EU4Environment in Eastern Partner Countries:
Water Resources and Environmental Data (ENI/2021/425-550)

REPORT ON THE ECOLOGICAL STATUS IN SELECTED COASTAL WATER BODIES OF AZERBAIJAN IN THE PERIOD 2022-2023

Contract-No: 20940-C1/AZ-AZELABLCC-2023/4

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ABOUT EU4ENVIRONMENT – WATER RESOURCES AND ENVIRONMENTAL DATA

This Programme aims at improving people's wellbeing in EU's Eastern Partner Countries and enabling their green transformation in line with the European Green Deal and the Sustainable Development Goals (SDGs). The programme's activities are clustered around two specific objectives: 1) support a more sustainable use of water resources and 2) improve the use of sound environmental data and their availability for policy-makers and citizens. It ensures continuity of the Shared Environmental Information System Phase II and the EU Water Initiative Plus for Eastern Partnership programmes.

The Programme is implemented by five Partner organisations: Environment Agency Austria (UBA), Austrian Development Agency (ADA), International Office for Water (OiEau) (France), Organisation for Economic Co-operation and Development (OECD), United Nations Economic Commission for Europe (UNECE). The action is co-funded by the European Union, the Austrian Development Cooperation and the French Artois-Picardie Water Agency based on a budget of EUR 12,75 million (EUR 12 million EU contribution). The implementation period is 2021-2024.

https://eu4waterdata.eu

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List of abbreviations

BQE .... Biological Quality Elements

Chla .... Chlorophyll *a*

CTW .... Coastal and Transitional Waters

CW .... Coastal Waters

DIN .... Dissolved inorganic nitrogen

EU4EnvWD........... EU4Environment in Eastern Partner Countries: Water Resources and Environmental Data

EUWI+ .... European Union Water Initiative Plus

PO4 .... Orthophosphates

TW .... Transitional Waters

UBA .... Umweltbundesamt GmbH, Environment Agency Austria

WFD .... Water Framework Directive

Country Specific Abbreviations Azerbaijan

MENR................... Ministry of Ecology and Natural Resources

HYDROMET .... National Hydrometeorological Service of the Ministry of Environmental Protection

Executive Summary

In October 2022 and June 2023, two monitoring surveys were carried out in the coastal and transitional waters of Azerbaijan in accordance with the requirements of the EU Water Framework Directive. The measurements and sampling were carried out at 13 stations in four selected coastal water bodies and one transitional water in the Kura River Delta.

In the coastal waters, a reference station in the northern part of Azerbaijan (station MP3, water body AZ_CW1_NSS) was identified and, based on the data from this station, threshold values for the supporting quality elements "oxygen and nutrient conditions" and for the biological quality element phytoplankton were proposed.

The results of the monitoring surveys showed that the Baku Bay area is the most ecologically threatened area, characterized by a large deviation of dissolved oxygen saturation from its equilibrium and elevated concentrations of nutrients and chlorophyll a. The assessment of the ecological status of the coastal waters showed that the water body AZ_CW1_BB (Baku Bay) can be classified as "bad" while the adjacent water bodies AZ_CW1_STB (Turkan to Baku) and AZ-CW_SBS (Baku to Sangachai) were assessed as “moderate". The only coastal water body that was assessed as “good" is the water body AZ_CW1_NSS (coastal area from Samurchay to Shuraabad) in the northern part of Azerbaijan.

The ecological status of the transitional waters of the Kura River was not assessed, as no reference station was identified for this type of surface water. From the physical and chemical data collected and the chlorophyll-a concentration, it can be concluded that the transitional waters in the Kura River delta are not eutrophic.

During the study period, special attention was paid to four specific problems that occur in the Kura River Delta and the lower reaches of the river.

For example, in October 2022, seawater intrusion upstream was investigated during low flow of the Kura River (a phenomenon already observed in summer 2020); however, as this phenomenon was not detected, it can be assumed that other factors besides low flow are responsible for seawater intrusion, such as low air pressure, storm winds, etc.

In May 2022, samples were taken at six stations in the section of the Kura River from Muğan Ganjali to Neftchal and analyzed for the concentration of nutrients to determine their possible input through leaching from agricultural land and untreated wastewater flowing into the Kura River. For both nutrients, i.e. dissolved inorganic nitrogen and orthophosphates, a negative concentration gradient towards the river mouth was found.

Since a drainage channel (Mughan-Salyan Canal) with a length of 100 km runs through the agricultural area of the lower Kura River, the basic physico-chemical and biological properties of its water were investigated in May and June 2023. The results of the study showed a relatively good condition of the water in the channel in May (characterized by the usual seasonal temperature, low salinity and low nutrient concentration), while in June 2024 increased salinity and severe eutrophication were observed.

Studies of the barriers erected by the relevant national authorities in the two arms of the Kura River (Ana Kura and Bala Kura) to prevent seawater intrusion upstream of the Kura River have shown that the barrier in the Ana Kura arm successfully prevents seawater intrusion, while in the Bala Kura arm the river water upstream of the barriers was slightly saline.

1. Introduction and Scope

1.1. Surveillance monitoring surveys in coastal and transitional waters

The implementation of WFD-compliant surveillance monitoring of Azerbaijan's transitional and coastal waters in 2022 and 2023 required several preparatory steps which included the following:

- Preparation of a proposal for delineation of transitional and coastal waters of Azerbaijan into types and water bodies (EUWI+, 2018),
- Equipping AZELAB LLC, the responsible analytical laboratory of MENR, with equipment for field measurements and sampling as well as laboratory and analytical equipment;
- Introduction of suitable analytical methods for the determination of physico-chemical and biological parameters in seawater at AZELAB LCC;
- Training of AZELAB LCC staff in the areas of field measurements and sampling, sample preservation, analytical techniques and data processing.

The objectives of the surveillance monitoring surveys, which were carried out at 13 selected stations in 2022 and 2023 were:

- Implement the entire monitoring system from station selection to sampling protocols and laboratory work to establish regular surveillance monitoring in the transitional and coastal waters of Azerbaijan
- Selection of a coastal reference site;
- Data collection to propose type-specific threshold values for physico-chemical parameters and the biological element phytoplankton;
- Assessment of the ecological status of selected coastal water bodies.

Table 1 contains information on the sampling data and the chemical and biological analyses carried out as part of the surveillance monitoring surveys

1.2. Investigative monitoring surveys in the Kura River Delta and upstream

The Kura is the longest transboundary river in the South Caucasus and flows into the Caspian Sea via two branches (Bala Kura and Ana Kura) near the city of Neftchala in Azerbaijan (Figure 1). The water resources upstream of the Kura delta are used extensively for the irrigation of agricultural land (Figure 2) and the supply of drinking water.

The Kura River in this area is under pressure from the discharge of untreated wastewater from households and industry in the settlements near the river and from the leaching of fertilizers, herbicides and pesticides from agricultural land.

Figure 1: The inflow of the river Kura via two branches (Bala and Ana Kura) into the Caspian Sea

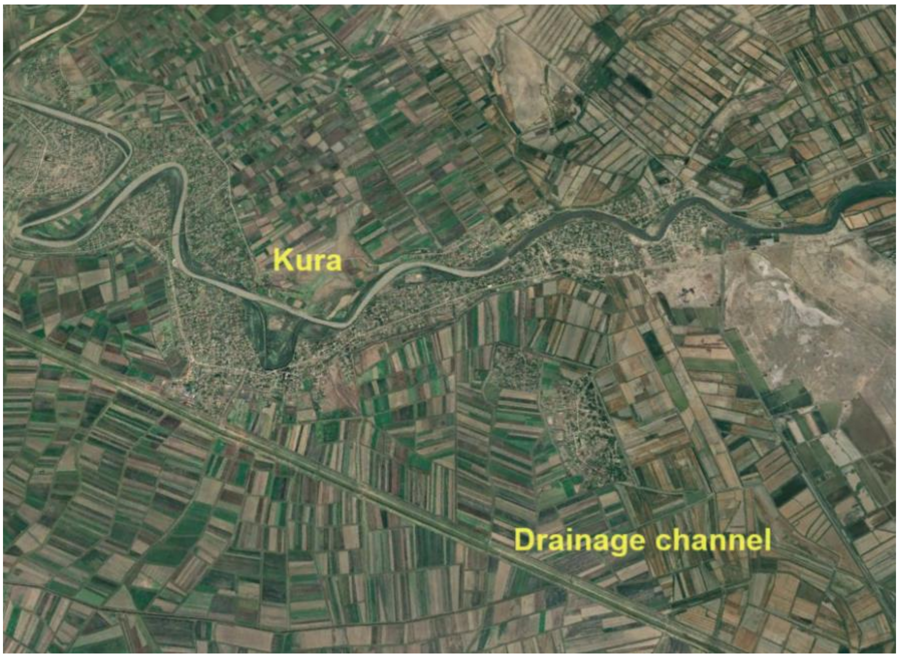

Figure 2: Intensive agricultural land use along the lower Kura river

A 100 km long drainage canal runs through this area from Qaracalar to the Caspian Sea, collecting the excess water from the agricultural land (Figures 2 and 3).

Figure 3: The Mughan-Salyan canal near the inflow to the Caspian Sea

The intensive extraction of freshwater for various purposes led to a significant decrease in the discharge of the Kura River from 570 m3/s in 1940 to 350 m3/s in 2015 (EUWI+, 2019). In times of very low discharge, such as in the summer of 2020, the entire water column of the Kura River about 66 km upstream of the delta was heavily salinized (EUWI+, 2020), leading to restrictions in the freshwater supply of the local population and livestock. To prevent similar salinization events, the national authorities erected barriers in both branches of the Kura River in 2023 (Figure 4).

Figure 4: Construction works in 2023 in the Ana Kura branch to prevent seawater intrusion

In order to clarify the issues of seawater intrusion, eutrophication of the lower Kura River, the basic physico-chemical properties of the Mughan-Salyan drainage channel and the hydrographic effects of the barriers, investigative surveys were carried out in:

- October 2022, when temperature and salinity were measured at 7 stations in the two branches of the Kura River (Ana Kura and Bala Kura);
- May 2023, when nutrient concentrations were measured at 6 stations along the Kura River section from Muğan Gəncəli to Neftchala;
- May and June 2023, when physico-chemical properties and nutrients in the Mughan-Salyan canal were measured at various locations;
- June 2023, when physico-chemical properties were measured at the constructed barriers and further seaward.

Information on the sampling dates and the chemical and biological analyses carried out as part of the investigative monitoring studies is presented in Table 1.

Table 1: Parameters analysed in the field and in the laboratory

Country	Azerbaijan	
Campaigns	Autumn 2022 and Spring 2023	
Objectives	Surveillance monitoring: • Collection of data on supporting physico-chemical parameters and the biological quality element Phytoplankton (Chl a) in selected coastal and transitional water bodies for the ecological status assessment	
	Investigative monitoring: • Determination of seawater intrusion upwards the Kura River delta; • Determination of the nutrient distribution along the Kura River section from Neftchala to Muğan Gəncəli; • Water quality check in the drainage channel; • Impact of constructed barriers in the Bala- and Ana Kura branches onto hydrographic properties in the Kura Delta	
Quality elements	Surveillance and investigative monitoring: • General physico-chemical quality elements (temperature, salinity, nutrients) Biological quality components: • Phytoplankton (biomass of Chlorophyll a).	
Monitoring surveys	2022	2023
Preparation of field work	CTW surveillance monitoring and Investigative monitoring (seawater intrusion): 24. October 2022	Investigative monitoring (nutrient distribution, drainage channel): 18.-24. April 2023 CTW surveillance monitoring and Investigative monitoring (drainage channel, barriers): 8.-18. May 2023
Field work	25.- 29. October 2022	Investigative monitoring (nutrient distribution, drainage channel): 19.-20. May 2023 CTW Surveillance monitoring and investigative monitoring (drainage channel, barriers): 12.-16. June 2023
Chemical analyses	30. October – 2. November 2022	Investigative monitoring: 24.-25. May 2023 and 12.-20. June 2023 CTW Surveillance monitoring: 12.-20. June 2023
Biological analyses	2. – 15. November 2022	Investigative and CTW surveillance monitoring : 12.-16. June 2023
Reporting	16. November – 1. December 2022	Investigative monitoring 25. May 2023 and 22. June 2023 CTW surveillance monitoring: 22. June2023
Submission of technical report	CTW surveillance monitoring and Investigative monitoring: January 2023	CTW surveillance monitoring and Investigative monitoring: July 2024

2. Methods

2.1. Selection of sampling sites for the surveillance monitoring surveys based on the delineation proposal for Azerbaijan's

As part of the EUWI+ programme, a proposal was submitted for the delineation of Azerbaijan's transitional and coastal waters according to the WFD "A" system (WFD, 2000; CIS WFD, 2003; EUWI+, 2018).

According to this proposal, all transitional waters occurring in Azerbaijan belong to a type that is oligohaline (with an annual salinity of 0.5 to < 5) and microtidal (< 2 m). The code for this type is proposed as AZ_TW1. Surface waters with lower salinity compared to the Caspian Sea occur in Azerbaijan in any estuary or delta formed by a freshwater stream flowing into the sea. Four transitional water bodies have been identified in this proposal (Table 2), with water discharge being the main criterion. Each of the proposed transitional waters also constitutes as a separate water body, with the exception of the delta of the Kura River, where two water bodies have been suggested (Figure 4).

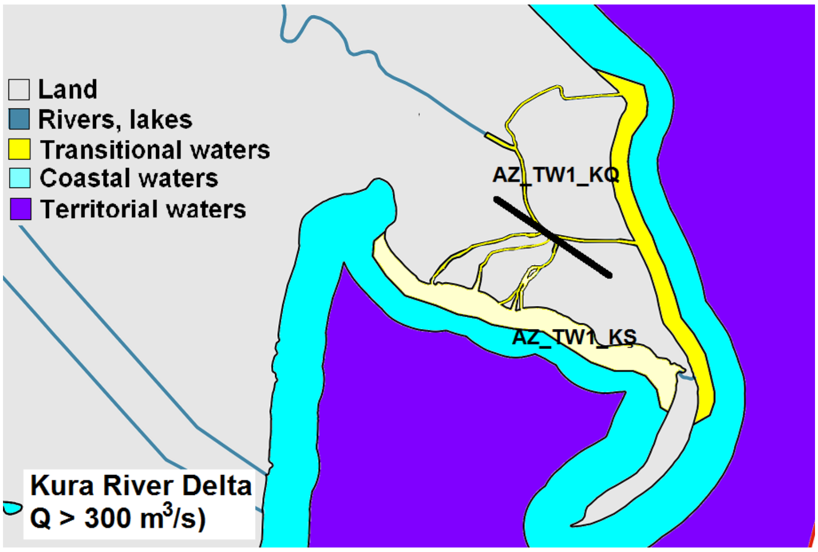

Figure 5: Two water bodies (AZ_TW1_KQ and AZ_TW1_KŞ) in the transitional waters of the Kura river delta

The coastal waters form a stretch along the coast of Azerbaijan with a width of 1 NM from the nearest point of the baseline from which the width of the territorial waters is measured and extend to the outer limit of the transitional waters, where appropriate. All coastal waters occurring in Azerbaijan also belong to a single type, namely mesohaline (with an annual salinity of 5 to <18) and shallow (<30 m). The code for this type is proposed as AZ_CW1. Taking into account the hierarchical approach proposed in the WFD for the identification of water bodies, the type AZ_CW1 has been subdivided into 13 water bodies.

The type and water body codes for transitional and coastal waters are listed in Table 2, while the geographical location of the coastal water bodies is shown in Figure 6.

Table 2: Proposed type and water body codes for transitional and coastal waters occurring in Azerbaijan

Surface water category	River mouth/delta	Type code	Water body code	Definition
Transitional waters	**Qusarçay**	AZ_TW1	AZ_TW1_QS	Oligohaline and microtidal transitional waters of the Qusarçay river
	Qudialçay		AZ_TW1_QD	Oligohaline and microtidal transitional waters of the Qudialçay river
	Kura		AZ_TW1_KQ	Oligohaline and microtidal transitional waters in the northern part of the Kura river delta
			AZ_TW1_KŞ	Oligohaline and microtidal transitional waters in the southern part of the Kura river delta
Coastal waters	-	AZ_CW1	AZ_CW1_NSS	Oligohaline and shallow coastal waters from Samurchay to Shuraabad
			AZ_CW1_NSB	Oligohaline and shallow coastal waters from Shuraabad to Shuvelan Beach
			AZ_CW1_NBA	Oligohaline and shallow coastal waters from Shuvelan Beach to Absheron
			AZ_CW1_NCH	Oligohaline and shallow coastal waters of Chilow Island
			AZ_CW1_SAT	Oligohaline and shallow coastal waters from Absheron to Turkan
			AZ_CW1_STB	Oligohaline and shallow coastal waters from Turkan to Baku
			AZ_CW1_SBB	*Candidate of heavily modified oligohaline and shallow coastal waters of Baku Bay*
			AZ_CW1_SBS	Oligohaline and shallow coastal waters from Baku to Sangachal
			AZ_CW1_SSK	Oligohaline and shallow coastal waters from Sangachal to Kura river
			AZ_CW1_SKQ	Oligohaline and shallow coastal waters from Kura river to Qizilağac
			AZ_CW1_SQR	Oligohaline and shallow coastal waters of Qizilağac State Reserve (Protected area)
			AZ_CW1_SQL	Oligohaline and shallow coastal waters from Qizilağac to Lankaran
			AZ_CW1_SLA	Oligohaline and shallow coastal waters from Lankaran to Astara

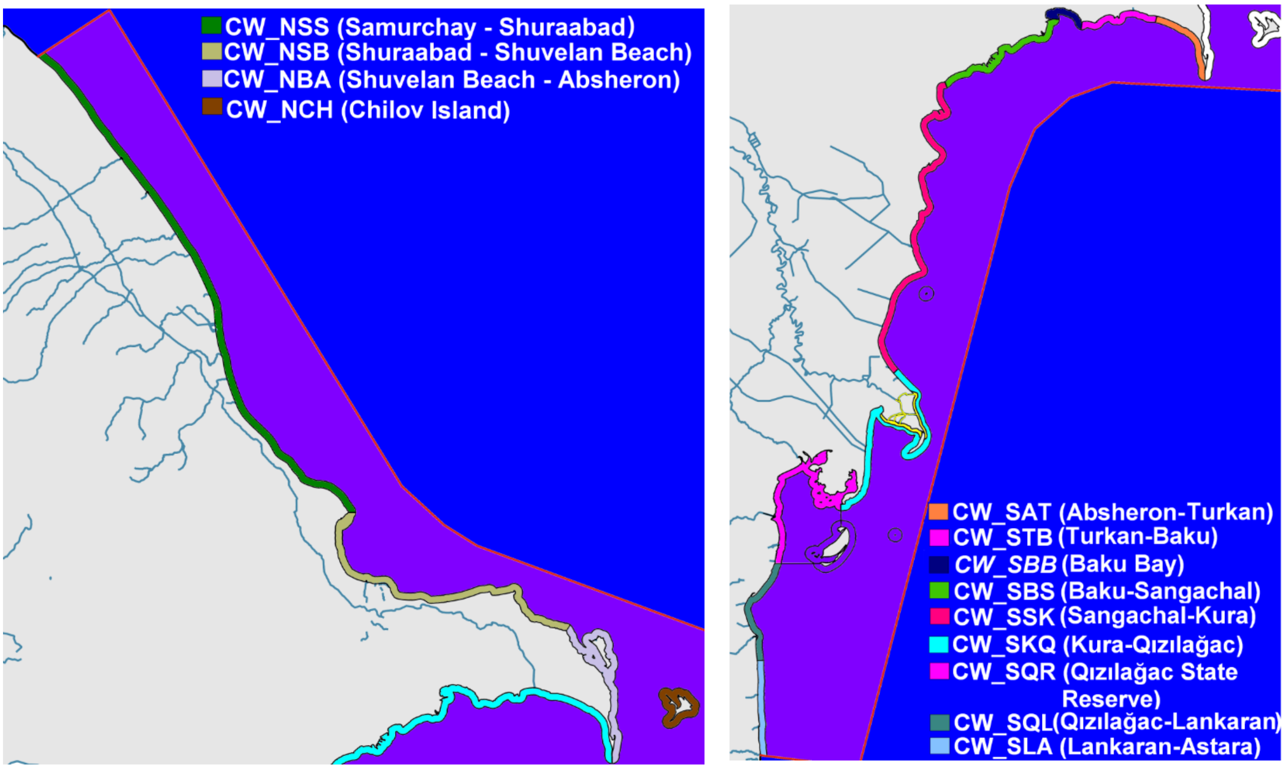

Figure 6: Coastal water bodies appearing in Azerbaijan

Basic data for the selected CTW sampling sites during the surveillance monitoring surveys in October 2022 and June 2023 are presented in Tables 3 and 4, while the geographical location of the sampling sites is shown in Figures 7 and 8.

Table 3: List of sampling sites in coastal and transitional water bodies during the surveillance monitoring survey in October 2022

WB	WB definition and location	Site	Nr	HMWB [1)]	Risk [2)]	Significant Pressure [3)]	Latitude [4)]	Longitude [4)]
AZ_CW1_NSS	Oligohaline and shallow coastal waters from Samurchay to Shuraabad	CW near Nizovaya	MP1	NO	NR	N	41.529489	48.929900
		CW near Gilgilcay	MP2	NO	NR	N	41.109153	49.172856
		CW near Suraabad	MP3	NO	NR	N	40.8227290	49.512763
AZ_CW1_STB	Oligohaline and shallow coastal waters from Turkan to Baku	CW in front of Turkan	MP4	NO	PR	U	40.34560	50.178228
AZ_CW1_BB	Candidate of heavily modified oligohaline and shallow coastal waters of Baku Bay	CW in front of Baku	MP5	YES	P, E, H	P, E, H	40.334438	49.945942
AZ-CW_SBS	Oligohaline and shallow coastal waters from Baku to Sangachal	CW near Sahil	MP6	NO	PR	U	40.213662	49.566108
AZ_TW1_KQ	Oligohaline and microtidal transitional waters in the northern part of the Kura river delta	TW Kura delta	K1	YES	PR	H	38.380623	49.396581

[1)] Assignment as provisional HMWB: yes / no

[2)] Assignment of the risk status: R = at risk, PR = possibly at risk, NR = not at risk

[3)] Significant pressure: N = no significant pressure, P = organic pollution, E = eutrophication, T = toxic impact, H = hydro-morphological alterations,
M = multistressor, O = other, U = unknown

[4)] Latitude, Longitude: Format = Degree with six decimals (e.g. as 44.630139, conversion from 44° 37’ 48.5’’ through calculation 44 + 37 / 60 + 48.5 / 3600)

[5)] Site: CW = Coastal waters, TW = Transitional waters

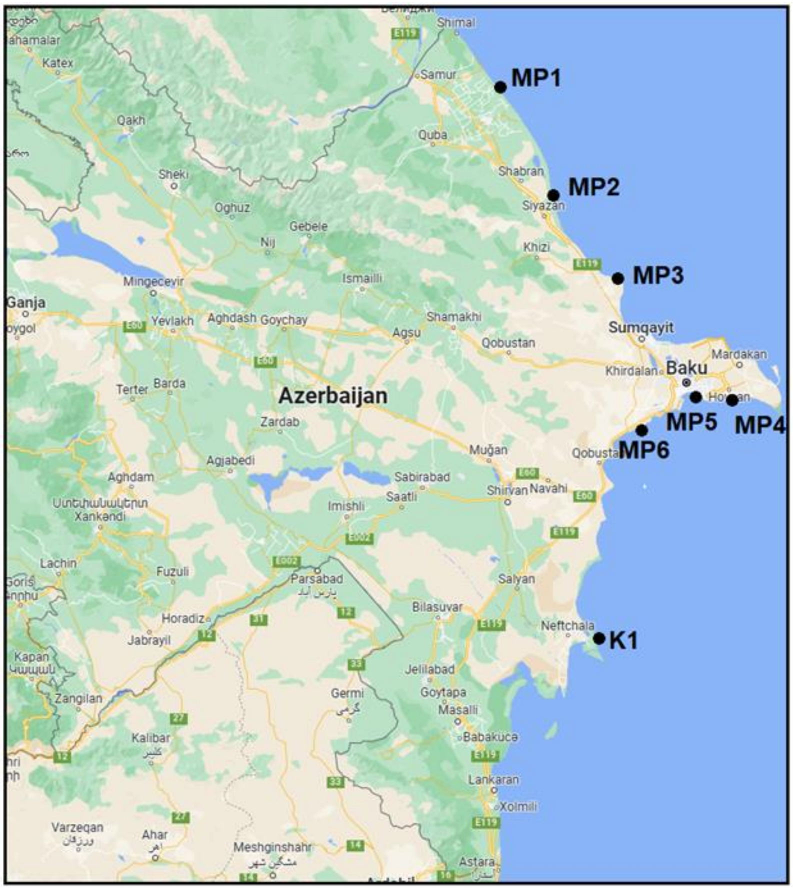

Figure 7: Map of sampling sites for coastal and transitional waters during the surveillance monitoring survey in October 2022

Table 4: List of sampling sites in coastal and transitional waters during the surveillance monitoring survey in June 2023

WB	WB definition and location	Site	Nr	HMWB 1)	Risk 2)	Significant Pressure 3)	Latitude 4)	Longitude 4)
AZ_CW1_NSS	Oligohaline and shallow coastal waters from Samurchay to Shuraabad	CW near Suraabad	MP3	NO	NR	N	40.372975	49.512927
AZ_CW1_STB	Oligohaline and shallow coastal waters from Turkan to Baku	CW in front of Turkan	MP4a	NO	PR	U	40.365944	50.111203
AZ_CW1_BB	Candidate of heavily modified oligohaline and shallow coastal waters of Baku Bay	CW in front of Baku	MP5	YES	P, E, H	P, E, H	40.330697	49.966552
			BB-C	YWS	P, E, H	P, E, H	40.373911	49.882294
AZ-CW_SBS	Oligohaline and shallow coastal waters from Baku to Sangachal	CW south to Baku	MP6a	NO	PR	P, E	40.302283	49.782358
		CW near Sahil	MP6b	NO	PR	P, E	40.220236	49.576717
AZ_TW1_KQ	Oligohaline and microtidal transitional waters in the northern part of the Kura river delta	TW Kura delta	BK1	NO	NR	H	39.381642	49.395408
			AK4	NO	NR	H	39.321457	49.408395

1) Assignment as provisional HMWB: yes / no

2) Assignment of the risk status: R = at risk, PR = possibly at risk, NR = not at risk

3) Significant pressure: N = no significant pressure, P = organic pollution, E = eutrophication, T = toxic impact, H = hydro-morphological alterations, M = multistressor, O = other, U = unknown

4) Latitude, Longitude: Format = Degree with six decimals (e.g. as 44.630139, conversion from 44° 37’ 48.5’’ through calculation 44 + 37 / 60 + 48.5 / 3600)

5) Site: CW = Coastal waters, TW = Transitional waters

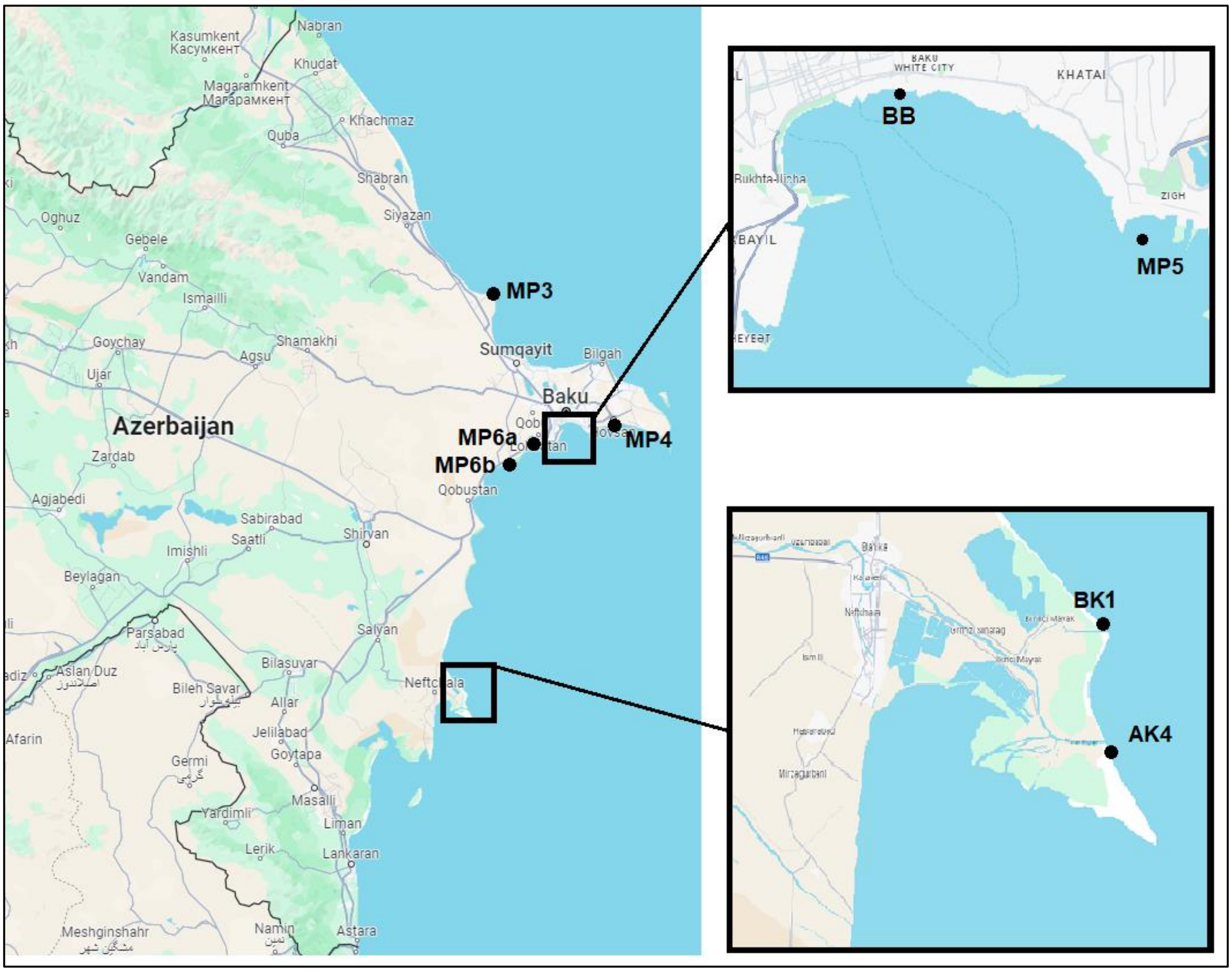

Figure 8: Map of sampling sites for coastal and transitional waters during the surveillance monitoring survey in June 2023

2.2. Selection of sampling sites for the investigative monitoring surveys in the Kura Delta and upstream the Kura River

The geographical positions of the:

- temperature and salinity monitoring sites in the Kura Delta in relation to the seawater intrusion monitoring conducted in the Kura River Delta in October 2022 are given in Table 5 and shown in Figure 9;

- the nutrient monitoring sites along the Kura River section from Neftchala to Muğan Gəncəli (May 2023) are listed in Table 6 and shown in Figure 10;

- the measuring and sampling stations in the Mughan-Salyan drainage channel are listed in Table 7 and shown in Figure 11;

- the measuring stations at the barriers constructed in the Bala and Ana Kura arms of the river are listed in Table 8 and shown in Figure 12.

Table 5: List of measuring points for salinity and temperature in the Kura River Delta in October 2022

WB	WB definition and location	Site	Nr	Latitude [4)]	Longitude [4)]
AZ_TW1_KQ	Oligohaline and microtidal transitional waters in the northern part of the Kura river delta	Bala Kura	BAK1	38.380623	49.396581
			BAK2	38.380137	49.384422
			BAK3	39.369822	49.344527
		Kura	BAK4	39.361562	49.348846
		Ana Kura	BAK5	39.356361	49.352123
			BAK6	39.351873	49.352919
			BAK7	39.330396	49.366368

Figure 9: Map of measuring points for saltwater intrusion into the Kura River delta in October 2022h

Table 6: List of sampling points in the section of the River Kura from Neftchala to Muğan Gəncəli for the determination of nutrients in May 2023

WB	WB definition and location	Site	Nr	Latitude 4)	Longitude 4)
To be delineated		Neftchala	KR1	39.414861	49.240500
		Khilli	KR2	39.427722	49.117639
		Gadimkand	KR3	39.450306	49.045458
		Ərəbqardaşbəyli	KR4	39.532667	49.008611
		Salyan	KR5	39.591611	48.990786
		Muğan Gəncəli	KR6	39.714514	48.951697

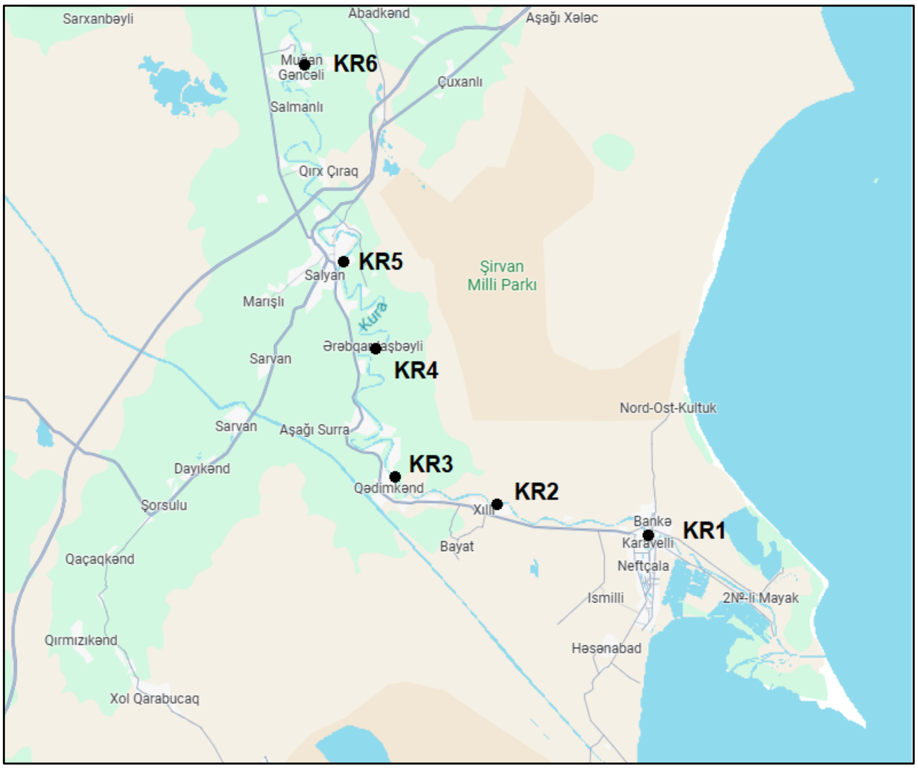

Figure 10: Map of the sampling points in the Kura River for nutrient analysis

Table 7: List of sampling points in the Mughan-Salyan drainage channel in May and June 2023

WB definition and location	Site	Sampling	Nr	Latitude [4)]	Longitude [4)]
To be delineated **Mughan Salyan drainage channel**	Near inflow point to Caspian Sea	May 2023	C1	39.246056	49.233500
			C2	39.247417	49.230583
	Roadbridge between (Mirzequrbanli – Mikayilli)	June 2023	C3	39.267883	49.196967
	Roadbridge (Sarvan)		C4	39.488683	48.911661

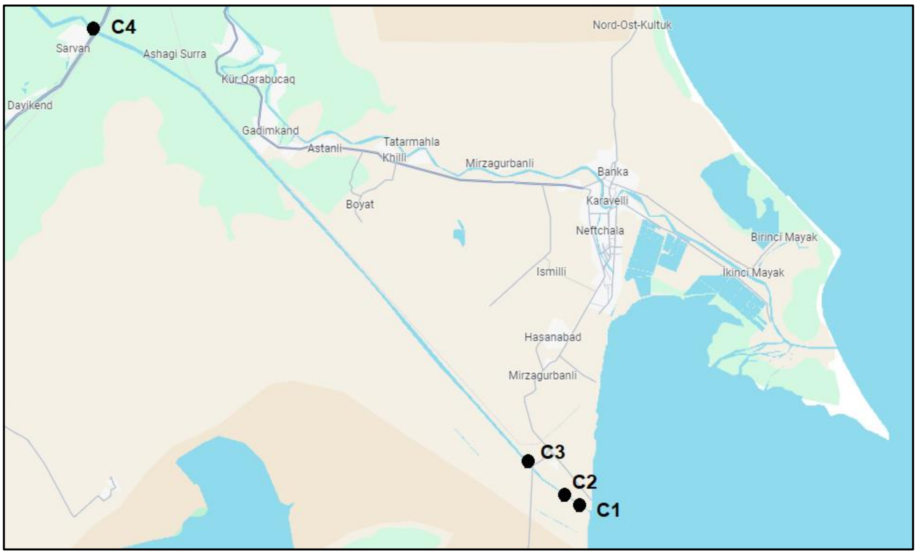

Figure 11: Map of the sampling points in the Mughan Salyan drainage channel

Table 8: List of sampling points at the barriers constructed in the Bala and Ana Kura branches

WB	WB definition and location	Site	Nr	Latitude 4)	Longitude 4)
AZ_TW1_KQ	Oligohaline and microtidal transitional waters in the northern part of the Kura river delta	Bala Kura Barrier	BKB1	39.380603	49.394794
			BKB2	39.380594	49.395029
		Bala Kura Delta	BK1	39.381642	49.395408
		Ana Kura Barrier	AKB1	39.329066	49.374254
			AKB2	39.329038	49.374401
		Ana Kura Delta	AK1	39.327525	49.397931
			AK2	39.326825	49.402967
			AK3	39.323342	49.406536
			AK4	39.321457	49.408395

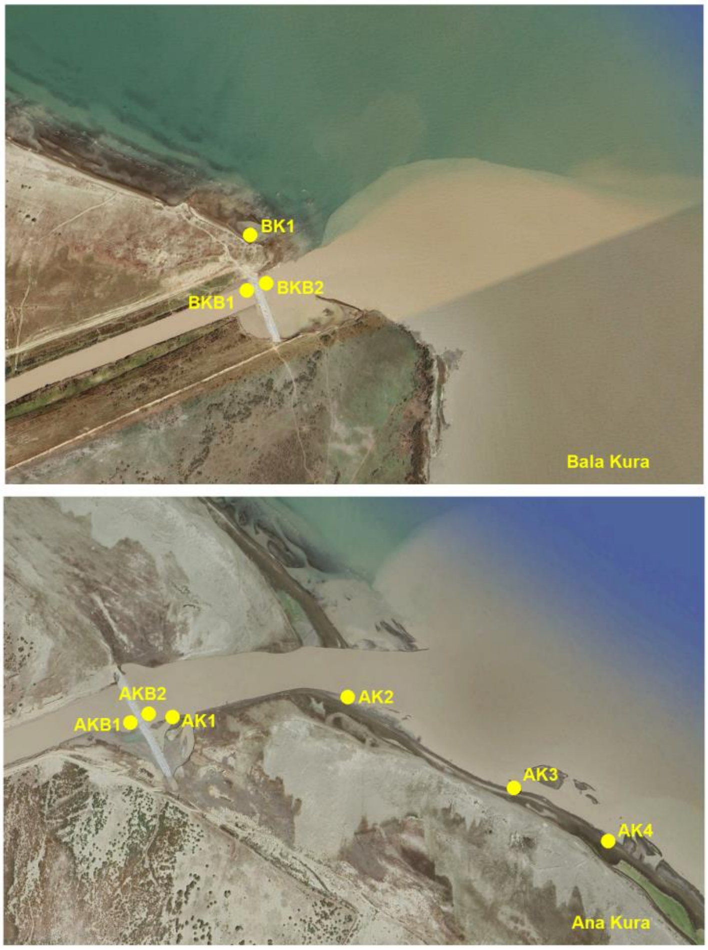

Figure 12: Map of the sampling points at the barriers constructed in the Bala and Ana Kura branches and seaward

2.3. Sampling period and conditions

CTW surveillance monitoring: Water samples were taken from October 25 to 28, 2022 and June 12 to 16, 2023 and measurements of physico-chemical properties were carried out for the assessment of the ecological status. The meteorological conditions during these periods were free of precipitation, but with strong north to northeast winds that caused rough seas (sea state: 2-4) in the shallow coastal waters.

Due to the high swell at certain stations, sampling with a Zodiac was only possible at stations MP3 and MP5 (October 2022) and MP3 and MP5a (June 2023). At all other stations, the samples were not taken from the Zodiac, but from the shore.

Investigative monitoring: Water sampling and measurements of physico-chemical parameters were carried out on October 28, 2022 in the Bala and Ana Kura branches of the Kura River (seawater intrusion), on May 24 and 25, 2023 in the Kura River section from Neftchala to Muğan Gəncəli (nutrient distribution), on May 25 and June 15, 2023 in the Mughan-Salyan drainage channel (water quality) and on June 15, 2023 at the newly constructed barriers (hydrographic impact).

The weather conditions during the investigative surveys were free of precipitation; during and before the study survey on nutrient distribution in the lower Kura, heavy rain increased the discharge of the Kura, followed by brief flooding during the sampling.

The flow rate of the Kura (m3/s) at hydrological station "A" during the investigative surveys is shown in Table 9.

Table 9: Flow of the river Kura at the hydrological station during the investigative surveys

Investigative survey	**Date**	**Kura flow (m^3/s)**		
		Date of survey	Monthly average	
			Year of investigative monitoring	Period 2010-2020
Sea water intrusion	October 28 2022	90	92	247
Nutrient distribution	May 24-25 2023	243	169	428
Hydrographic impacts by constructed barriers	June 15 2023	105	125	363

2.4. Quality Elements and sampling methods

Of the physico-chemical quality elements in coastal and transitional waters, temperature and salinity, were measured in situ, while dissolved oxygen and nutrients were determined in subsamples in the laboratory.

Transparency have been measured only at stations where a Zodiac was used for sampling (stations MP3, MP5 and MP5a) by the use of a white Secchi disc.

Of the physico-chemical quality elements in the coastal and transitional waters, temperature and salinity were measured in situ, while dissolved oxygen and nutrients were determined in subsamples in the laboratory.

Transparency was measured only at the stations where a Zodiac was used for sampling (stations MP3, MP5 and MP5a), using a white Secchi disc.

Temperature and salinity were measured with a calibrated YSI multiparameter probe.

Water samples were collected from the surface layer (all CTW monitoring points) and 1 m above the seafloor (stations MP5 and MP5a) using a General Oceanics 5L water sampler. Dissolved oxygen and nutrient subsamples were collected in Winkler bottles and high-density polyethylene bottles, respectively.

Subsamples for the analysis of chlorophyll-a content (biological quality element phytoplankton) were also collected in high-density polyethylene bottles.

All subsamples collected during the day were stored in portable coolers and analysed in the laboratory on the same day (dissolved oxygen), filtered and prepared for analysis (chlorophyll a) or frozen (nutrients).

2.5. Analyses of supporting physico-chemical parameters and Phytoplankton biomass (Chlorophyll a)

Seawater temperature and salinity were measured with a multiparameter probe. The readings from the probe were noted after the readings were stabilised.

Dissolved oxygen was measured by the iodometric method (Table 10) in subsamples of seawater collected in Winkler bottles (bottles of well-defined volume). Solutions of KJ, NaOH, and $MnCl_2$ were then added to the samples, resulting in the binding of dissolved oxygen in a precipitate of $Mn(OH)_3$. After transporting the samples to the laboratory, the precipitate was decomposed by adding concentrated acid, and after its decomposition, the samples were titrated with thiosulfate until the colour disappeared.

All nutrient salts were determined spectrophotometrically at specific wavelengths on a Specord 205 (Analytik Jena) UV-VIS Spectrophotometer[1].

Chlorophyll a was determined in the laboratory with a fluorimeter after the samples were filtered (GF/F, 0.7 µm) and the chlorophyll a was extracted from the filter with acetone[2].

Table 10: List of analysed parameters and analytical methods

Parameter	Unit	Method
Field measurements		
Temperature	°C	*In situ* measurement by Probe
Salinity	-	In situ measurement by Probe
Transparency	m	In situ measurement by Secchi disk
Laboratory analyses		
Nitrate	µmol/L	Spectrophotometric determination[1]
Nitrate		Spectrophotometric determination[1]
Ammonia		Spectrophotometric determination[1]
Orthophosphate		Spectrophotometric determination[1]
Dissolved oxygen	ml/L and %	ISO 5813:1983, Water quality — Determination of dissolved oxygen — Iodometric method
Chlorophyll a	µg/L	Fluorometric determination[2]

[1]K. Grasshoff, K. Kremling and M. Erhardt, 1999. Methods of Seawater Analysis. Third Edition, Wiley-VCH, 600 p.

[2]J.D.H. Strickland and T.R. Parsons, 1972. A Practical Handbook of Seawater Analysis. Fisheries Research Board of Canada, Bulletin 167, 310 p.

2.6. Responsibilities

The individuals responsible for field study preparation, instrument calibration, field work, and production of solutions, standards, and laboratory analyses are listed in Table 11.

The private company Sadic LLC was responsible for transportation and management of the Zodiac during sampling.

Table 11: Responsibilities during the surveillance and investigative monitorings in 2022 and 2023

Responsibilities	Surveys	Institution, contact person, email-address
General		
Responsible for the organisation of surface water body sampling	2022 & 2023	Institute/Laboratory: AZELAB LLC Contact person: Ramina Abdullayeva E-Mail: abdullayevaramina@gmail.com
Field work		
Responsible for field work (biological and chemical sampling)	2022	Institute/Laboratory: AZELAB LLC Contact person: Gunel Qurbanova UBA/International expert: Grozdan Kušpilić Supporting person(s): Rafig Verdiyev E-Mail: gunel-qurbanova-90@mail.ru
	2023	Institute/Laboratory: AZELAB LLC Contact person: Ilaha Qurbanova UBA/International expert: Grozdan Kušpilić Supporting person(s): Rafig Verdiyev E-Mail: qurbanovailahe04@gmail.com
Responsible for functional check of sampling equipment	2022 & 2023	Institute/Laboratory: AZELAB LLC Contact person: Vusel Nabiyev E-Mail: nabiyevusal@gmail.com
Responsible for calibration of on-site measuring equipment		Institute/Laboratory: AZELAB LLC Contact person: Ziber Aghazada E-Mail: ziber.agayeva@gmail.com
Chemical analysis		
Overall responsible for the chemical analysis in the lab, including reporting and data delivery	2022 & 2023	Institute/Laboratory: AZELAB LLC Contact person: Ramina Abdullayeva E-Mail: abdullayevaramina@gmail.com
Responsible for sample transport from the field to the laboratory		Institute/Laboratory: AZELAB LLC Contact person: Vusel Nabiyev E-Mail: nabiyevusal@gmail.com
Analysing laboratory and contact person		Institute/Laboratory: AZELAB LLC Contact person: Ziber Aghazada E-Mail: ziber.agayeva@gmail.com
Biological analysis		
Overall responsible for the biological analysis in the lab, including reporting and data delivery	2022	Institute/Laboratory: AZELAB LLC Contact person: Gunel Qurbanova E-Mail: gunel-qurbanova-90@mail.ru
	2023	Institute/Laboratory: AZELAB LLC Contact person: Ilaha Qurbanova E-Mail: qurbanovailahe04@gmail.com

3. RESULTS

The results of the field measurements carried out in October 2022 and June 2023 in selected coastal and transitional waters, as well as the results of the laboratory analysis of samples, are presented in the attached Excel file "Annex1_CTW Surve y& Analysis data_2022-23".

3.1. Results of field measurements, chemical and biological results obtained during the surveillance monitoring in coastal and transitional waters

All results of the field measurements and laboratory analyses of the physico-chemical and biological parameters in the coastal and transitional waters carried out in 2022 and 2023, which are shown in Figures 13 - 15, relate to the surface layer (0.5 m).

The spatial distribution of temperature and salinity at the investigated stations in October 2022 and June 2023 is shown in Figure 13.

The concentrations of dissolved inorganic nitrogen (sum of nitrate, nitrite and ammonia salts) and orthophosphate are shown in Figure 14.

The saturation of the surface layer with dissolved oxygen and the concentrations of chlorophyll a determined at certain stations are shown in Figure 15.

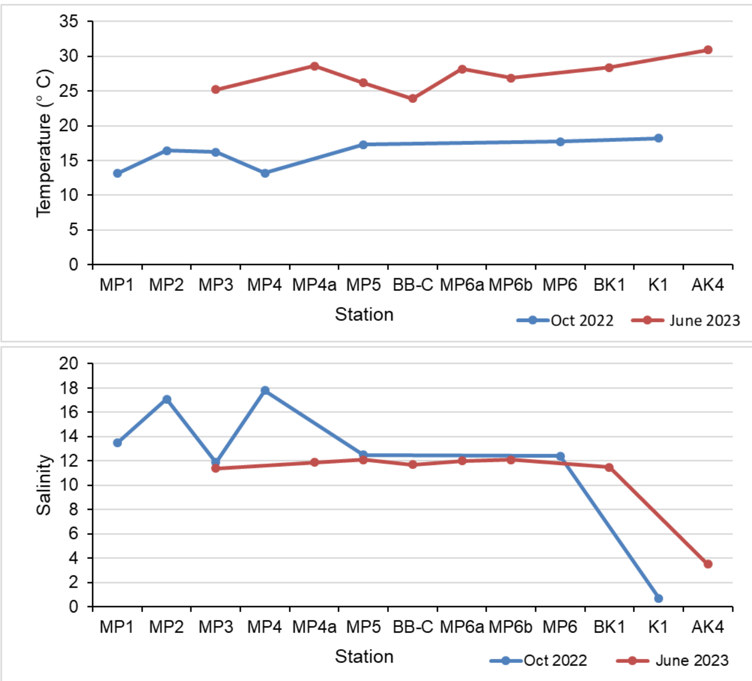

Figure 13: Surface temperature and salinity measured at the monitoring stations in October 2022 and June 2023

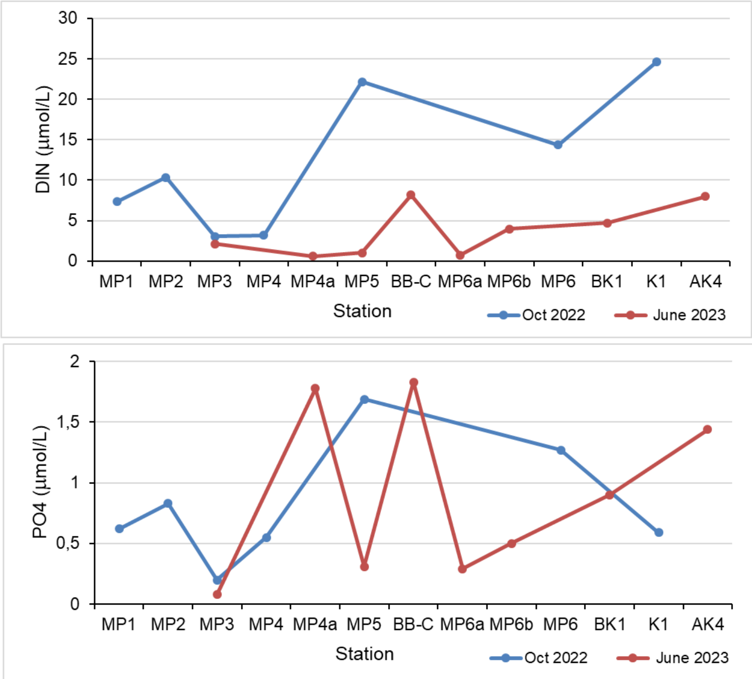

Figure 14: Concentrations of dissolved inorganic nitrogen (DIN) and orthophosphate (PO4) in surface samples collected at the monitoring stations in October 2022 and June 2023

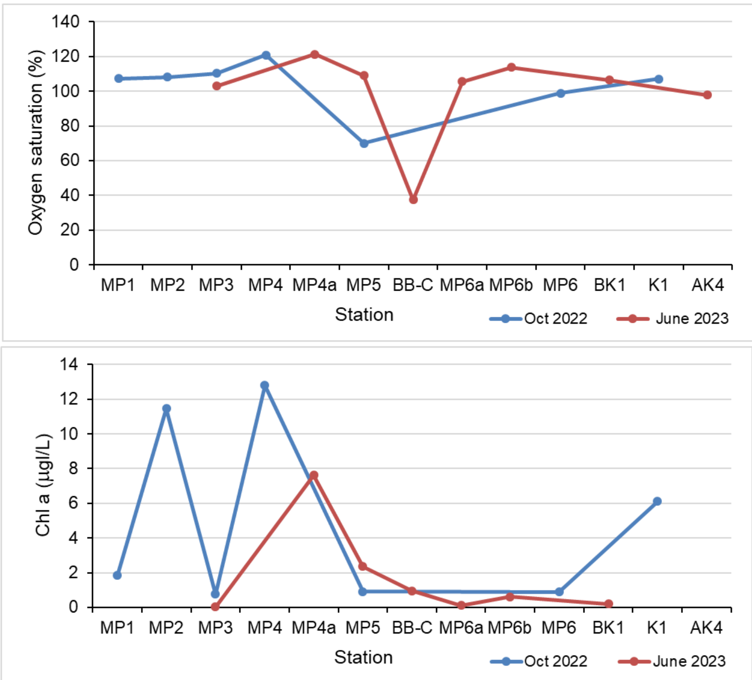

Figure 15: Dissolved oxygen saturation and concentration of chlorophyll *a* (Chl a) in surface samples collected at the monitoring stations in October 2022 and June 2023

3.2. Results of the surveys carried out as part of the investigative monitoring

3.2.1. Salinization of the river Kura

The results of the temperature and salinity measurements carried out in October 2022 at 7 stations in the two arms of the Kura River are shown in Figure 16. The measurements were carried out at all stations in the surface layer and at five selected stations (BAK1, BAK3, BAK4, BAK5 and BAK6) from the surface to the bottom (Figure 17).

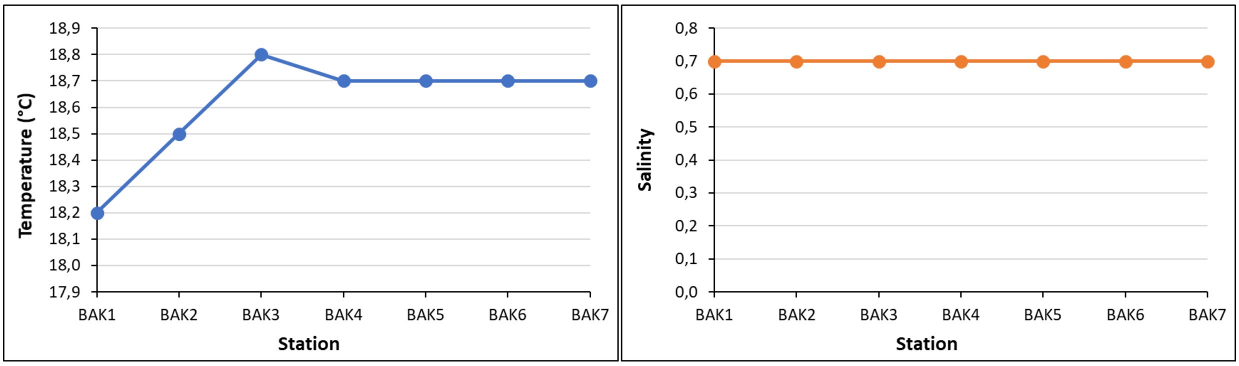

Figure 16: Temperature and salinity distribution in the surface layer along the Kura River delta in October 2022

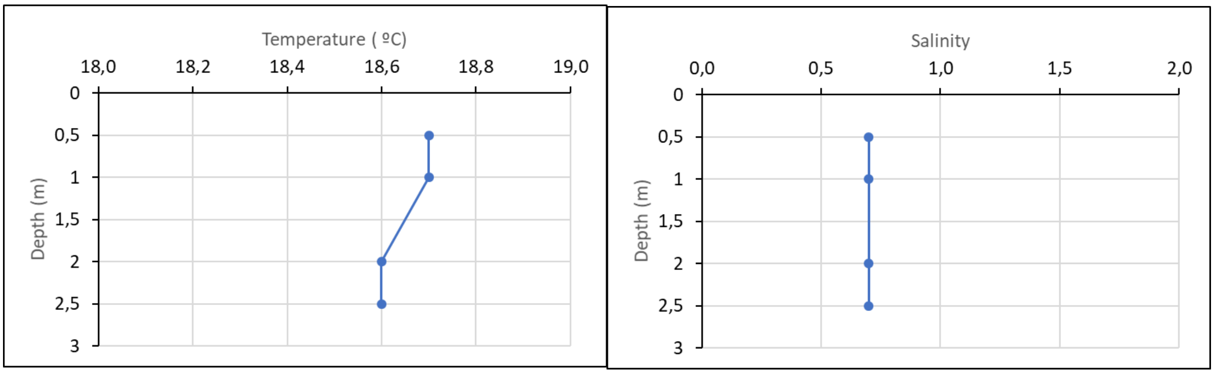

Figure 17: Vertical temperature and salinity distribution at station BAK4 (representative also for other investigated stations) in the Kura River Delta in October 2022

3.2.2. Nutrient distribution in the river section of the Kura from Neftchala to Muğan Gəncəli

The nutrient concentrations (dissolved inorganic nitrogen and orthophosphate) analysed in river samples taken in May 2023 at 6 stations between Neftchala and Muğan Gəncəli (Figure 10) are shown in Figure 18.

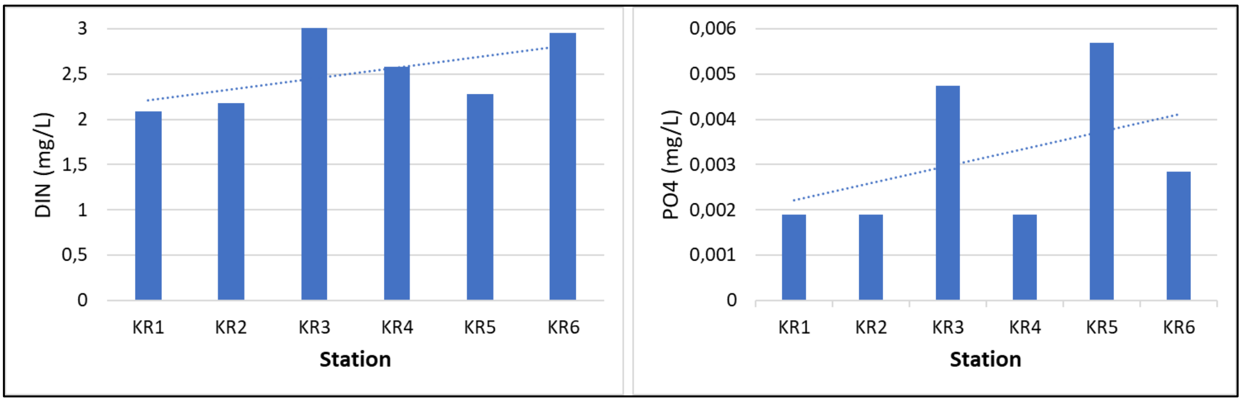

Figure 18: Distribution of dissolved inorganic nitrogen (DIN) and orthophosphate at the stations between Neftchala and Muğan Gəncəli in May 2023 with indicated trend

3.2.3. Measurements in the the Mughan Salyan drainage channel

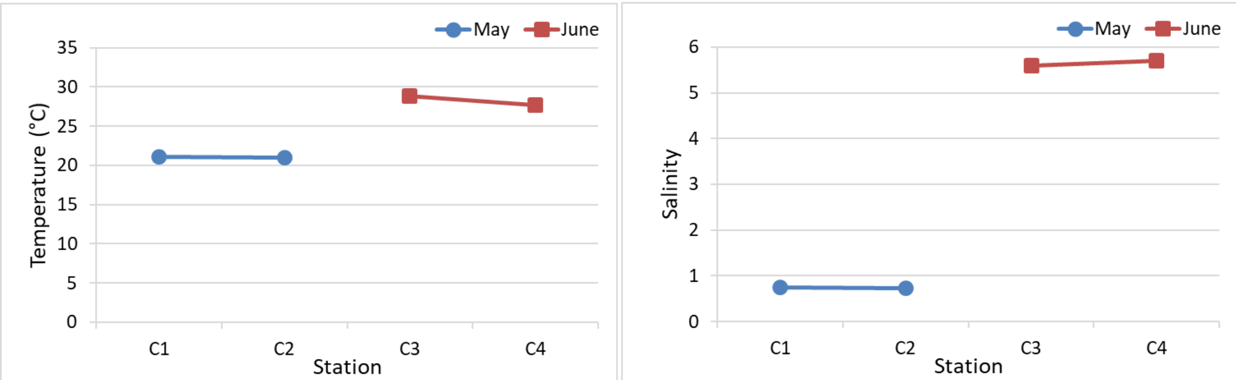

Figure 19: Thermohaline properties of the surface layer in the Mughan-Salyan drainage channel in May and June 2023 at the investigated stations

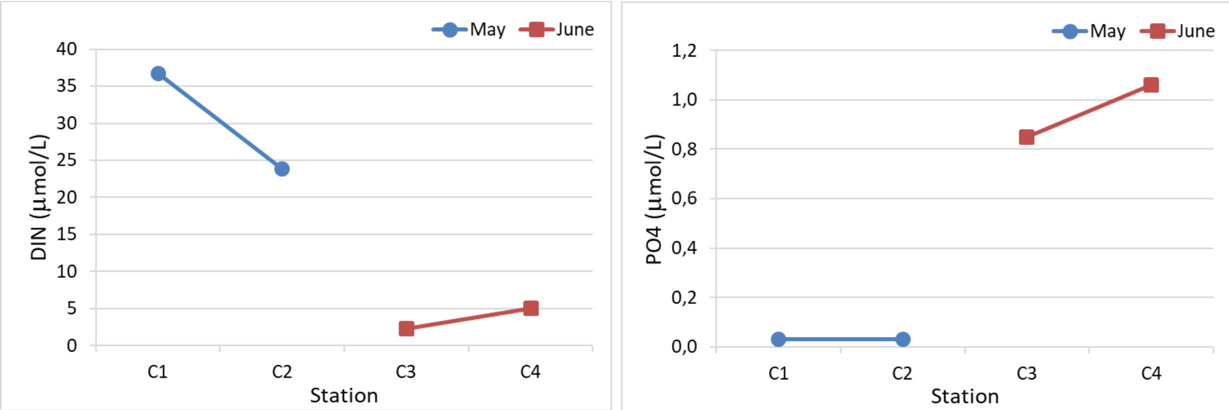

Figure 20: Concentrations of dissolved inorganic nitrogen (DIN) and orthophosphate (PO4) in the surface layer of the Mughan-Salyan drainage channel in May and June 2023 at the investigated stations

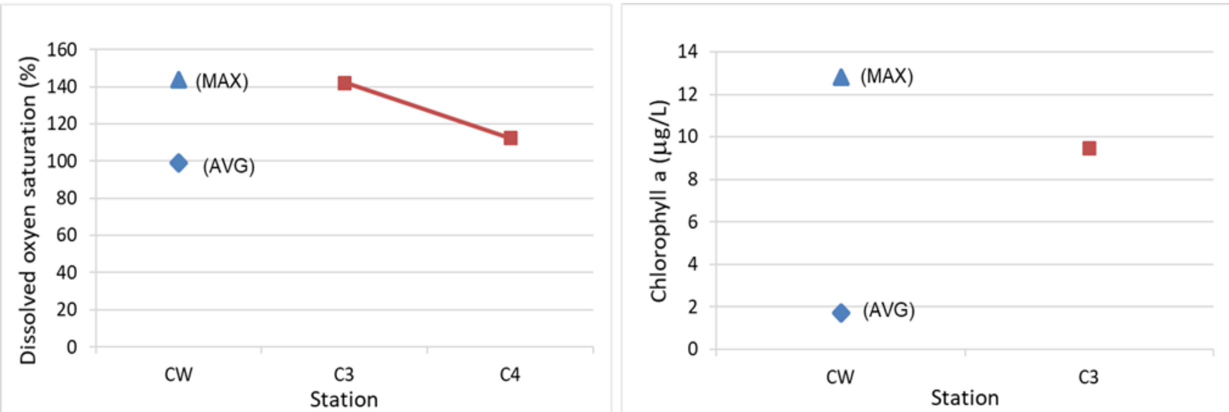

Figure 21: Oxygen saturation and chlorophyll a concentration in the surface layer of the Mughan-Salyan Channel in May and June 2023 at the investigated stations in relation to the average (AVG) and maximum (MAX) values in the coastal waters

3.2.4. Measurements near the constructed Bala and Ana Kura barriers

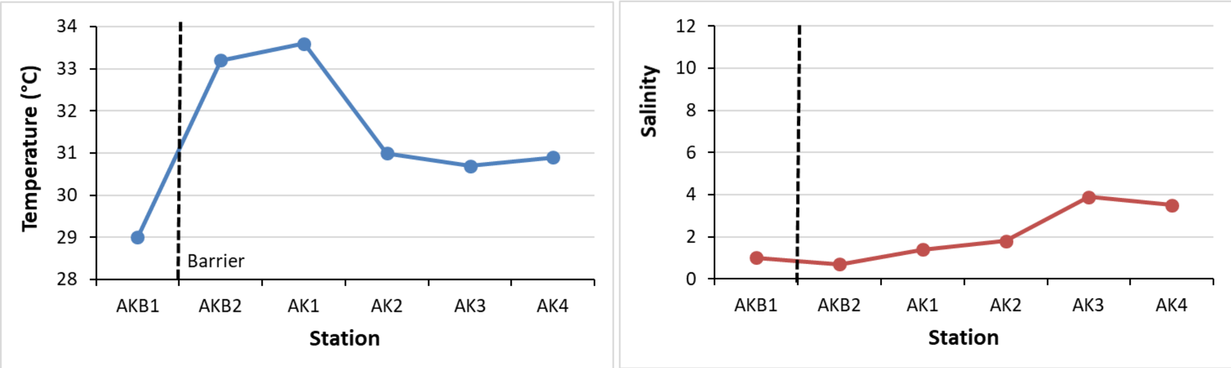

Figure 22: Thermohaline properties of the surface layer at the stations near the constructed barrier In the Ana Kura Branch and seaward in June 2023

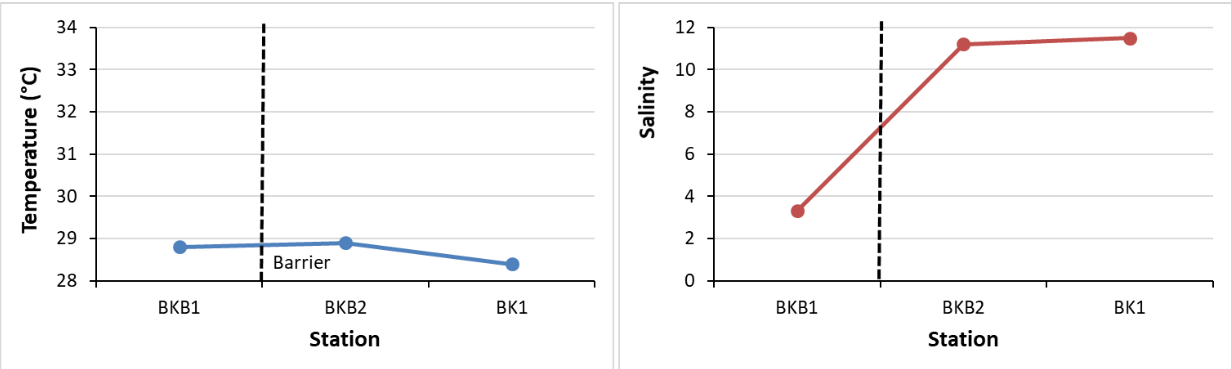

Figure 23: Thermohaline properties of the surface layer at the stations near the constructed barrier In the Bala Kura Branch and seaward in June 2023

4. DISCUSSION OF RESULTS

4.1. Surveillance monitoring

4.1.1. Coastal and transitional waters

The surface layer temperature ranged from 13.2 °C (station MP1) to 18.2 °C (station K1) during the October 2022 and from 23.9 °C (station BB-C) to 30.9 °C (station AK4) during the June 2023. As can be seen in Figure 13, a general positive trend from the northern part of Azerbaijan to the southern part (with the exception of stations MP4 in October 2022 and BB-C in June 2023) is clearly visible. The vertical temperature distribution was only examined at one station (MP5) during both surveys, where a small difference of 0.3°C (October 2022) and 0.6°C (June 2023) was observed between the surface and bottom layers (4.5 m depth).

The salinity of the surface layer varied between 11.9 and 17.8 at the coastal stations (MP) in October 2022 (Figure 13), while it was 0.7 at the transition station K1 on the Kura River, which corresponds to a typical freshwater salinity for Azerbaijan. During the June 2023 survey, the surface salinity at the coastal stations was in a very narrow range from 11.4 to 12.1 and from 3.5 (station AK4) to 11.5 (station BK1) in the front part of the Ana and Bala Kura branches. The vertical difference in salinity at station MP5 was only 0.1 in October 2022 and only 0.2 in June 2023, i.e. the water column at this station was homogeneous in both periods, both in terms of salinity and temperature.

The oxygen saturation of the surface layer of the investigated stations (Figure 15) fluctuated between 69.9 % and 120.9 % during the survey in October 2022, while the oxygen saturation in June 2023 fluctuated between 37.4 % and 121.4 %. During both surveys, the lowest oxygen saturation was measured at stations in Baku Bay (station MP5 in October 2022 and station BB-C in June 2023), while the highest saturations in the water body from Turkan to Baku Bay were measured at stations MP4 – October 2022 and MP4a – June 2023. If we take into account that the saturation of seawater with oxygen indicates the ratio between the processes of photosynthesis and respiration (which are equal at 100% saturation), we can say that at most stations the processes of photosynthesis and respiration are balanced or photosynthesis slightly predominates in the water column (stations MP4 and MP4a), while at stations MP5 and BB-C in Baku Bay the process of respiration, i.e. the decomposition of organic matter, strongly predominates. Since a significant deviation of saturation from the theoretical value (100 %) was observed at this station, it can be assumed that the Baku Bay area is exposed to heavy pollution from untreated wastewater.

The results of the analysis of nitrogen and phosphorus nutrient salts (Figure 14) show that in October 2022, the concentrations of dissolved inorganic nitrogen (DIN) in the surface layer at the coastal stations were in a wide range from 3 µmol/L (station MP3) to 22.18 µmol/L (station MP5 in Baku Bay), while an even higher concentration (45 µmol/L) was found in the bottom layer of station MP5. In June 2023, nitrogen concentrations decreased significantly (Figure 14, Table X), but still showed considerable differences between the individual coastal stations (Figure 14). The highest concentration was again measured at station BB-C in Baku Bay.

Even though the concentrations of dissolved inorganic nitrogen at the stations in the transitional waters near the Bala or Ana Kura branches were relatively high compared to most coastal stations at 24.6 µmol/L (station K1, October 2022) and 8.0 (station AK4, June 2023), we consider these values to be natural, as DIN concentrations in freshwater are generally higher than in seawater (up to two orders of magnitude).

Table 12: Ranges and averages of dissolved oxygen saturation and dissolved inorganic nitrogen, orthophosphate and chlorophyll a concentrations at coastal stations

Surveillance monitoring	Parameter	Range	Station (Min value)	Station (Max value)	Average
October 2022	O2 (%)	69.9 – 120.9	MP5	MP4	102.6
June 2022		37.4 – 121.4	BB-C	MP4a	98.3
October 2022	DIN (µmol/L)	3.03 – 22.18	MP3	MP5	10.1
June 2022		0.59 – 8.2	MP4a	BB-C	2.8
October 2022	PO4 (µmol/L)	0.2 – 1.69	MP3	MP5	0.86
June 2022		0.08 – 1.83	MP3	BB-C	0.8
October 2022	Chl a (µg/L)	0.77 – 12.8	MP3	MP4	4.78
June 2022		0.02 – 7.61	MP3	MP4a	1.95

The orthophosphate concentrations (Figure 14) at the coastal stations in October 2022 ranged from 0.2 µmol/L (station MP3) to 1.69 µmol/L (station MP5). Concentrations were below 1 µmol/L at most stations, with only stations MP5 and MP6 showing higher values. The concentrations during the survey in June 2023 were in a slightly larger range (0.08 to 1.83 µmol/L), with the highest concentration again measured at station BB-C in Baku Bay. In contrast to dissolved inorganic nitrogen, the average orthophosphate concentrations were very similar during both sampling campaigns (Table 12).

Orthophosphate concentrations in the transitional waters were relatively high during both sampling campaigns (0.59 µmol/L at station K1 in October 2022 and 1.44 µmol/L at station AK4 in June 2022). These elevated values indicate a possible influence of phosphate input into the transitional waters from the Kura River, which originates from agricultural fertilizers on the intensively cultivated land in the lower Kura area (Figure 2).

Chlorophyll a concentrations (Figure X) at the coastal stations were in relatively wide ranges in both sampling periods, i.e. 0.77 to 12.8 µg/L in October 2022 and 0.02 to 7.61 µg/L in June 2023. In both periods, the lowest concentrations were detected at station MP3, while the highest concentrations were detected at stations MP4 (October 2022) and MP4a (June 2023), which correlates well with the dissolved oxygen saturation observed at these stations and indicates a higher nutrient input into the water body from Turkan to Baku Bay.

The concentrations at the transitional waters were also elevated during the study in October (6.11 µg/L at station K1), while chlorophyll a was unfortunately not measured upstream of the Ana Kura arm in June 2023: The elevated Chl a concentration at station K1 measured during the October 2022 survey is likely the result of naturally elevated DIN concentration and anthropogenic orthophosphates in the transitional waters of the Kura River. In summary, the worst status in terms of all ecological parameters was found at station MP5, while low or balanced values of certain parameters at station MP3 in the northern part of

Azerbaijan indicate that there is little anthropogenic pollution at this site and it can be used as a reference station.

4.1.2. Assessment of the ecological status of selected coastal water bodies

In the draft delineation proposal for coastal and transitional waters (EUWI+, 2018) in Azerbaijan, 13 coastal and 4 transitional water bodies were identified (Table 2). Measurements of physico-chemical and biological quality elements within the framework of the EU4Env Water and Data Programme were carried out in 4 coastal water bodies and 1 transitional water body in autumn 2022 and spring 2023 (Tables 3 and 4). A reference station (station MP3, water body AZ_CW1_NSS) for coastal water bodies was established on the basis of the monitoring results obtained.

Since measurements and sampling in transitional waters were only carried out in the delta of the Kura River during the monitoring in 2022 and 2023, no reference station was determined for this type of surface water.

The approach for determining threshold values for physico-chemical and biological quality elements depends mainly on the amount of available data for certain types of surface waters. If a long-term series with a large amount of data is available, a "bottom-up" approach is used, while a "top-down" approach is used if the amount of data "is small. The main difference between these two approaches is that the thresholds determined using the "top-down" approach need to be reviewed over a long period of time (with newly collected data) and modified if necessary, whereas the thresholds determined using the bottom-up method often require less fine-tuning.

The threshold values for physico-chemical quality elements still need to be harmonized with the status of the biological quality elements. For this process, statistical programs such as the Nutrient Toolkit (JRC ECOSTAT Working Group) have been developed in recent years.

Although only two surveys have been conducted, a draft proposal based on the top-down approach for the threshold values of the three supporting physico-chemical quality elements (dissolved oxygen, dissolved inorganic nitrogen and orthophosphate) and the BQE “"phytoplankton" for coastal waters is presented in Tables 13 and 14.

For the assessment of ecological status, threshold values from high/good to good/moderate are proposed for the supporting physico-chemical quality elements and threshold values from high/good to bad/poor are proposed for the BQE “Phytoplankton" (Table 13).

Thresholds for the physico-chemical quality elements “temperature” and “salinity” were not proposed due to the lack of monthly data, while “transparency" does not appear to be a suitable physico-chemical quality element for Azerbaijani coastal waters due to the very shallow coastal waters, which are often exposed to strong wind-induced sediment resuspension.

Table 13: Draft proposal of status thresholds for supporting physico-chemical quality elements in coastal waters

Quality element	Unit	Threshold value			
		High/Good	Good/Moderate	Moderate/Poor	Poor/Bad
Oxygen saturation	(%)	90 (lower value) 110 (upper value)	125 (lower value) 75 (upper value)	-	-
Dissolved inorganic nitrogen	(µmol/L)	2	6	-	-
Orthophosphate	(µmol/L)	0.2	0.6	-	-

Table 14: Draft proposal of status thresholds for the biological quality element Phytoplankton in coastal waters

Quality element	Unit	Reference value	Threshold value			
			High/Good	Good/Moderate	Moderate/Poor	Poor/Bad
Phytoplankton EQR (Ecological Quality Ratio)	-	1.0	0.8	0.6	0.4	0.2
Phytoplankton (Concentration of Chlorophyll a)	(µg/L)	0.80	1.00	1.33	2.00	2.67

The thresholds proposed in Tables 13 and 14 need to be modified/re-adjusted in view of the data from the new surveillance monitoring cycles.

Based on the average values of the results of the physico-chemical parameters and the biological element phytoplankton, which were determined in four water bodies of coastal waters (Figures 14, 15) in the period from October 2022 to June 2023, and the proposed threshold values (Tables 13, 14), the status of these parameters is shown in Figures 24 to 27.

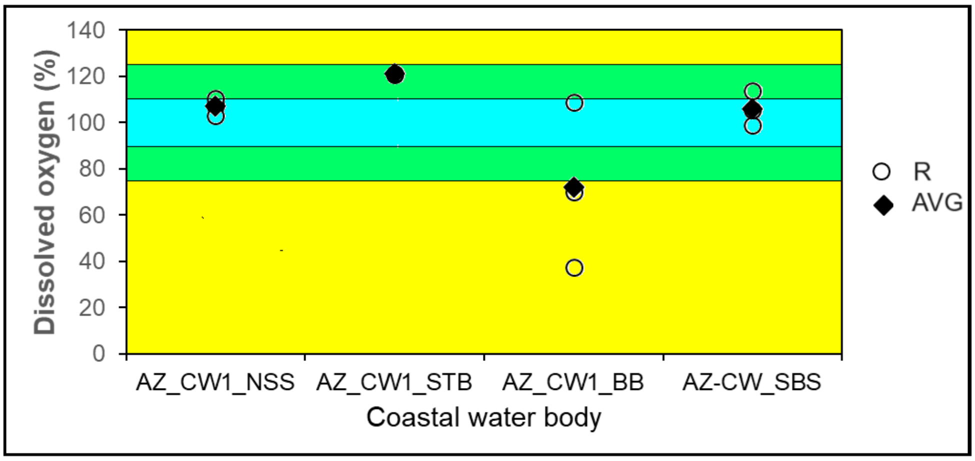

Figure 24: Dissolved oxygen saturation at stations in four coastal water bodies in Azerbaijan in the period from October 2022 to June 2023 (R) and corresponding average saturation values (AVG) with indicated status ranges (blue = high; green = good and yellow = moderate)

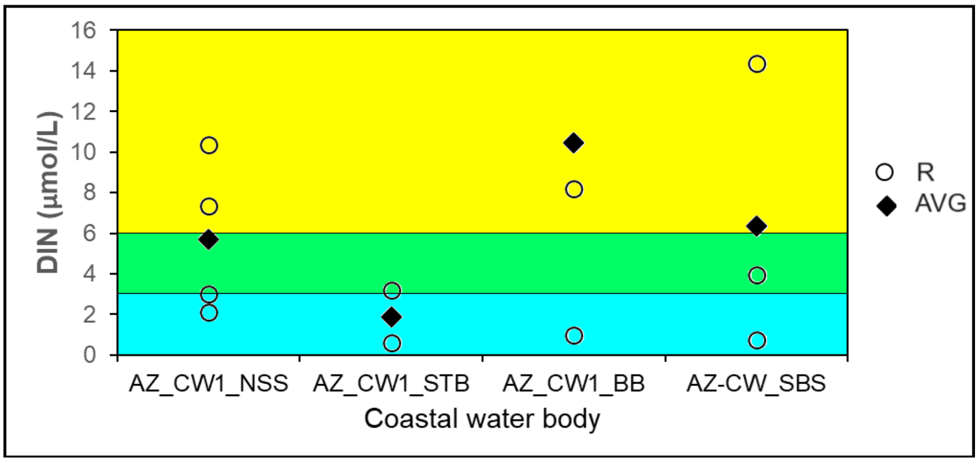

Figure 25: Concentrations of dissolved inorganic nitrogen (DIN) at stations in four coastal water bodies in Azerbaijan in the period from October 2022 to June 2023 (R) and corresponding average concentration values (AVG) with indicated status ranges (blue = high; green = good and yellow = moderate)

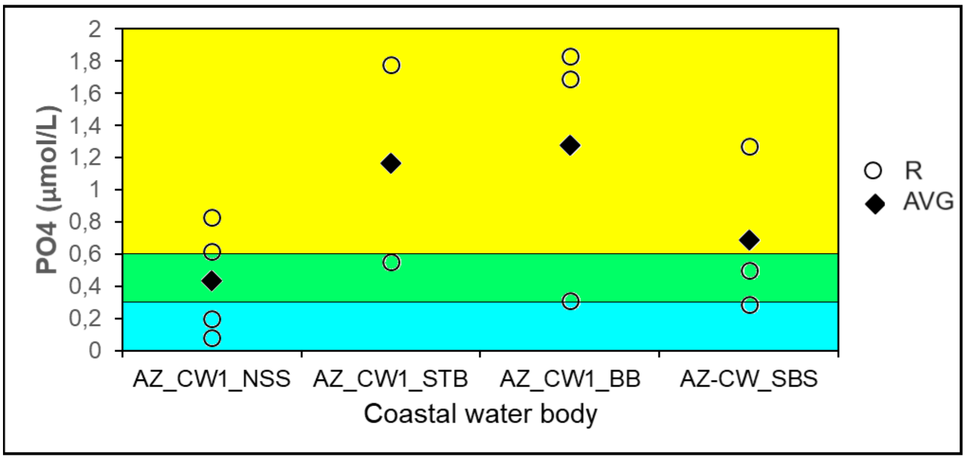

Figure 26: Orthophosphate (PO4) concentrations at stations in four coastal water bodies in Azerbaijan in the period from October 2022 to June 2023 (R) and corresponding average concentration values (AVG) with indicated status ranges (blue = high; green = good and yellow = moderate)

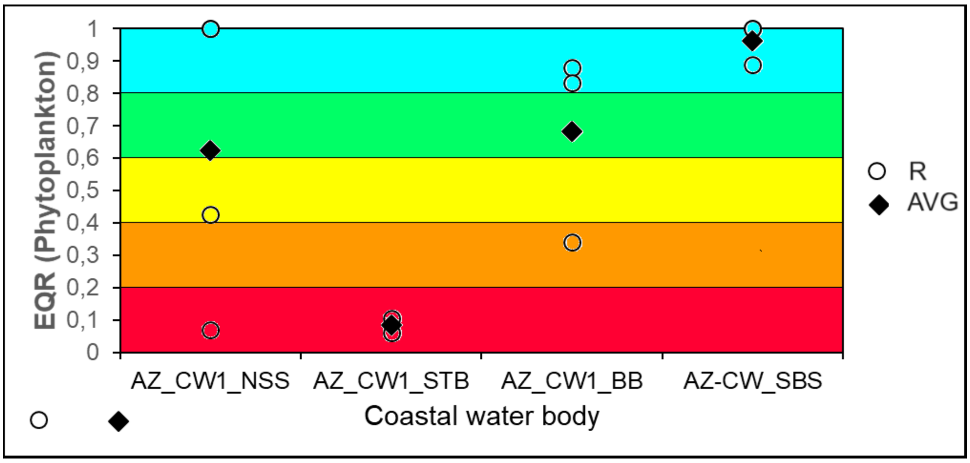

Figure 27: Ecological quality ratios (EQR) calculated from the chlorophyll a concentration determined at stations in four coastal water bodies in Azerbaijan in the period from October 2022 to June 2023 (R) and the corresponding average concentration values (AVG) with the indicated status ranges (blue = high; green = good and yellow = moderate)

The individual ecological quality ratios have been calculated as follows:

EQR = REF-*c* (Chl a) / Sample-*c* (Chl a);

while the average quality ratios were calculated as follows:

AVG EQR = REF-*c* (Chl a) / AVG Sample *c* (Chl a);

where: REF-*c* (Chl a) is the reference concentration of chlorophyll a for Azerbaijan's coastal waters (0.8 µg/L);

Sample-*c* (Chl a) represents sample concentrations at the investigated stations;

AVG EQR represents the average EQR value for a particular water body;

AVG Sample *c* (Chl a) is the average concentration of chlorophyll a established at stations located in a water body during October 2022 to June 2023.

The status of coastal water bodies with regard to individual physico-chemical parameters and the biological element of phytoplankton quality is summarized in Table 15. The same table also shows the resulting ecological status of the water bodies, which is determined according to the classification scheme for ecological status shown in Figure 28.

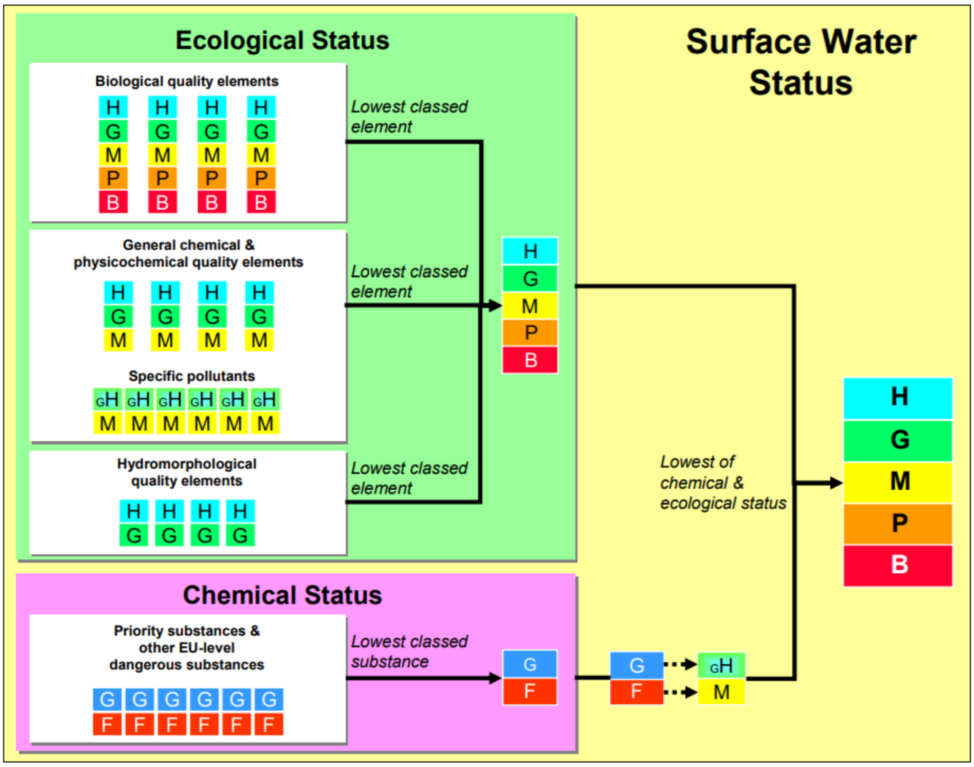

Figure 28: The Water Framework Directive classification scheme of the ecological, chemical and surface water status (H = High; G = Good; M = Moderate, P = Poor, B = Bad, GH = Good or better and is normally treated as High for calculating surface water status, F = failing to achieve good surface water chemical status)

Table 15: Assessment of the status of physico-chemical and biological quality elements and the ecological status for four coastal water bodies in Azerbaijan for the time period from October 2022 to June 2023

Coastal water body	Type and location of water body	STATUS				
		Physico-chemical quality elements			Biological quality element	ECOLOGICAL
		O_2	DIN	PO4	Phytoplankton	
AZ_CW1_NSS	Oligohaline and shallow coastal waters from Samurchay to Shuraabad	H	G	G	G	**G**
AZ_CW1_STB	Oligohaline and shallow coastal waters from Turkan to Baku	G	H	M	B	**B**
AZ_CW1_BB	*Candidate of heavily modified oligohaline and shallow coastal waters of Baku Bay*	M	M	M	G	**M**
AZ_CW1_SBS	Oligohaline and shallow coastal waters from Baku to Sangachal	H	M	M	H	**M**

In the period from October 2022 to June 2023, the ecological status of the investigated coastal water bodies in Azerbaijan was assessed as good only in the northern water body AZ_CW1_NSS, while in the other water bodies it was assessed as moderate (AZ_CW1_BB and AZ_CW1_SBS) or bad (AZ_CW1_STB). The fact that the orthophosphate status in the Baku Bay water body and nearby water bodies (AZ_CW1_SBS and AZ_CW1_STB) was always moderate indicates a strong influence of wastewater on these parts of the Azerbaijani coastal zone.

4.2. Investigative monitoring surveys

4.2.1. Intrusion of seawater into the river Kura

Considering that in the summer of 2020, when the Kura River discharge was low, a strong upstream seawater intrusion was detected, causing the entire water column of the Kura River, about 66 km upstream of the delta, to be heavily salinized (EUWI+, 2020), an investigation of seawater intrusion into the Kura Delta was carried out in October 2022 under similar conditions, i.e. at a low river flow of 90 m^3/s (Table 9). The results obtained at seven stations showed that the spatial distribution of temperature and salinity in the transition area of the Kura River (Figures 16 and 17) has a homogeneous structure of the water column with uniformly low salinity values (typical for freshwater). The fact that no seawater intrusion occurred in October 2022 indicates that, in addition to the low discharge of the river, other factors such as low air pressure, storm winds, high sea level or high tides could also be important for the intrusion of seawater.

4.2.2. Nutrient enrichment of the Kura in the lower section of the river from Muğan Gəncəli to Neftchala

The lower section of the Kura River is polluted by the discharge of untreated wastewater from households and industry in the settlements near the river and by the leaching of fertilisers, herbicides and pesticides from agricultural land. To investigate the effects of these pressures on nutrient enrichment along the river section from Muğan Gəncəli to Neftchala, six surface samples were taken (Figure 10) and analysed for dissolved inorganic nitrogen and orthophosphate concentrations. The results (Figure 18) indicate negative concentration gradients from Muğan Gəncəli (station KR6) to Neftchala (station KR1) for both nutrients, with the highest concentrations found at stations KR3 (Arabkardashbeyli) and KR6 (Muğan Gəncəli) for dissolved inorganic nitrogen and at stations KR3 (Arabkardashbeyli) and KR5 (Khilli) for orthophosphates. The average concentrations for this river section are 2.51 mg/L for dissolved inorganic nitrogen and 0.003 mg/L for orthophosphates.

The nutrient concentrations in the Kura River are given in mg/L, the standard unit for rivers, but unfortunately cannot be directly compared with the nutrient concentrations in coastal waters (which are given in the standard unit for seawater, µmol/L). Converting the nutrient concentrations in the Kura River from mg/L to µmol/L gives an average concentration of 41.5 µmol/L for dissolved inorganic nitrogen and 0.102 µmol/L for orthophosphates for the section of river studied.

Comparing these values with the average concentrations in the coastal waters (6.14 µmol/L for dissolved inorganic nitrogen and 0.80 µmol/L for orthophosphates), it can be said that the inflow of the Kura River significantly enriches the adjacent coastal waters with dissolved inorganic nitrogen and reduces the orthophosphate concentrations. The enrichment of coastal waters with dissolved inorganic nitrogen from rivers is also a widespread phenomenon in many European countries.

4.2.3. Basic physico-chemical and biological properties of the water in the Mughan-Salyan drainage channel

The Mughan-Salyan artificial drainage channel is the main collection channel for excess water from agricultural land in the lower Kura (Figures 2 and 3). Results from two monitoring surveys conducted in May and June 2023 showed normal seasonal surface temperatures at all stations for May and June (Figure 19), while salinity measurements conducted at stations C1 and C2 in May indicated low dissolved solids concentrations (< 1ppm), which can be considered as typical freshwater concentrations in the canal waters in May (Figure 19), and elevated dissolved solids concentrations (5.6 and 5.7 ppm at stations C3 and C4) in June 2023.).

Due to the relative proximity of station C3 to the mouth of the canal into the sea (4 km), it could be assumed that the increased concentration of dissolved solids was caused by seawater entering the canal. However, since an elevated concentration was also detected at station C4 (40 km from the mouth), the possibility of anthropogenic discharge of wastewater into the canal must also be considered.

In addition to the thermohaline properties of the canal water, the concentrations of nutrient salts were also investigated. During the May sampling, the concentrations of dissolved inorganic nitrogen were relatively high (36.7 µmol/L at station C1 and 23.8 µmol/L at station C2), which corresponds to the concentrations in the Kura River, while the concentrations of orthophosphate were relatively low (0.03 µmol/L) at both stations (Figure 20). The results of the analysis of the samples collected in June 2023 show that dissolved inorganic nitrogen concentrations decreased by an order of magnitude to 2.2 µmol/L (station C3) and 5.1 µmol/L (station C4), while orthophosphate concentrations increased significantly to 0.85 µmol/L (station C3) and 1.06 µmol/L (station C4). The results for oxygen saturation (142 %) and chlorophyll a concentration (9.47 µg/L) measured at station C3 in June 2023 (Figure 21) indicate high primary production in the channel caused by excess orthophosphate concentrations. The values determined for oxygen saturation and chlorophyll a are also significantly higher than the average values measured at the coastal stations (Figure 21) or similar to the maximum values determined at stations MP5 (oxygen saturation) and MP4 (chlorophyll a).

4.2.4. Results of the measurements taken near the constructed Bala and Ana Kura barriers

In order to prevent the intrusion of seawater upstream of the Kura River in spring 2023, both branches of the Kura River were blocked by stone embankments with relatively small culverts for the river's outflow towards the Caspian Sea (Figure 4).

In June 2023, temperature and salinity measurements were carried out on the river and seaward of the barriers as well as at additional stations in the transitional waters (Figure 12). According to the results of the measurements in the Ana Kura branch (Figure 22), the constructed barrier successfully prevents the mixing of river and sea water, followed by a significant temperature difference of up to 4 °C between the water masses in front of and behind the barrier. Considering that small passages were created in the barrier for fish migration, the observed temperature differences could pose a serious problem for the fish. In contrast to the temperature, the salinity values are uniform and low on both sides of the barrier, and the salinity rises only slowly from station AK1 to typical values for transitional waters.

In the case of the barrier in Bala Kura Branch (Figure 23), no temperature differences were detected in the water masses before and after the barrier, while there were large differences in salinity. The measurements showed a salinity of 3.3 on the river side and 11.2 seaward. These values indicate that the barrier in this branch of the Kura River cannot completely prevent seawater from entering the river and that the flow of the river (during the measurements) was so low that the water masses behind the barrier are coastal waters.

5. CONCLUSIONS

From October 2022 to June 2023, two monitoring surveys were carried out in selected coastal and transitional waters of Azerbaijan and four investigative surveys in the lower Kura River and its delta. During the field measurements and sampling, AZELAB personnel received further training for future independent work, while methods suitable for seawater were introduced in the laboratory to analyze dissolved oxygen content, nutrient concentration and chlorophyll a. Before all field trips, a joint planning of the sampling, the selection of the stations and the methods for sample preparation and storage up to the analysis in the laboratory was carried out. The measurement results were jointly evaluated and threshold values for three basic physico-chemical elements (oxygen ratios, concentrations of dissolved inorganic nitrogen and concentrations of orthophthate) and for the biological quality element phytoplankton were proposed in accordance with the top-down principle.

The mean values of the measurements carried out in October 2022 and June 2023 were used to assess the ecological status of the water bodies examined. The lowest status (bad) was found for the water body in Baku Bay, while a moderate status was found for two neighboring water bodies (from Turkan to Baku Bay and from Baku Bay to Sangachai). The only water body with a good status was found in the northern part of Azerbaijan. The status of transitional waters in the Kura River Delta was not assessed as the reference station for this type of surface water was not identified.

In addition to the monitoring surveys, four investigative surveys were also organized to gather new information on the problem of seawater intrusion upstream of the Kura, the enrichment of the lower Kura with nutrients from agricultural land leaching and the inflow of untreated wastewater, and the water quality of the Mughan-Salyan drainage channel.

6. REFERENCES

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7. Annexes

Annex 1: AZ_CTW Survey & Analysis data 2022-23 (in Excel format)

Annex 2: AZ_CTW Survey_2022-23 Photo documentation

Annex 3: EU4Env_CTW_metadata_form_Azerbaijan-(EN&AZ)

Annexes are available as separate documents

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