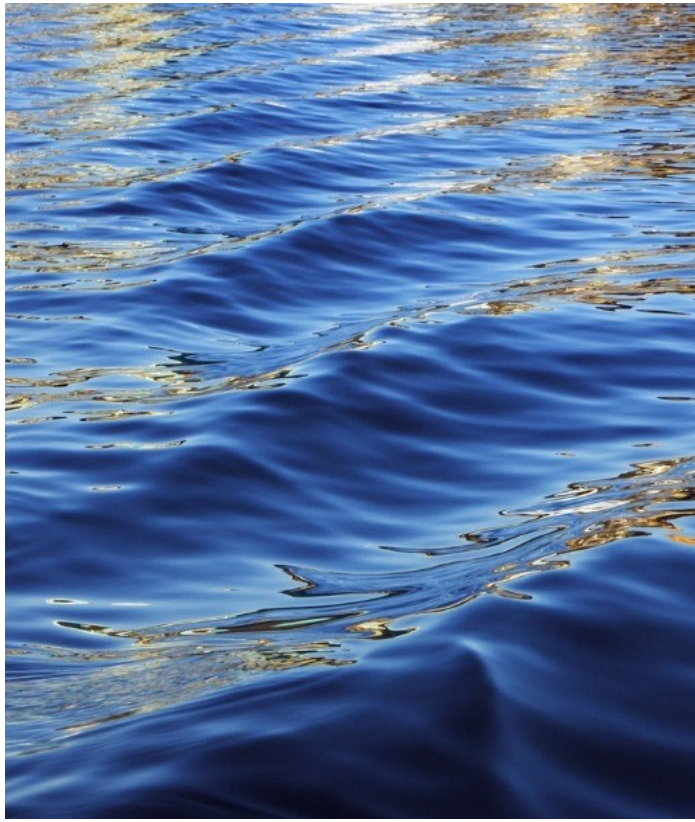
Ministry of Environment, RA
Hydrometeorology and Monitoring Center (HMC)

Nitrogen and Heavy Metals in the Arpa River Basin

Alina Zurnachyan, Armenia



Clean Air 40 YEARS

6th joint, 31st ICP IM and 39th ICP Waters Task Force Meeting
Lunz, Austria, 9-11 May 2023

Content

- Departments of HMC
- Observation Networks in Armenia
- Meteorology and Climate
- Air Qualit
- Water Quality Monitoring
- Information analytical Service
- Future

Departments of HMC

- *Air quality monitoring* - Nox, SOx, CO, ground-level ozone (O_3), dust
- *Surface water quality monitoring* - oxygen conditions, mineralization conditions, pH, Nutrients, Major Ions, heavy metals, primary organic pollutants
- *Groundwater quality monitoring* - oxygen conditions, mineralization conditions, pH, Nutrients, main anions and cations, heavy metals
- *Soil monitoring* - mineralization conditions, pH, humidity, Nutrients, main anions and cations, heavy metals
- *Forest monitoring*
- *Waste monitoring*
- *Landfills monitoring*
- *Climate* - Climate change, Temperature, atmospheric pressure, wind direction and speed, air humidity, amount of precipitation, form and amount of cloud cover, horizontal visibility and atmospheric others phenomena
- *About Agrometeorology* - Agriculture, Agro-climatic information, etc.
- Information analytical service

Surface and groundwater quality and quantity, atmospheric air quality, hydrometeorological monitoring network

Surface water quality observation network

The monitoring observation network of the surface water includes 155 observation points of water objects (rivers, reservoirs, Arpa-Sevan water pipeline and Lake Sevan) of 6 water basin management areas of the Republic (Northern, Akhuryan, Hrazdan, Sevan, Araratyan, Southern). Water quality is characterized by up to 65 physicochemical indicators (basic anions and cations, nutrients, heavy metals, primary organic pollutants), with a frequency of 5-12 times a year. The water quality assessment is supervised in accordance with the N75-N decree (January 27, 2011) of the RA Government.

Underground freshwater observation network

Underground freshwater monitoring survey network consists of 100 groundwater springs of republic's 6 water basin management areas (Northern, Akhuryan, Hrazdan, Sevan, Araratyan, Southern), which include 25 self-flowing wells, 32 borehole wells and 43 natural springs. The monitoring of water volume, level (pressure) and temperature is done 6 times per month. Also, groundwater quality monitoring is accomplished in 40 springs twice a year, in each of which around 40 indicators are determined (major anions and cations, metals and salt regime elements).

Atmospheric air quality observation network

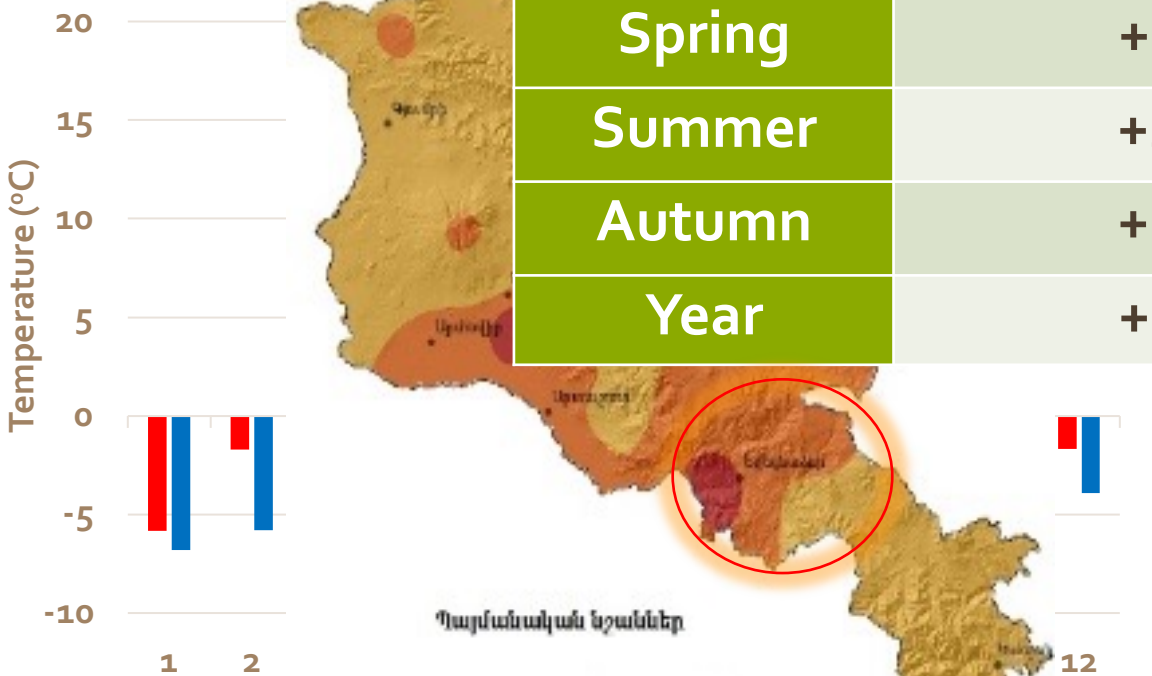
Atmospheric air quality monitoring is carried out in Yerevan, Gyumri, Vanadzor, Alaverdi, Hrazdan, Ararat, Tsaghkadzor, Charentsavan, Kapan and Kajaran cities. There are 15 stationary active sampling observation stations and 214 mobile passive sampling observation stations in the above settlements. The assessment of atmospheric air quality is performed by comparison with the limit permissible concentrations of pollutants (Ls) approved by the RA Government's decision N 160-H of February 2, 2006.

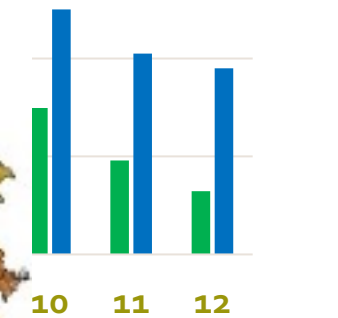
Meteorological observation network

Meteorological observations are made at 46 (including 6 hard-to-reach and 3 specialized) meteorological stations of the republic. Observations are carried out in accordance with the procedure established by the World Meteorological Organization and in accordance with international standards: once every 3 hours starting at 00:00 (GMT), atmospheric phenomena and weather conditions are observed every day.

1935-2022 in the territory of Armenia seasonal and annual variation of average temperature and precipitation from normal

	Temperature (°C)	Precipitation (%)
Winter	+1.4	-1.6
Spring	+1.7	-13
Summer	+2.0	-32
Autumn	+1.0	-31.2
Year	+1.5	-19. 5





Air Quality Monitoring

Atmospheric air pollution can be natural or anthropogenic. The main causes of pollution can be:

- fuel burning (electricity production, transport, industry and households);
- industrial emissions, for example from the chemical and mining industries,
- agriculture,
- open burning of waste,
- natural sources, including volcanic eruptions, the spread of mountain dust, emissions of volatile organic compounds from plants, etc.

The main pollutants

Sulfur dioxide *- It appears in the atmosphere during the burning of sulfur-containing fuels, the extraction of metals from ores and other industrial processes. Long-term exposure to sulfur dioxide causes respiratory diseases, changes in lung defense mechanisms. Its high content in the atmospheric air especially affects children and people suffering from asthma, affects the narrowing of the airways, making breathing worse.*

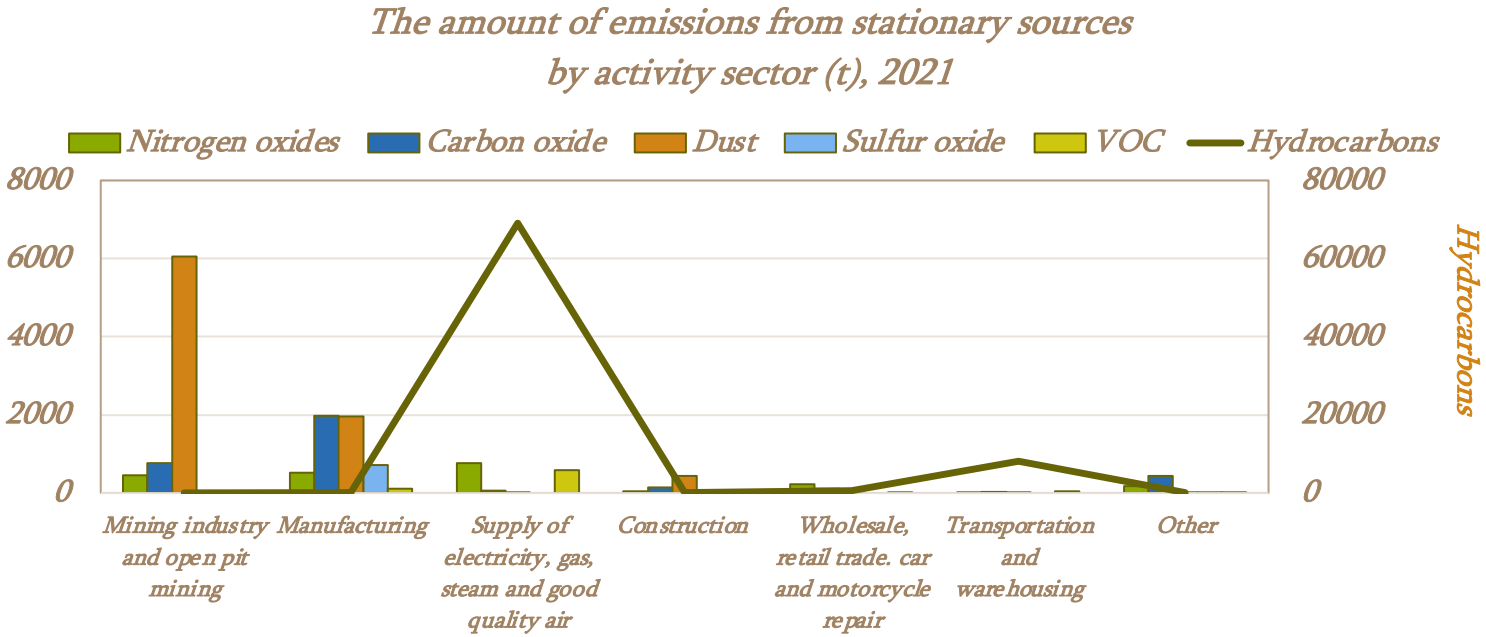
Nitrogen dioxide *– The main source of atmospheric emissions is motor vehicles. The high content of nitrogen dioxide in the atmospheric air can seriously damage the lungs, cause respiratory diseases, and changes in the protective mechanisms of the lungs. Its high content can affect people suffering from asthma.*

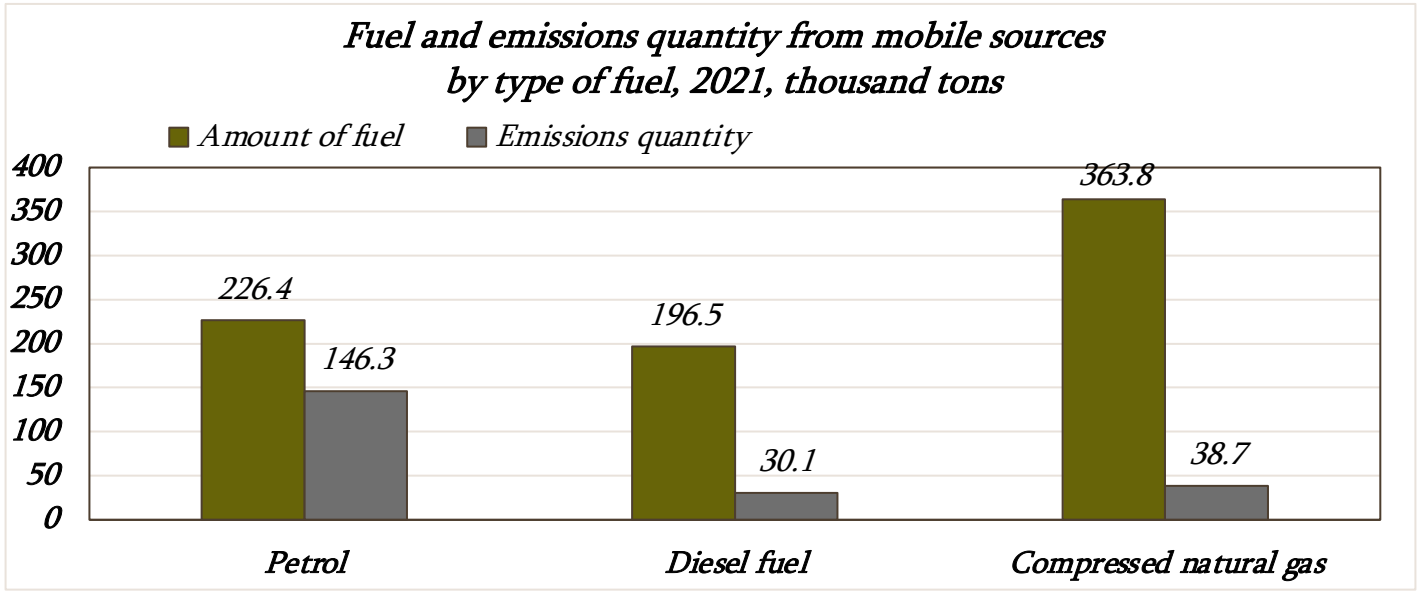
Carbon monoxide *- The main source of production is motor vehicles, but can also be caused by boiler exhaust emissions. Its content is high in large cities, especially near intersections and bus stops. High levels of carbon monoxide in atmospheric air can affect the brain, cardiovascular system, skeletal muscles, and fetal development.*

Dust *- a set of hard, small particles of organic or mineral origin. Dust pollution comes from various sources: industrial processes, vehicles, road dust, construction, some agricultural activities, lack of green spaces. The impact of dust in ambient air on human health depends on the size and composition of dust particles, as well as the duration of exposure. Dust can contribute to a number of health problems, many diseases, including coughs, itchy skin, lung diseases, asthma and heart attacks.*

The content of heavy metals in dust - Pb, Cu, Mo, Fe, Co, Zn, Ni, Cd, etc.

Air Quality Monitoring





Atmospheric emissions in 2021 amounted to **308,900 tons**, 69.6% () of which fell to mobile emission sources, 30.4% to stationary sources.

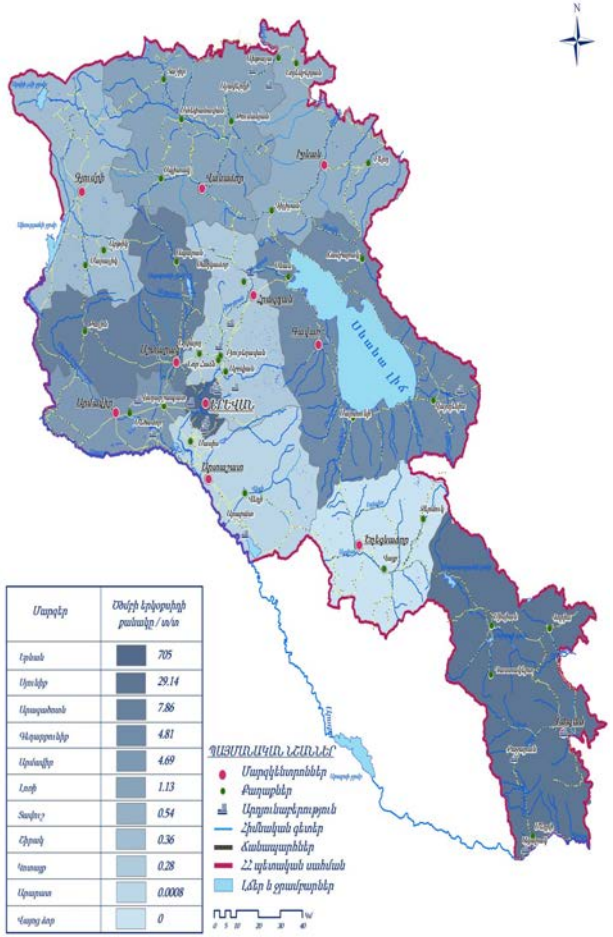
The amount of harmful substances released into the atmosphere from mobile sources in 2021 was **215 thousand tons**. About 72.5% of the total amount of harmful substances emitted is carbon monoxide, 17.2% - volatile organic compounds, 9.9% - nitrogen oxides, 0.4% - other substances.

Pollutants emitted into the atmosphere from stationary emission sources, 2021

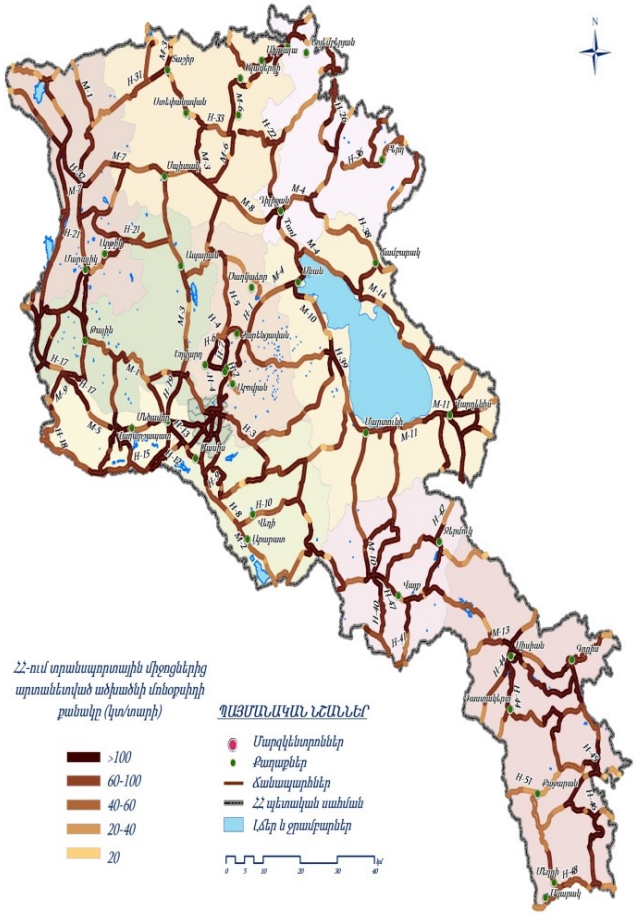
Dust

Nitrogen oxide

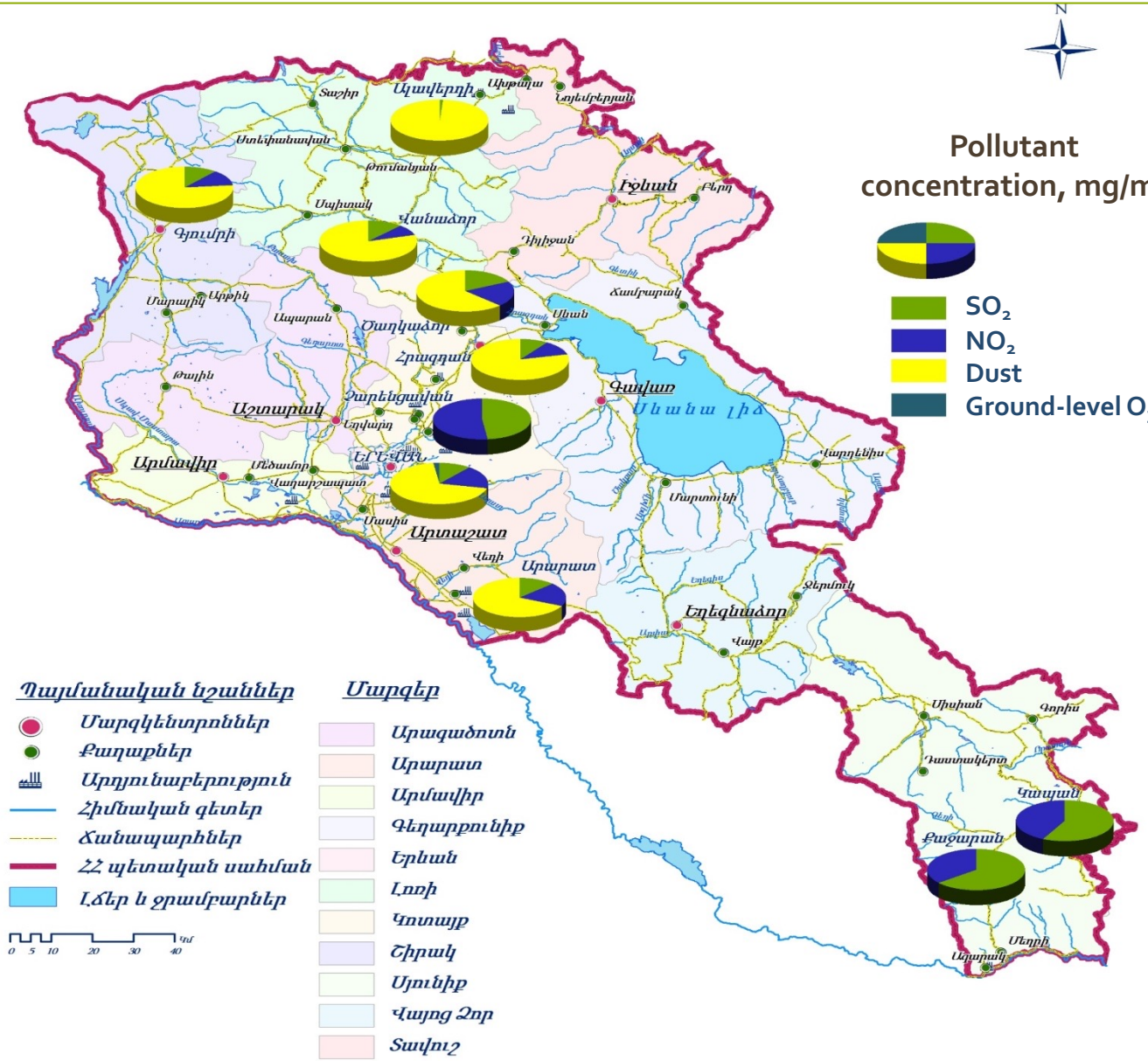
Sulfur oxide



Carbon monoxide, according to the density of the road network

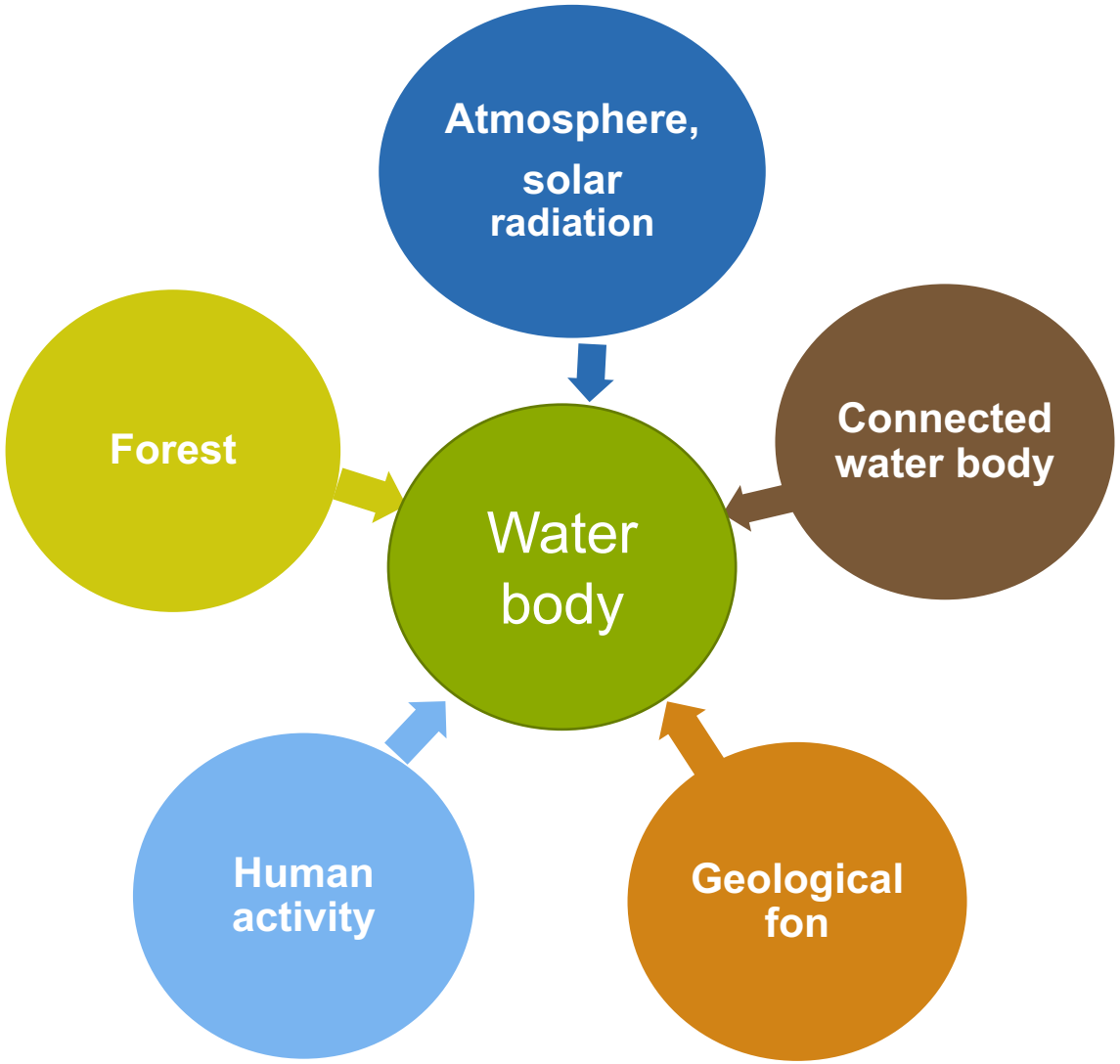


Pollutant emissions quantity from mobile sources, 2021



Water Quality Monitoring

Main impacts on water bodies



The types of monitoring required

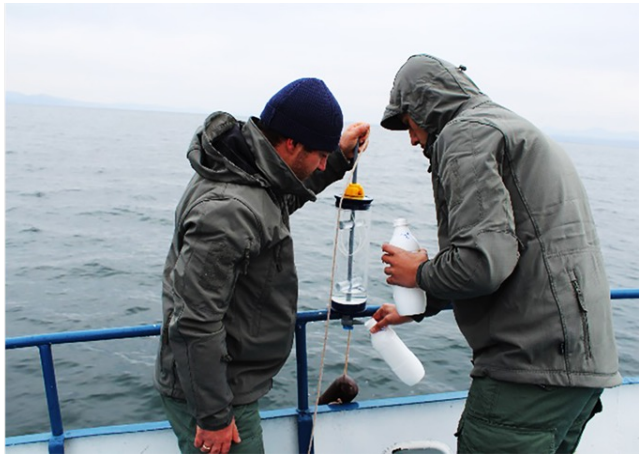
- Meteorological monitoring
- Field physico-chemical measurment
- Chemical monitoring
- Biological monitoring

Field multiparameter devices

YSI ProDSS

YSI EXO2

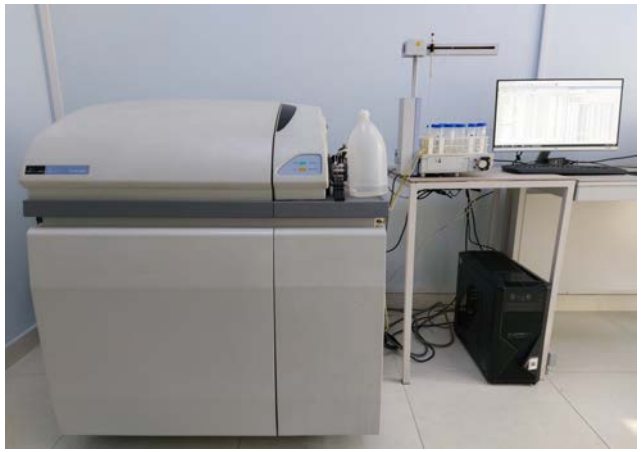
Secchi disk



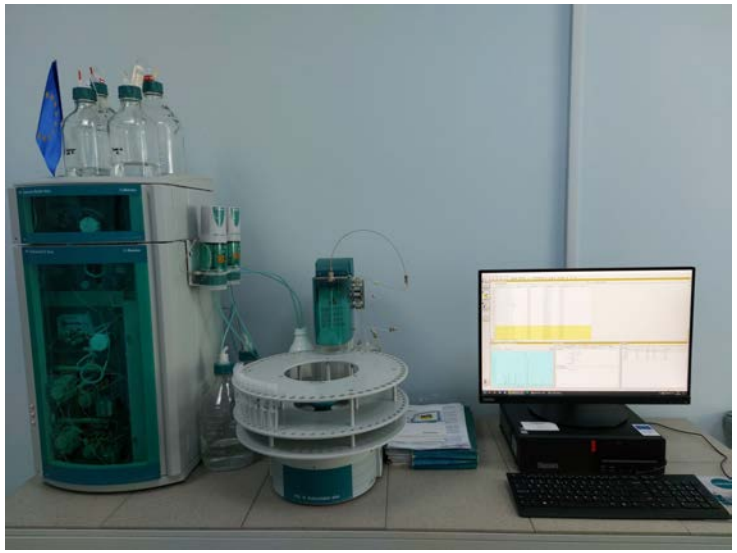
Batometer

Sampling procedure

Chemical analysis



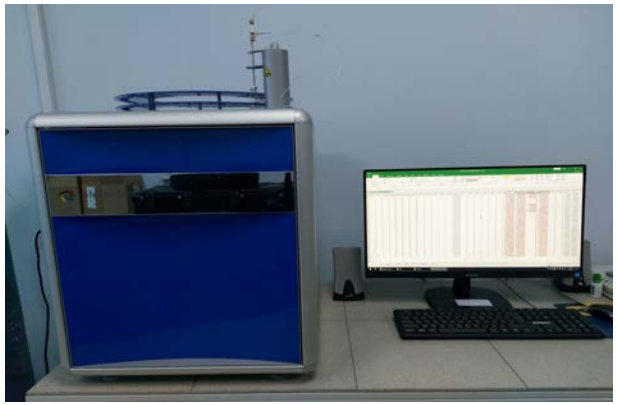
ICP-MS, ELAN 9000, Perkin Elmer



IC, Metrohm

GC-MS 7890A/5975C Agilentr

Spectrophotometry, Specord 210 Plus

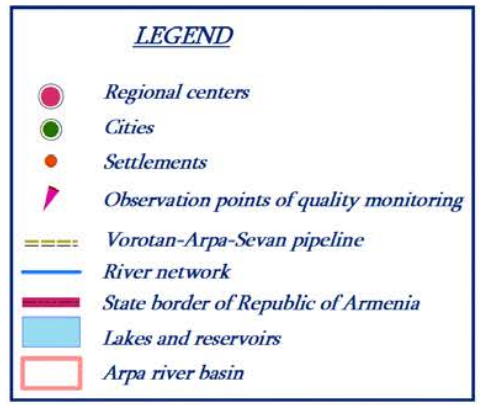


Vario TOC Cube, Elementary

XRF analyser, OLYMPUS, VANTA

Microscope, SZM-2

Arpa river Basin



- Vayots Dzor Region is located in the south-east of Armenia, in the basin of the Arpa River.
- The altitude here varies from 850 meters (Areni) to 3522 meters above sea level.
- Large reserves of copper, tuff, marble, limestone, clay, basalt, granite, felsite (Martiros felsite) and mineral water have been found in the area.

Characterization of sampling sites and monitoring types in the Arpa river basin

River	Sampling points	Latitude	Longitude	Location	*Type of sampling site*	Type of monitoring
Arpa	83	39,83758	45,67689	0.5km above Jermuk town	*R*	Biological, Physical-chemical Hydrological and hydro-morphological
Kechut reservoir	114	39,78933	45,64754	At Kechut reservoir	*C*	Physical-chemical
Darb	348	39.68578	45.68348	On Darb tributary, above Ughedzor settlements	*R*	Biological, Physical-chemical Hydrological and hydro-morphological
Darb	349	39.69362	45.56768	On Darb tributary, 0.5 km above river mouth	*C*	Biological, Physical-chemical Hydrological and hydro-morphological
Herher	350	39.82404	45.54257	On Herher tributary, 1km above Village Karmrashen	*R*	Biological, Physical-chemical Hydrological and hydro-morphological
Herher	351	39.69232	45.52348	On Herher tributary, 0.5 km above river mouth	*I*	Biological, Physical-chemical Hydrological and hydro-morphological
Yeghegis	352	39.92165	45.50629	On Yeghegis river, 5 km above Village Getikvank	*R*	Biological, Physical-chemical Hydrological and hydro-morphological
Yeghegis	88	39,74828	45,31125	On Yeghegis river, 1 km above river mouth	*C*	Biological, Physical-chemical Hydrological and hydro-morphological
Arpa	84	39,68389	45,49789	On Arpa river, 0.5km above Vayk town	*I*	Physical-chemical
Arpa	85	39,70756	45,42639	On Arpa river, 0.5km below Vayk town	*I*	Biological, Physical-chemical Hydrological and hydro-morphological
Arpa	86	39,74028	45,34383	On Arpa river, 0.5km above Yeghegnadzor town	*I*	Biological, Physical-chemical Hydrological and hydro-morphological
Arpa	87	39,72078	45,15533	On Yeghegis river, 1 km above river mouth	*I*	Biological, Physical-chemical Hydrological and hydro-morphological

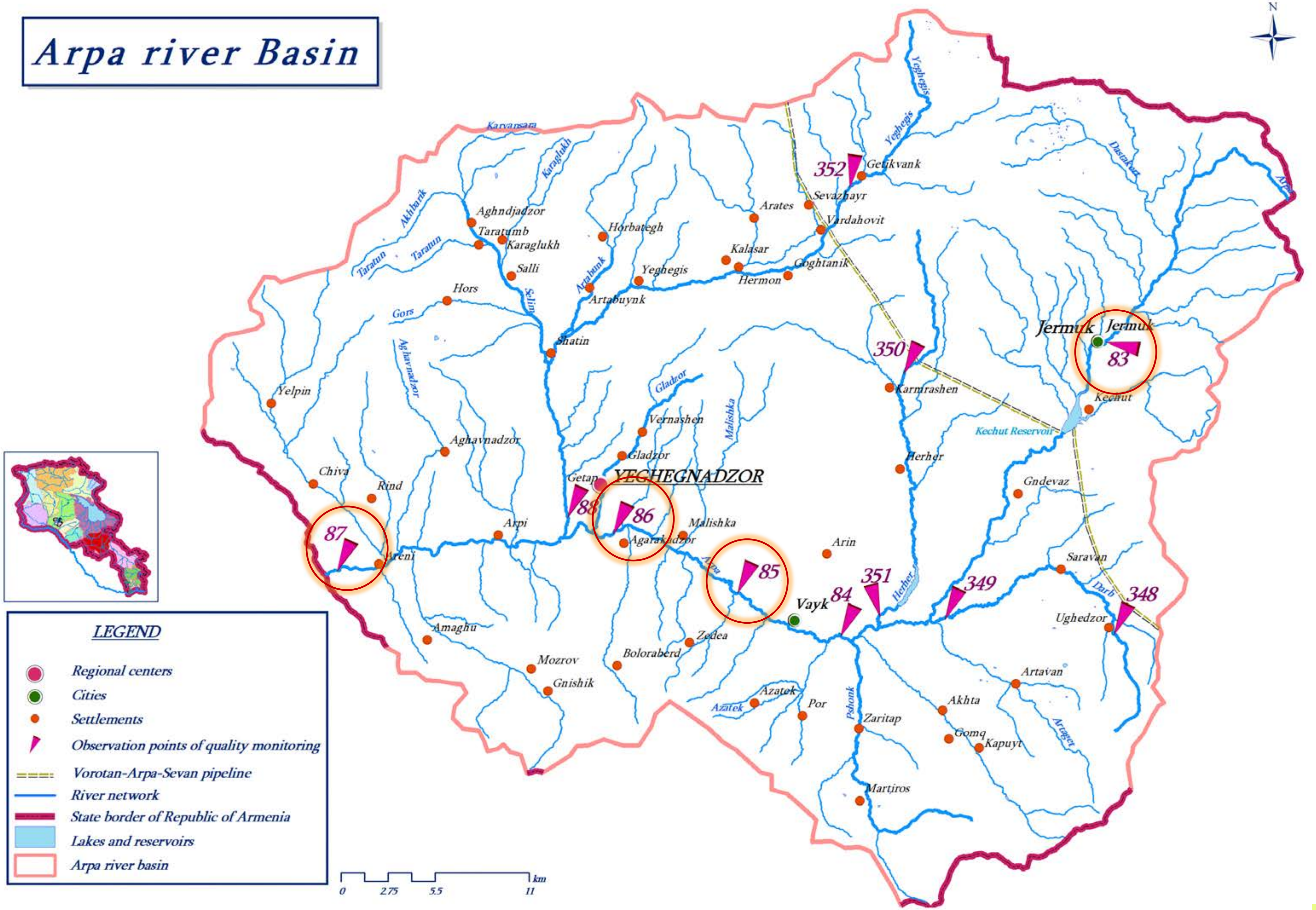
(R=reference, I=influenced, C=comperative)

Assessed water quality at the sampling sites of the Arpa River Basins based on the national water quality norms

2020						
River basin	***River***	***Sampling Site***	***Site number***	***Water quality parameter***	***Water quality class***	***Integrated class of water quality***
Ararat	*Arpa*	*0.5 km above Jermuk city*	*N83*	*Phosphate ion, Fe*	*Moderate*	*Moderate*
		0.5 km above Vayq city	*N84*	*Mo*	*Moderate*	*Moderate*
		0.5 km below Vayq city	*N85*	*Mo, Ba, Sb*	*Moderate*	*Moderate*
		0.5 km above Yeghegnadzor city	*N86*	*Mo, Mn, Ba*	*Moderate*	*Moderate*
		0.5 km below Areni city	*N87*	*Mn, Fe, Ba, K, Al*	*Moderate*	*Poor*
				Mo	*Poor*	
	Darb	*Source of the river*	*N348*	*Fe, B, Al*	*Moderate*	*Moderate*
		Delta of the river	*N349*	*Mo, Mn, Fe, Ba, K*	*Moderate*	*Moderate*
	Herher	*Source of the river*	*N350*	*-*	*Good*	*Good*
		Delta of the river	*N351*	*Mo*	*Moderate*	*Moderate*
	Yeghegis	*Above Getikvanq village*	*N352*	*Fe*	*Moderate*	*Moderate*
		0.5 km below Shatin village	*N88*	*Ba*	*Moderate*	*Poor*
				Mo	*Poor*	
Southern	*Ketchut reservoir*	*near a dam*	*N114*	*-*	*Good*	*Good*

2021						
River basin	***River***	***Sampling Site***	***Site number***	***Water quality parameter***	***Water quality class***	***Integrated class of water quality***
Ararat	*Arpa*	*0.5 km above Jermuk city*	*N83*	*-*	*Good*	*Good*
		0.5 km above Vayq city	*N84*	*Mo, Fe*	*Moderate*	*Moderate*
		0.5 km below Vayq city	*N85*	*Fe, Ba, Sb*	*Moderate*	*Poor*
				Mo	*Poor*	
		0.5 km above Yeghegnadzor city	*N86*	*Fe, Ba, Sb*	*Moderate*	*Bad*
				Mo	*Bad*	
		0.5 km below Areni city	*N87*	*Fe, Ca, sulphate ion*	*Moderate*	*Poor*
				Mo, Ba	*Poor*	
	Darb	*Source of the river*	*N348*	*Mo, Fe*	*Moderate*	*Moderate*
		Delta of the river	*N349*	*Mo, Fe, Ba, Sb*	*Moderate*	*Moderate*
	Herher	*Delta of the river*	*N351*	*Mo, Fe*	*Moderate*	*Moderate*
	Yeghegis	*Above Getikvanq village*	*N352*	*Fe*	*Moderate*	*Moderate*
		0.5 km below Shatin village	*N88*	*Fe*	*Moderate*	*Moderate*
Southern	*Ketchut reservoir*	*near a dam*	*N114*	*-*	*Good*	*Good*

2022						
River basin	***River***	***Sampling Site***	***Site number***	***Water quality parameter***	***Water quality class***	***Integrated class of water quality***
Ararat	*Arpa*	*0.5 km above Jermuk city*	*N83*	*Mn, Fe*	*Moderate*	*Poor*
				Al	*Poor*	*Poor*
		0.5 km above Vayq city	*N84*	*Mo*	*Moderate*	*Moderate*
		0.5 km below Vayq city	*N85*	*Sb*	*Moderate*	*Poor*
				Mo	*Poor*	*Poor*
		0.5 km above Yeghegnadzor city	*N86*	*Mo, Ba*	*Moderate*	*Moderate*
		0.5 km below Areni city	*N87*	*Ba*	*Moderate*	*Poor*
				Mo	*Poor*	*Poor*
	Darb	*Source of the river*	*N348*	*Fe, Ba*	*Moderate*	*Bad*
				Mn	*Bad*	
		Delta of the river	*N349*	*Mo, Ba*	*Moderate*	*Moderate*
	Herher	*Delta of the river*	*N350*	*Mo*	*Moderate*	*Moderate*
	Yeghegis	*Above Getikvanq village*	*N352*	*Fe*	*Moderate*	*Moderate*
		0.5 km below Shatin village	*N88*	*Ammonia ion, Mo, Ba*	*Moderate*	*Moderate*
Southern	*Ketchut reservoir*	*near a dam*	*N114*	-	*Good*	*Good*


Arpa river Basin
N
LEGEND
Regional centers
Cities
Settlements
Observation points of quality monitoring
Vorotan-Arpa-Sevan pipeline
River network
State border of Republic of Armenia
Lakes and reservoirs
Arpa river basin
0
2.75
5.5
11
km
YEGHEGNADZOR
Jermuk
Vayk
Getikvank
Sevazhayr
Arates
Vardahovit
Kalasar
Hermon
Goghtanik
Yeghegis
Artabuynk
Horbategh
Aghndjadzor
Taratumb
Karaglukh
Salli
Hors
Shatin
Yelpin
Aghavnadzor
Chiva
Rind
Arpi
Areni
Getap
Gladzor
Vernashen
Malishka
Agarakadzor
Arin
Karmrashen
Herher
Kechut
Kechut Reservoir
Gndevaz
Saravan
Ughedzor
Artavan
Akhta
Gomq
Kapuyt
Zaritap
Martiros
Por
Azatek
Zedea
Boloraberd
Mozrov
Gnishik
Amaghu
Karvansara
Karaglukh
Akhbarik
Taratun
Gors
Selim
Artabunk
Gladzor
Malishka
Yeghegis
Dastakert
Arpa
Herher
Darb
Arpa
Azatek
Pshonk
Artaget
Aghavnadzor
352
350
83
87
88
86
85
84
351
349
348

Pictures of Arpa River Basin

Jermuk waterfall

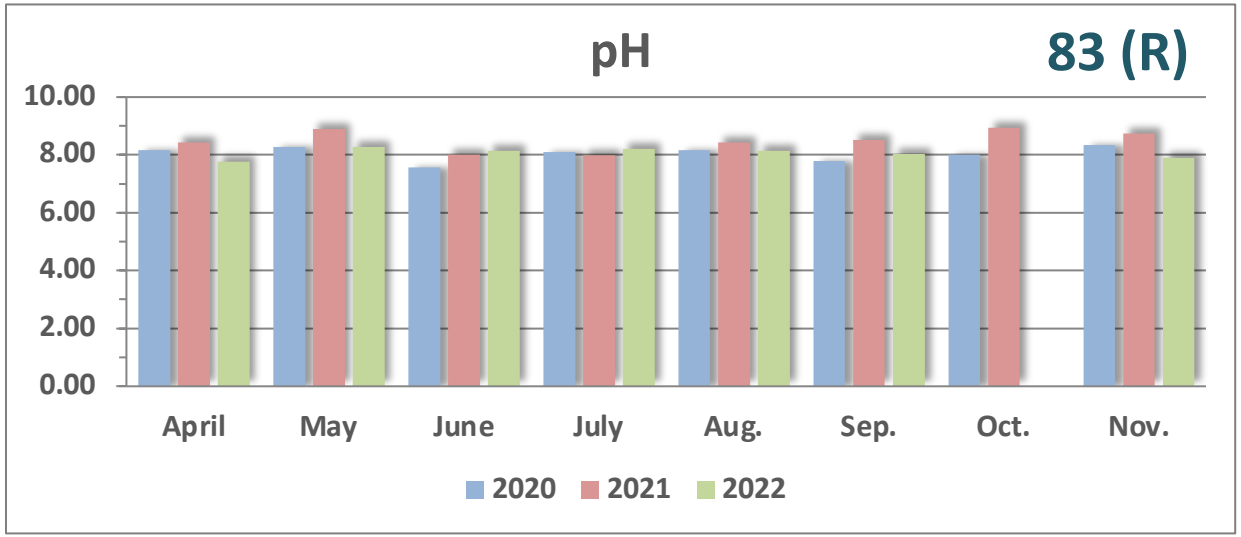
Kechut reservoir (114)

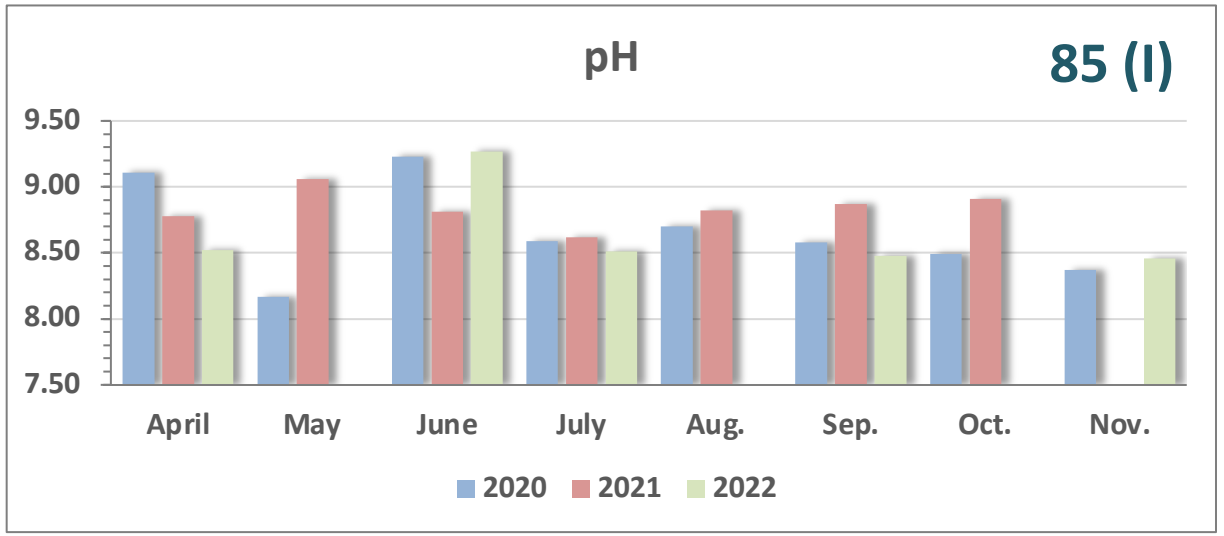
Upper reaches of the Arpa River (83)

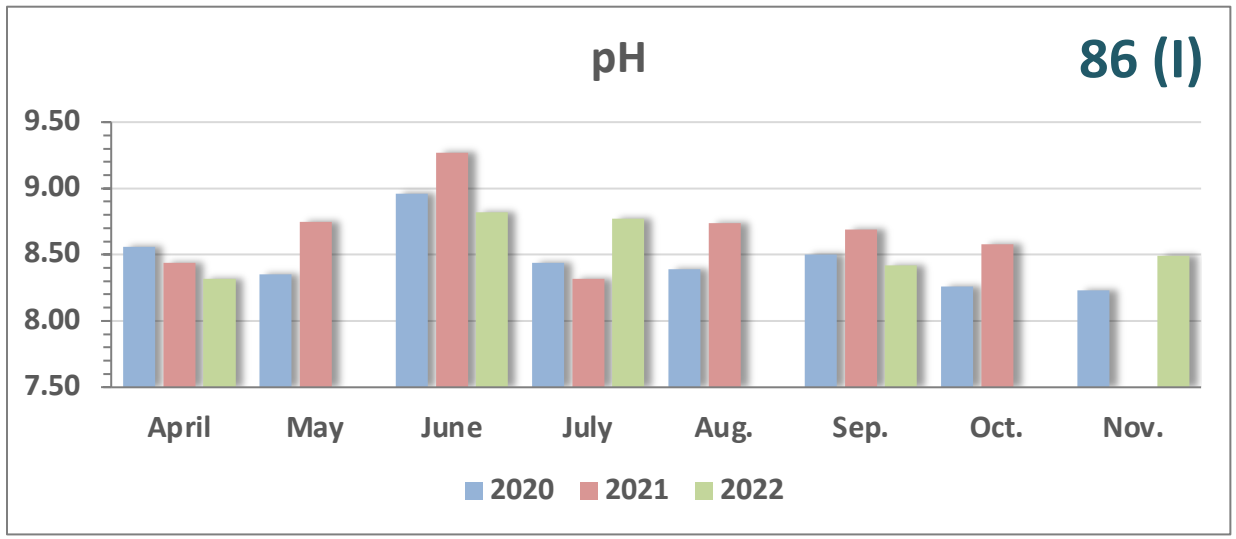
Middle reaches of the Arpa River (86)

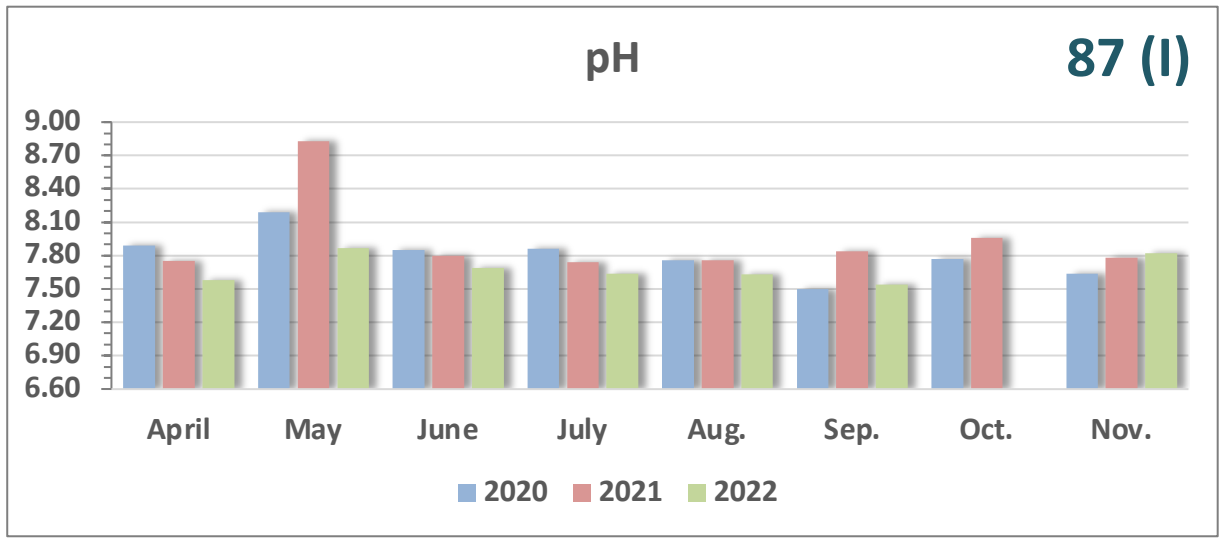
Lower reaches of the Arpa River (87)

Changes of pH in 2020, 2021, 2022 in the same stations

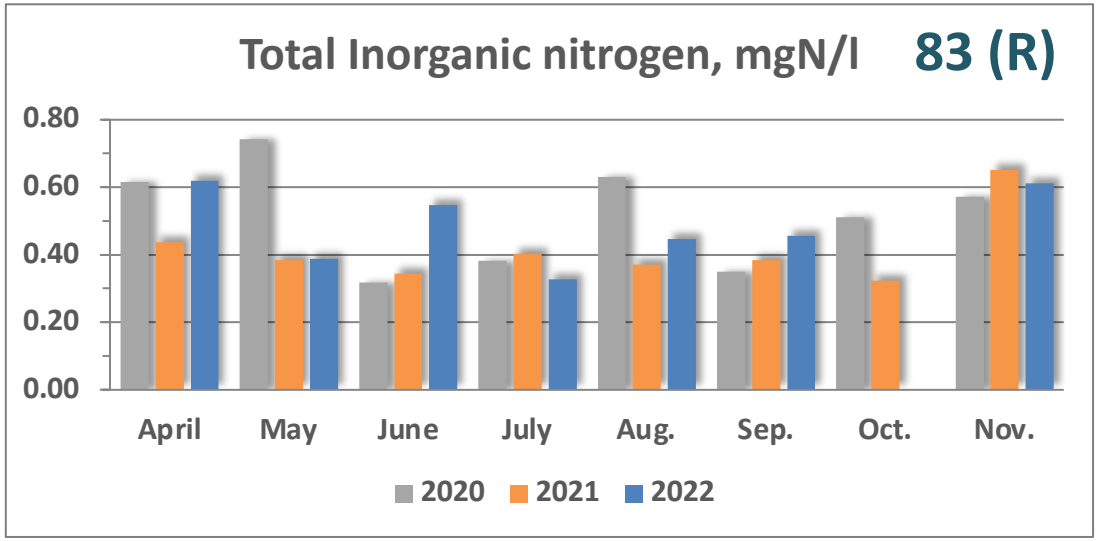


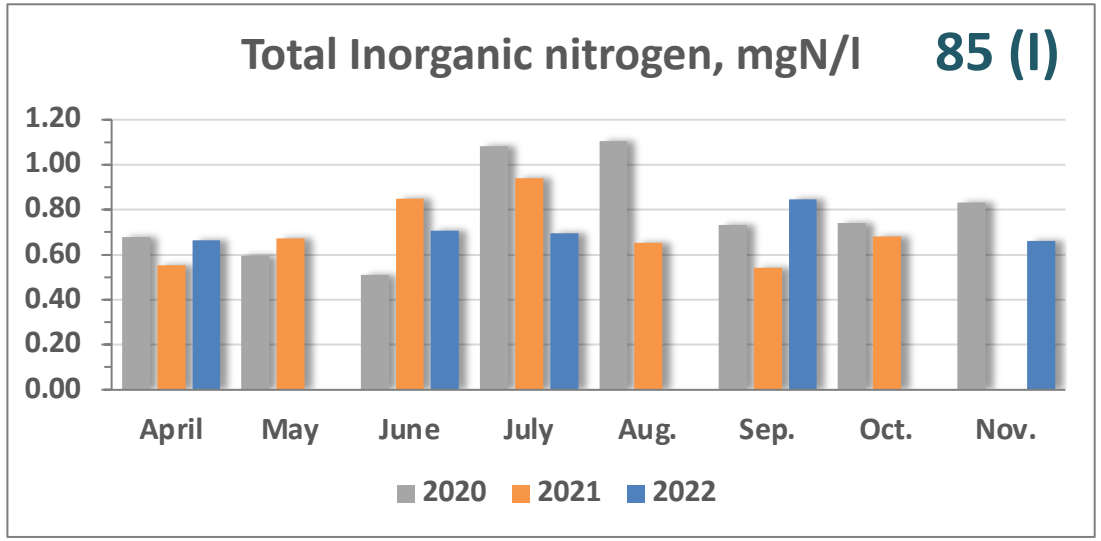


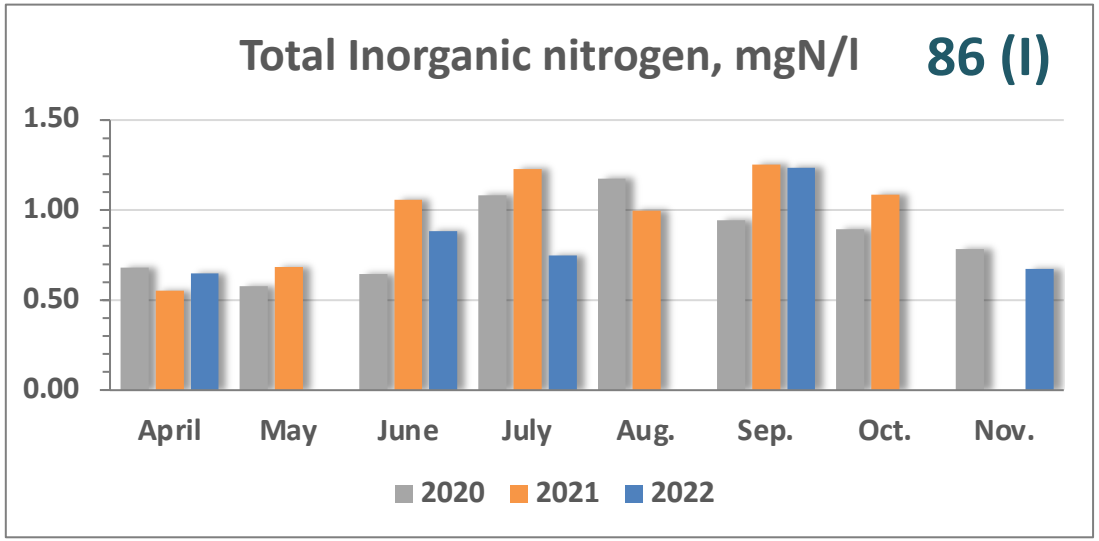


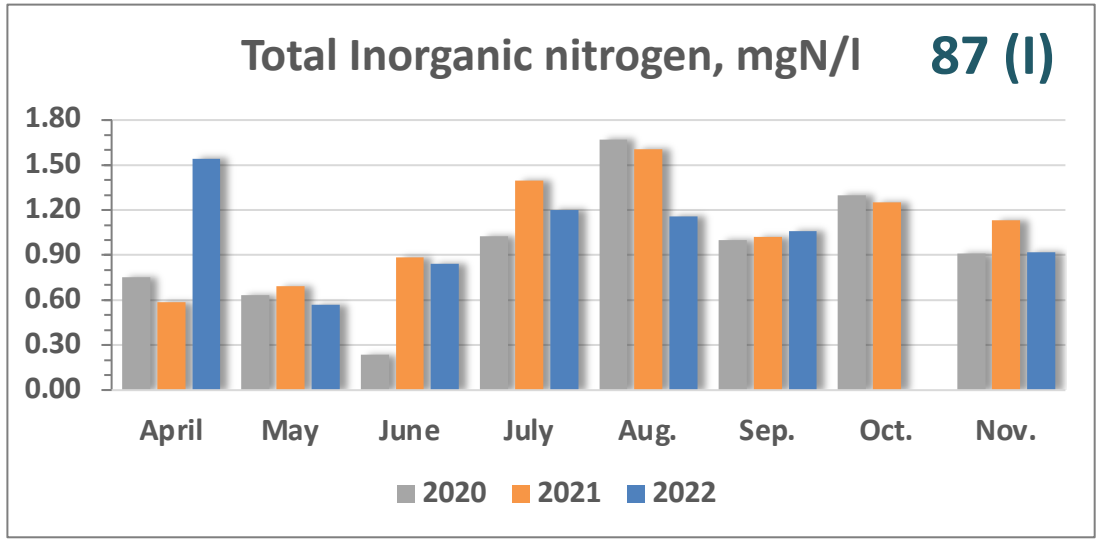


Changes of Total Inorganic Nitrogen in 2020, 2021, 2022 in the same stations

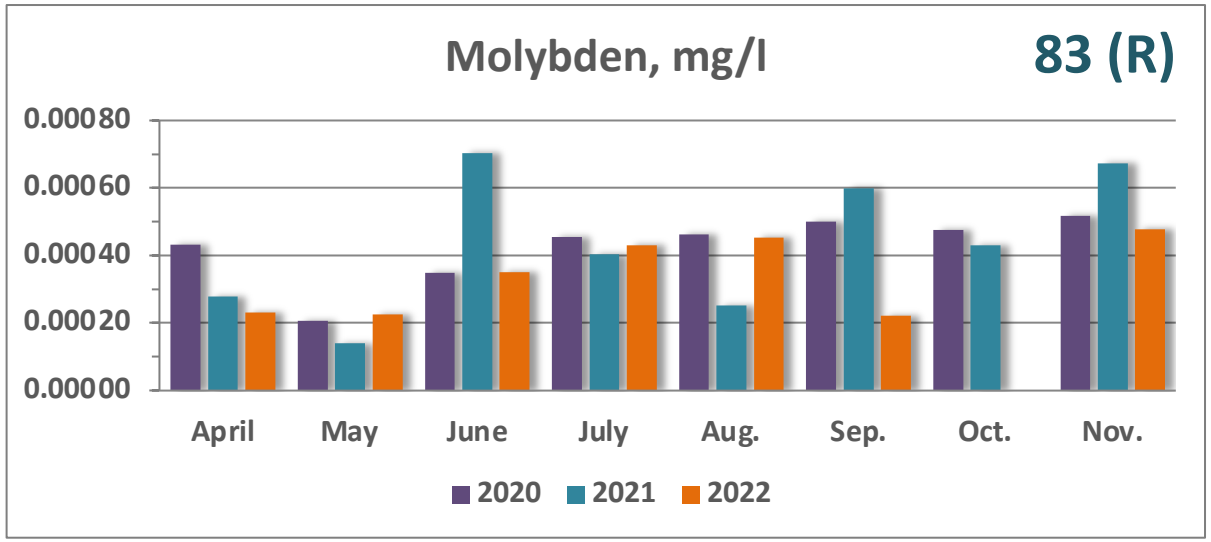


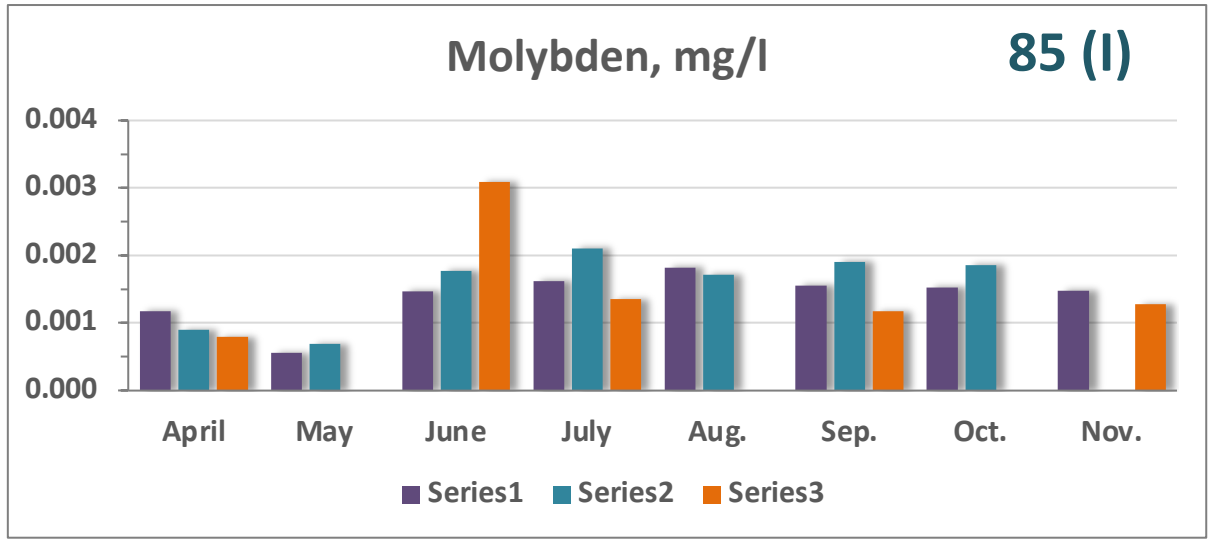


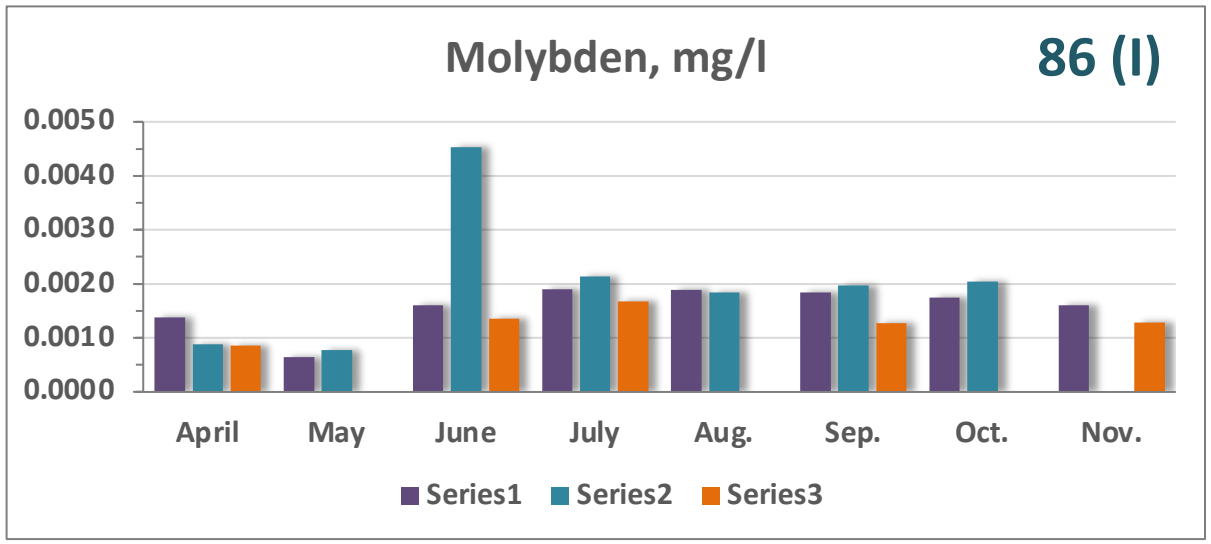


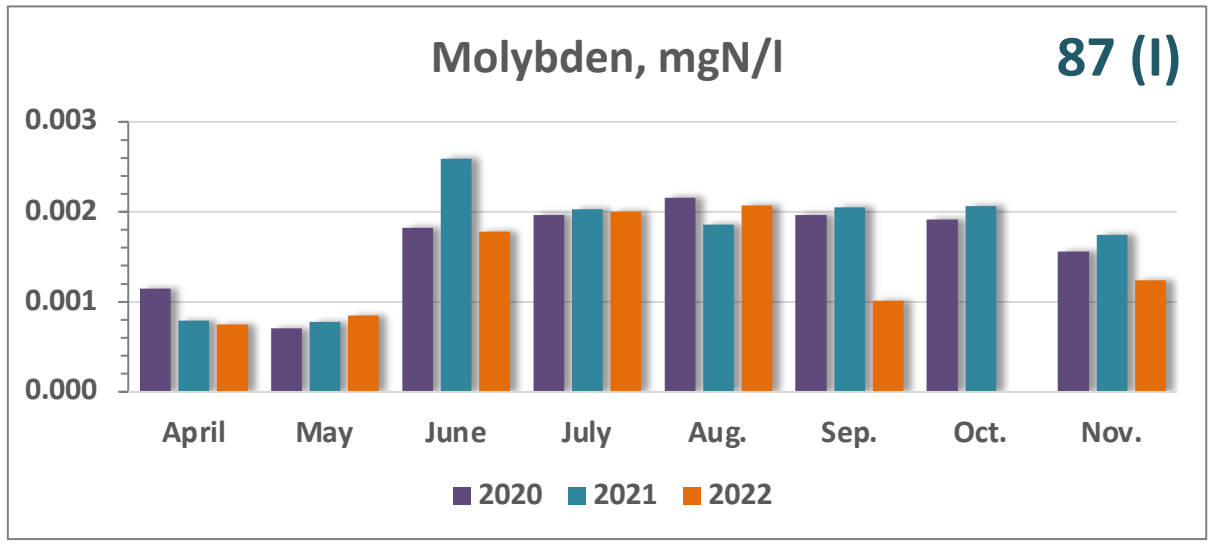


Changes of Molybden in 2020, 2021, 2022 in the same stations









Ecological Status at the sampling sites

River	Site No.	Type of sampling site	nEQR	Ecological status	nEQR	Ecological status	nEQR	Ecological status
			2020		2021		2022	
Arpa	83	R	1.00	High	1.00	High	1.00	High
Kechut reservoir	114	C	-	-	-	-	-	-
Darb	348	R	1.00	High	1.00	HIGH	1.00	HIGH
Darb	349	C	0.66	GOOD	0.80	HIGH	0.76	GOOD
Herher	350	R	0.69	GOOD	Parched		Parched	
Herher	351	I	1.00	HIGH	1.00	HIGH	1.00	HIGH
Yeghegis	352	R	1.00	HIGH	1.00	HIGH	1.00	HIGH
Yeghegis	88	C	0.64	GOOD	0.61	GOOD	0.43	MODERATE
Arpa	84	I	-	-	-	-	-	-
Arpa	85	I	0.61	GOOD	0.45	MODERATE	0.83	HIGH
Arpa	86	I	0.73	GOOD	0.36	POOR	1.00	HIGH
Arpa	87	I	0.60	MODERATE	0.38	POOR	0.64	GOOD

(R=reference, I=influenced, C=comperative)

Pollution source risk

Amulsar gold mine

According to the information distributed by Lydian Armenia company, the confirmed total reserves of Amulsar mine are 89376.3 thousand tons of ore, 73733 kg of gold, 294.367 tons of silver.

The extraction of metals from ore is planned to be carried out by heap leaching, during which on the ore heap a dilute solution of cyanide to be added dropwise.

Future

- ✓ We will continue carried out the monitoring of each components (water, air, soil and forest) to control any changes.
- ✓ We will add air quality monitoring stations to control dust and cyanide concentrations in ambient air.

Information analytical service

All this data from various departments is collected and analyzed by the Information Analytical Service and published on the official website of our organization (http://meteomonitoring.am),
in newsletters and on social platforms:
https://www.facebook.com/HydrometeorologyandMonitoringCenter
https://www.instagram.com/hydrometeorologymonitoring_hmc/

Water being the source of life, without which humanity is doomed to destruction, therefore, good water quality is the key to a good life.

Thank you