, which will enable it to continue along the path of approximation to the WFD and the principles of IWRM. It is recognised that the EUWI+ project will represent a first and important step in this direction, but that additional external support might be required at later stages of this approximation process.



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