Trans-Boundary River Management Phase II for the Kura River – Armenia, Georgia, Azerbaijan

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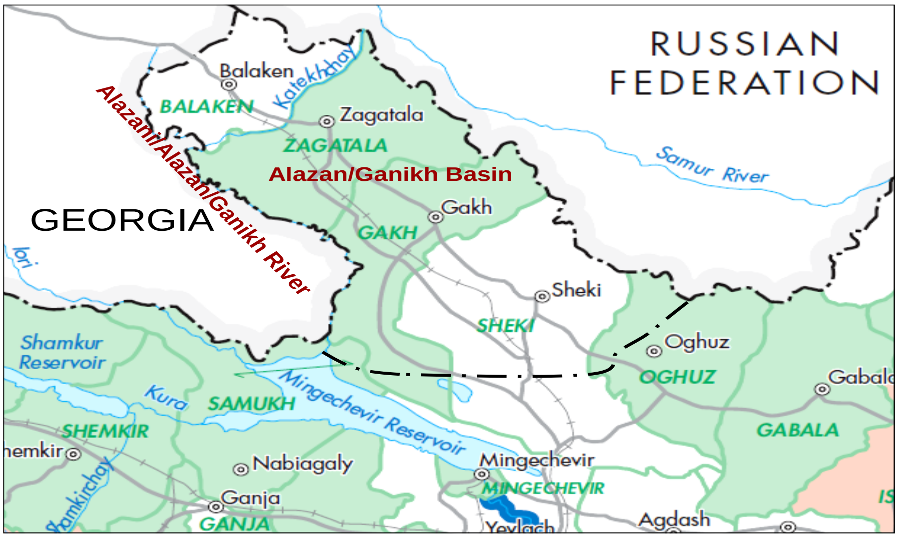

Pilot River Basin Management Plan for the Alazan/Ganikh river basin, Azerbaijan

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LIST OF ABBREVIATIONS

AWB	Artificial Water Body
BOD	Biological Oxygen Demand
CIS	WFD Common Implementation Strategy (Documents[1])
DPSIR	Driver Pressure State Impact Response
ELV	Emission Limit Value
EQR	Ecological Quality Ratio
EQS	Environmental Quality Standard
GIS	Geographic Information System
EU	European Union
HMWB	Heavily Modified Water Body
HPP	Hydro Power Plant
IFI	International Financing Institution
IMPRESS	CIS Guidance for the analysis of Pressures and Impacts In accordance with the Water Framework Directive.
IPPC	Integrated Pollution, Preventing and Control
IWRM	Integrated Water Resource Management
MAC	Maximum Allowable Concentration
MS	EU Member State
NWSSP	National Water Supply & Sanitation Project, Azerbaijan
PoM	Programme of Measures
RB	River Basin
RBMP	River Basin Management Plan
WB	Water Body
WBR	Water Bodies at Risk
UWWTD	EU - Urban Wastewater Treatment Directive
WFD	Water Framework Directive, 2000/60/EC
WSS	Water Supply and Sanitation
WWTP	Waste Water Treatment Plant
WTP	Wastewater Treatment Plant

[1] Available from http://ec.europa.eu/environment/water/water-framework/objectives/implementation_en.htm

Important Water Management Definitions

Additional measures (WFD)	"additional measures" is needed where monitoring or other data indicate that the objectives set under the WFD Article 4 for the body of water are unlikely to be achieved and the water body is not already addressed in the PoM.
Agglomeration (UWWTD)	According the Urban Waste Water Directive 'agglomeration' means an area where the population and/or economic activities are sufficiently concentrated for urban waste water to be collected and conducted to an urban waste water treatment plant or to a final discharge point
Artificial Water Body (WFD)	"Artificial water body" means a body of surface water created by human activity.
Bad status	Large portions of biological communities normally associated with the surface water type under undisturbed conditions are absent. [Severe alteration of structure and function of the ecosystem]
Basic measures	Basic measures includes: - technical interventions as a minimum needed to reach good status in a water body - measures deemed appropriate for the purposes of achievement of other WFD articles - measures required to implement other EU legislation for the protection of water
Baseflow	Baseflow is the usual, reliable, background level of flow in a river, maintained generally by seepage from groundwater storage.
Characterisation (WFD)	For each River Basin District carry out: – an analysis of its characteristics, – a review of the impact of human activity on the status of surface waters and on groundwater, and – an economic analysis of water use.
Classification	Addressing water bodies to high, good, moderate, poor or bad status based on monitoring data.
Competent authority (WFD)	The authority or authorities identified by the Member States for the application of the rules of the Water Framework Directive within each River Basin District lying within their territory.
Driver (IMPRESS)	An anthropogenic activity that may have an environmental effect (e.g. agriculture, industry)
Ecological Quality Ratio (EQR)	Ratio representing the relationship between the values of the biological parameters observed for a given body of surface water and values for these parameters in the reference conditions applicable to that body. The ratio shall be represented as a numerical value between zero and one, with high ecological status represented by values close to one and bad ecological status by values close to zero.
Ecological Quality Ratio (EQR)	Ratio representing the relationship between the values of the biological parameters observed for a given body of surface water and values for these parameters in the reference conditions applicable to that body. The ratio

	shall be represented as a numerical value between zero and one, with high ecological status represented by values close to one and bad ecological status by values close to zero.
Good Status (WFD)	Slight changes compared to the natural condition: The values of the biological quality elements for the surface water body type show low levels of distortion resulting from human activity, but deviate only slightly from those normally associated with the surface water body type under undisturbed conditions. [Some replacement of sensitive/rare species; ecosystem functions fully maintained]
Heavily modified water body (WFD)	"Heavily modified water body" means a body of surface water which as a result of physical alterations by human activity is substantially changed in character
High status	Little or no sign of anthropogenic disturbance. [No loss of species, small density changes may occur]
Impact (IMPRESS)	The environmental effect of the pressure (e.g. fish killed, ecosystem modified)
International River Basin Management Plan (WFD)	In the case of an international River Basin District falling entirely within the EU, Member States shall ensure coordination with the aim of producing a single International River Basin Management Plan.
Integrated Water Resource Management (GWP)	IWRM is a process which promotes the co-ordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems and the environment.
Macro-invertebrates	Animals that have no backbone and are visible without magnification. Stream-bottom macroinvertebrates include such animals as crayfish, mussels, aquatic snails, aquatic worms, and the larvae of aquatic insects.
Macrophytes	Large aquatic plants that grows in or near water. In lakes macrophytes normally is submerged (ie, completely covered by water) and rooted. But they can also be unrooted and either emergent (ie, only partly covered by water) or floating.
Measures (WFD)	Actions to ensure protection and sustainable use of water and achieve the objectives of the water bodies in the framework of the river basin.
Moderate status	Moderate changes compared to the natural condition. [Many sensitive species disappeared; ecosystem functions largely maintained]
Monitoring	The purpose of monitoring is to provide information on the status of the environments to authorities, organisations and for the public and to provide the information needed for the authorities to decide upon measures to protect and improve the status of the environment
Operational monitoring	– assess status of water bodies at risk, – assess any changes in the status of water bodies at risk resulting from the programmes of measures.
Persistent Organic Pollutants (POPs)	Chemical substances that persist in the environment, bioaccumulate through the food web, and pose a risk of causing adverse effects to human health and the environment. (UNEP)
Phytoplankton	Tiny, free-floating, photosynthetic organisms in aquatic ecosystems. They include blue-green algae (cyanobacteria), diatoms, desmids, and

	dinoflagellates.
Poor status	Biological communities deviate substantially from those normally associated with the surface water type under undisturbed conditions. [Tolerant species dominate; sensitive species are rare; ecosystem functions altered]
Population Equivalent (UWWTD)	'1 p.e. (population equivalent)' means the organic biodegradable load having a five-day biochemical oxygen demand (BOD_5) of 60 g of oxygen per day
Pressure (IMPRESS)	The direct effect of the driver for example, an effect that causes a change in flow or a change in the water chemistry.
Programme of Measures	A description of the actions necessary to achieve the objectives of the water bodies. The programme of measures can be phased in order to spread the costs of implementation.
Reference condition (WFD)	Type specific biological reference conditions represent the values of the biological quality elements at high ecological status for each surface water body type. The values of the biological quality elements for the surface water body reflect those normally associated with that type under undisturbed conditions and show no or only very minor, evidence of distortion.
Response (IMPRESS)	The measures taken to improve the state of the water body (e.g. restricting abstraction, limiting point source discharges, developing best practice Guidance for agriculture)
River basin (WFD)	The area of land from which all surface run-off flows through a sequence of streams, rivers and, possibly, lakes into the sea at a single river mouth, estuary or delta
River Basin District (WFD)	The area of land and sea, made up of one or more neighbouring river basins together with their associated groundwaters and coastal waters.
River Basin Management Plan	The River Basin Management Plan summarise and present the analysis, characterisation, monitoring results and programme of measures in one document, which can be used for the dialogue with the stakeholders (including the public information and consultation)
State (IMPRESS)	The condition of the water body resulting from both natural and anthropogenic factors (i.e. physical, chemical and biological characteristics)
Status (WFD)	The biological or ecological behaviour of a water body supported by hydromorphological and chemical data from the water body.
Significant Pressure (IMPRESS)	Any pressure that on its own, or in combination with other pressures, may lead to a failure to achieve the specified objective
Supplementary measures	Supplementary measures includes: Institutional, awareness, legislation, research, economic instruments, education, demonstration projects etc
Surface Water Body (WFD)	"Body of surface water" means a discrete and significant element of surface water such as a lake, a reservoir, a stream, river or canal, part of a stream, river or canal, a transitional water or a stretch of coastal water.
Surface water categories (WFD)	Rivers, lakes, transitional waters or coastal waters
Surveillance monitoring	- Check results of characterisation. - Input to the design of future monitoring programmes.

(WFD)	- To assess long term changes in natural conditions and long term changes resulting from widespread anthropogenic activity.
Typology (WFD)	For each surface water category, the relevant surface water bodies within the river basin district shall be differentiated according to type
Water Body	A coherent sub-unit in the river basin (district) to which the environmental objectives of the directive must apply. Hence, the main purpose of identifying "water bodies" is to enable the status to be accurately described and compared to environmental objectives.
Water body at risk (WFD)	A water body that is identified as being at risk of failing the environmental quality objectives based upon the characterisation as specified in article 5 of the WFD and results of operational monitoring as specified in article 8 of the WFD.

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INTRODUCTION

According to the EU Water Framework Directive (WFD) the purpose of a River Basin Management Plan is to summarise and present the analysis, characterisation, monitoring results and programme of measures for a river basin in one document, which can be used for the dialogue with the stakeholders (a dialogue that includes public information and consultation about the River Basin Management Plan).

The Alazan/Ganikh river basin has high precipitation and sufficient water resources in mountainous part, but in the alluvial plain, where the natural vegetation is steppe, irrigation is extensively used. The main reason of water scarcity in the densely populated alluvial plain is low precipitation, but also improper use and management of water resources through the existing administrative territorial approach.

Azerbaijan Republic extends its relation with European Union year after year and joins to International Conventions. Azerbaijan is receiving technical assistance from the European Union through the European Neighbourhood and Partnership Instrument (ENPI). Under the ENPI Action Plan agreed by the European Commission and the Government of Georgia, Georgia is looking to align its water management methods and practices along the lines of the European Union integrated approach to water management.

In the European Union the Water Framework Directive is the main piece of legislation for assessing of water resources based upon the river basin principle and it is mandatory for the EU member states to develop river basin plans in line with the requirements of the Directive.

This pilot River Basin Management Plan is elaborated according to the methodology of Water Framework Directive.

The core of the pilot river basin management plan is the actions needed to comply with a natural and diverse plant and animal life – “good status” in the WFD terminology. These actions are called the Programme of Measures (PoM).

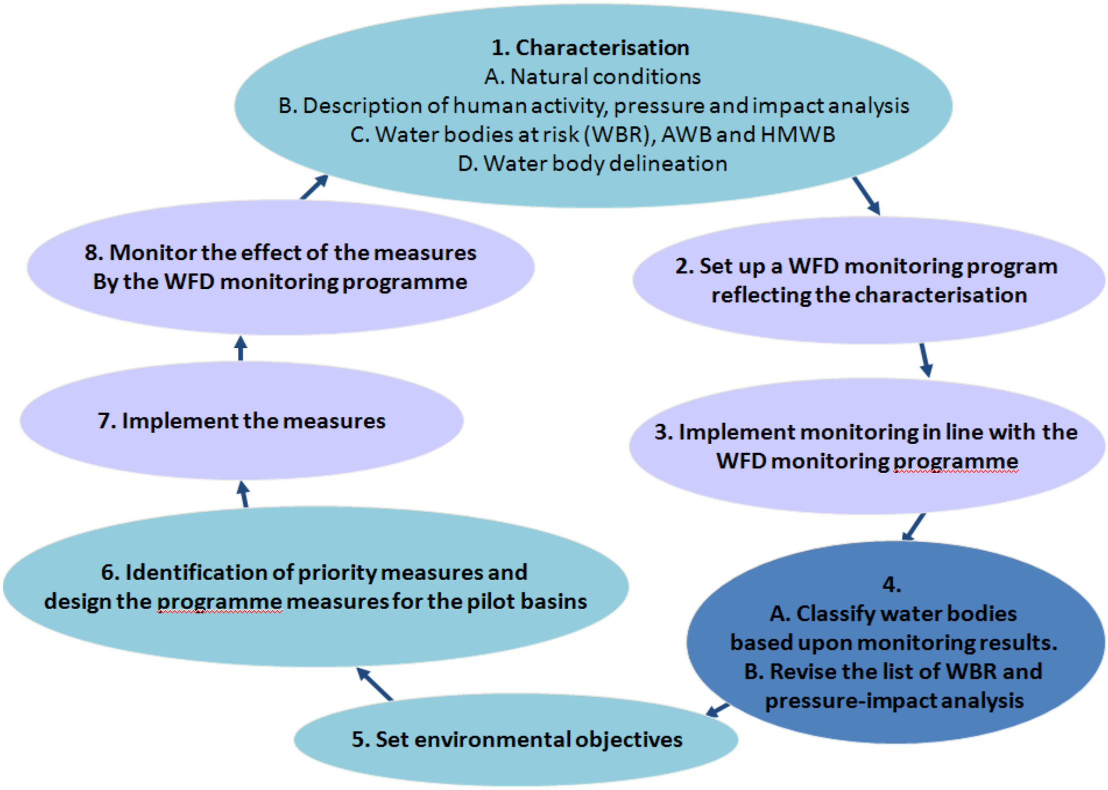
As a basis for setting up the PoM, the situation in the basin and the human impact on the rivers has to be analysed.

So the present knowledge on general physical-geographical situation and human activities of Alazan/Ganikh River basin, including water, plant, land use, present knowledge of river flow and quality of surface water, was collected.

A central step in the work is linking the human activities with their impact on the water ecosystem (the pressure-impact analysis in the WFD terminology). The pressure-impact analysis has to be site specific, resulting in identification of the specific problems and their causes (Water Bodies at Risk – WBR - in the WFD terminology).

For each WBR a Programme of Measures (PoM) has to be elaborated, meaning that the PoM is both site and pressure specific.

Below we present the diagram of planning cycle of the WFD, which the EU member countries have to reiterate every 6 years according the Directive:



The information provided in this document is illustrated by the corresponding graphs, maps and tables.

The aim of this draft pilot basin River Basin Management Plan is to help the authorities responsible for water management, the administration and the politicians in the Alazan/Ganikh river basin and the public in general to learn and understand the WFD methodology to be able to adopt and out into practice the better means of water resources management and protection.

As the purpose of this document is to pilot the WFD approach in Azerbaijan by preparing the pilot River Basin Management Plans, we have used the following proactive approach in relation to the characterisation of river basins in line with the WFD methodology: “Lack of data is not an excuse for doing nothing, demonstrate that you tried”.

We have produced the draft pilot RBMP for the Alazan/Ganikh river basin using the main table of contents outlined in the WFD for RBMPs as a guide. During the preparation of this pilot RBMP we have identified existing gaps in the present knowledge and technical expertise in the country and made recommendations for filling them accordingly.

The gaps in the knowledge identified in the course of the preparation of RBMP in line with the WFD methodology include lack of basic education, weak “knowledge infrastructure”, lack of technical expertise, a fragmented approach to analysing environmental and technical issues (where the WFD requires integration), serious lack of meaningful data about the human activities impacting water quality and quantity, and plus an inadequate monitoring providing only limited amount of meaningful information on the actual water quality and water quantity required for the preparation of RBMP.

SUMMARY

The present draft final river basin management plan is intended to be:

- A basis for the discussions among the key stakeholders on the present situation in the basin, where water quality problems are and what needs to be done to improve the situation,
- A basis for the design and update of the monitoring programmes
- Guidance to better understanding of what kind of data on human pressures are needed in order to establish a targeted and cost-effective programme of measures.

The Alazan/Ganikh basin

The Azeri part of the Alazani river basin is located in the North –Western corner of Azerbaijan at the south slope of the Greater Caucasus. The basin has borders with Georgia in the west and with Russia in the North.

The Alazan/Ganikh River comes from Major Caucasus Mountains in Georgia and runs into the Mingechevir reservoir. It's the biggest left tributary of Kura River.

The length of the Alazan/Ganikh River is 413 km; the area of the basin is 12,080 km^2. 4,755 km^2 of the Alazan/Ganikh River basin is in Azerbaijan (equivalent to 5.5% of the total area of Azerbaijan).

The basin consists three main parts:

- The alluvial plain.
- The mountainous part.
- A hilly dry part in the southern area of the basin.

There are big differences in elevation, temperature and precipitation from the high mountains in the northeast to the alluvial plains in the southwest. These differences are reflected in similar big differences in the natural vegetation in the Alazan basin. From northeast (high mountains) to southwest (alluvial plain) the natural vegetation changes from mountain tundra via alpine meadows, oak and hornbeam forests to meadow plants mixed with bushes.

Economic activities

The population of Alazan/Ganikh River basin is approximately 425,000 thousand. More than two thirds of the population (approximately 72%) is living in the rural areas. The four major towns (from west to east: Balakan, Zagatala, Gakh and Sheki) are situated along the main road through the basin where the mountains meet the alluvial plain.

Cereal grains including corn and wheat are important crops in the basin. Other important crops include sunflower, tobacco, mulberry for silk production, fruit and berry, wine and tea.

Pressures

The irrigated area is ca. 30% of the total area of the basin and there is a big demand for water for irrigation.

The towns and villages are lacking a modern system to handle their solid waste and wastewater. Towns are without functional wastewater treatment plants. Solid waste from the villages is either dumped where convenient (often on the bank of the river or in the river) or in primitive landfills.

The present agricultural practices in the basin are not very advanced in terms of effective use pesticides and of the nutrients in chemical fertiliser and manure for crop production.

Impacts

A crucial step in the WFD water planning procedure is to evaluate where the impacts from human activities have so negative consequences for rivers or other water bodies that something needs to be done.

Our analysis has shown that such significant impact on the river ecosystem is resulting from the following human activities:

1. Water abstraction for irrigation
2. Deforestation
3. Solid waste disposal
4. Car washing in rivers
5. Discharge of waste waters from residential areas to rivers
6. Hydromorphological changes
7. Pollution by pesticides and fertilisers from agriculture

We have reached this evaluation by expert judgments and analysis, as well as field observations.

Where problems are

18 river sections and two parts of a reservoir have been identified, where the ecosystem is not healthy due to the impact (pollution etc.) from the above mentioned human activities (water bodies at risk). All water bodies at risk are situated at the alluvial plain where most of the population of the basin lives. In the table below provides a short summary on the human impact on the 20 water bodies at risk:

Water Body at Risk	***Reason for risk***
16 river sections in the alluvial plain	*1. Water abstraction for irrigation* *2. Deforestation* *3. Solid waste disposal* *4. Car washing in rivers* *5. Discharge of waste waters from residential areas to rivers* *7. Pollution by pesticides and fertilisers from agriculture*
Ganikh on the territory of Azerbaijan	*1 Water abstraction for irrigation* *5. Discharge of waste waters from residential areas to rivers* *7. Pollution by pesticides and fertilisers from agriculture*
Ayrichay (below Ayrichay reservoir till mouth)	*1. Water abstraction for irrigation (Surface and ground waters)* *5. Discharge of waste waters from residential areas to rivers* *7. Pollution by pesticides and fertilisers from agricultural fields*
Ayrichay reservoir (HMWB)	*1. Water abstraction for irrigation (Surface and ground waters)* *3. Solid waste disposal* *5. Discharge of waste waters from residential areas to rivers* *6. Hydro morphological changes* *7. Pollution by pesticides and fertilisers from agricultural fields*
Ayrichay upper reservoir	*1. Water abstraction for irrigation (Surface and ground waters)* *3. Solid waste disposal* *4. Car washing in rivers* *5. Discharge of waste waters from residential areas to rivers* *6. Hydro morphological changes* *7. Pollution by pesticides and fertilisers from agricultural fields*

How to address problems

Water abstraction for irrigation

The process of designing measures to secure good status in the water bodies at risk due to water abstraction for irrigation and household use goes through five steps;

1. Setting separate requirements for minimum flow for all WBRs;
2. Detailed analysis of the present use of water and identification of possibilities to optimise the use;
3. Designing measures to meet the minimum flow requirement for al WBRs;
4. Socioeconomic evaluation of the measures;
5. Revision of objectives for WBRs if it is considered disproportionately costly or socially unacceptable to implement the measures (political evaluation).

There are too many gaps in the present data and information available on flow regime and water use to make it possible to make the analysis outlined above within the Kura project.

Wastewater

The measure to reduce pollution from untreated sewage is to collect the sewage in a sewerage system and lead it to a Waste Water Treatment Plant (WWTP).

We propose to build 4 new WWTPs with renewed and extended sewerage networks for the 4 main cities and surrounding villages:

1) For Balakan city also serving Gullar, Magamalar, Tulu and Garakly villages.
2) For Zagatala city also serving Jar, Yukhari Tala and Ashagi Tala villages.
3) For Gakh city also serving Gakhbash and Meshabash villages.
4) For Sheki city also serving Kish, Okhud and Gokhmukh villages.

Solid waste

The EU policy on solid waste emphasise the need to reduce, reuse (e.g. reusable bottles) and recycle (e.g. metal, glass, plastic). The aim of the EU waste policy is to extract the maximum practical benefits from products and to generate the minimum amount of waste.

The rest fraction of the waste should be disposed in a sanitary landfill. As the construction of a sanitary landfill is very expensive we propose that one central sanitary landfill is constructed covering the whole basin. The sanitary landfill has to fulfil four main conditions:

- no water percolating the waste enters surface or groundwater, all percolate has to collected and treated,
- the design should consider local geological conditions,
- trained staff shall run the landfill,
- waste should be handled in a way (coved etc.), that minimise the loss by wind and the accessibility to pests.

Agriculture

Very limited information is available on:

- The management of nutrient in different types of agriculture, incl. management of manure and use of chemical fertiliser.
- Use of pesticides - which pesticides, how much, for which crops, when, spraying equipment and practice, legislation etc.

- Irrigation practices, incl. illegal water abstraction.

Therefore we propose to launch a project (donor financed if possible) with the overall objective to secure that agriculture happens in an environmentally safe and economically sound way:
- Pollution through leaching of plant nutrients and pesticides from agriculture is minimized by efficient use and recirculation of farm inputs.
- Water for irrigation used in an environmental and economically sustainable way.

The specific objective of the proposed project will be:
A. To map the agricultural activities in the basin.
B. To propose Good Agricultural Practices minimising the environmental impact of the agricultural activities in the basin.
C. To implement the proposed Good Agricultural Practices on demonstration farms in the basin.

Polluter pays
In the EU the main principle to cover the costs of an improved environment is that the polluter pays. E.g. the households and industries discharging their sewerage to the sewerage system shall pay the construction and maintenance of the pipes and the WWTP.

International financing institutions are often willing to provide soft loans for the construction of sewage systems, WWTPs and sanitary landfills.

Many pollution problems are a result of inefficient practices in industries and agriculture resulting in waste of raw materials and energy. Often reducing the environmental impact of an enterprise or a farm will result in an improved economic performance.

The data and information problem
Our work has clarified that many of the data, that are needed to produce the River Basin Management plan are not available. The lack of data and information to support the “expert judgement” (which is always needed during the elaboration of a RBMP) means that the present plan should be considered as a very first iteration of a RBMP for the Alazan/Ganikh basin piloting the WFD methodology.

The gaps in data and information include very little information on the economic activities in the basin, and very few data from the monitoring of the environmental situation.

Also there is a crucial lack of knowledge infrastructure (technical experts in all involved sectors with knowledge of the EU approach to water management and trained in integrated planning) needed to set up River Basin Management Plans in Azerbaijan.

1. Natural condition, general presentation of the basin

This chapter provides the background understanding of the situation in the basin (without any human activity and impact), needed to evaluate of the human impact and to design the measures with the aim to achieve good status of surface water bodies.

The Azeri part of the Alazani river basin is located in the North –Western corner of Azerbaijan at the south slope of the Greater Caucasus. The basin has borders with Georgia in the west and with Russia in the North.

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The length of the Alazan/Ganikh River is 413 km; the area of the basin is 12,080 km^2. 4,755 km^2 of the Alazan/Ganikh River basin is in Azerbaijan (equivalent to 5.5% of the total area of Azerbaijan) and 7,325 km^2 in Georgia. The Alazan/Ganikh River flows about 177 km on Azerbaijan-Georgia border and more than 200 km on the central part of the plain.

The main tributary to the Alazan River from east is called Ayri or Ayrichay and collects the water from the river network in this part of the basin before it flows into the Alazan River..

Figure 1.1 shows how the Azeri part of the Alazani/Alazan/Ganikh basin is placed in the north-western corner of Azerbaijan, bordering Georgia and the Russian Federation. The border to Georgia follows the Alazani/Alazan/Ganikh River.

Figure 1.1: **The Azeri part of the Alazani/Alazan/Ganikh basin with administrative units (rayons)**

1.1 Altitudes of the basin

The basin consists three main parts:

- The alluvial plain.
- The mountainous part.
- A hilly dry part in the southern area of the basin.

The alluvial plain is 10-15 km wide, and the elevation of the alluvial plain is 200-500 m. The alluvial plain is relatively flat created by the deposition of sediment over a long period of time by the tributaries coming from the High Caucasus, from which the alluvial soils on the plain forms. The alluvial plain is a region with little relief (local changes in elevation), yet with a constant but small slope.

In the mountainous part of the basin the elevation changes within 500-4200 m. A digital elevation map is shown in figure 1.2 and a map with contour lines in figure 1.3.

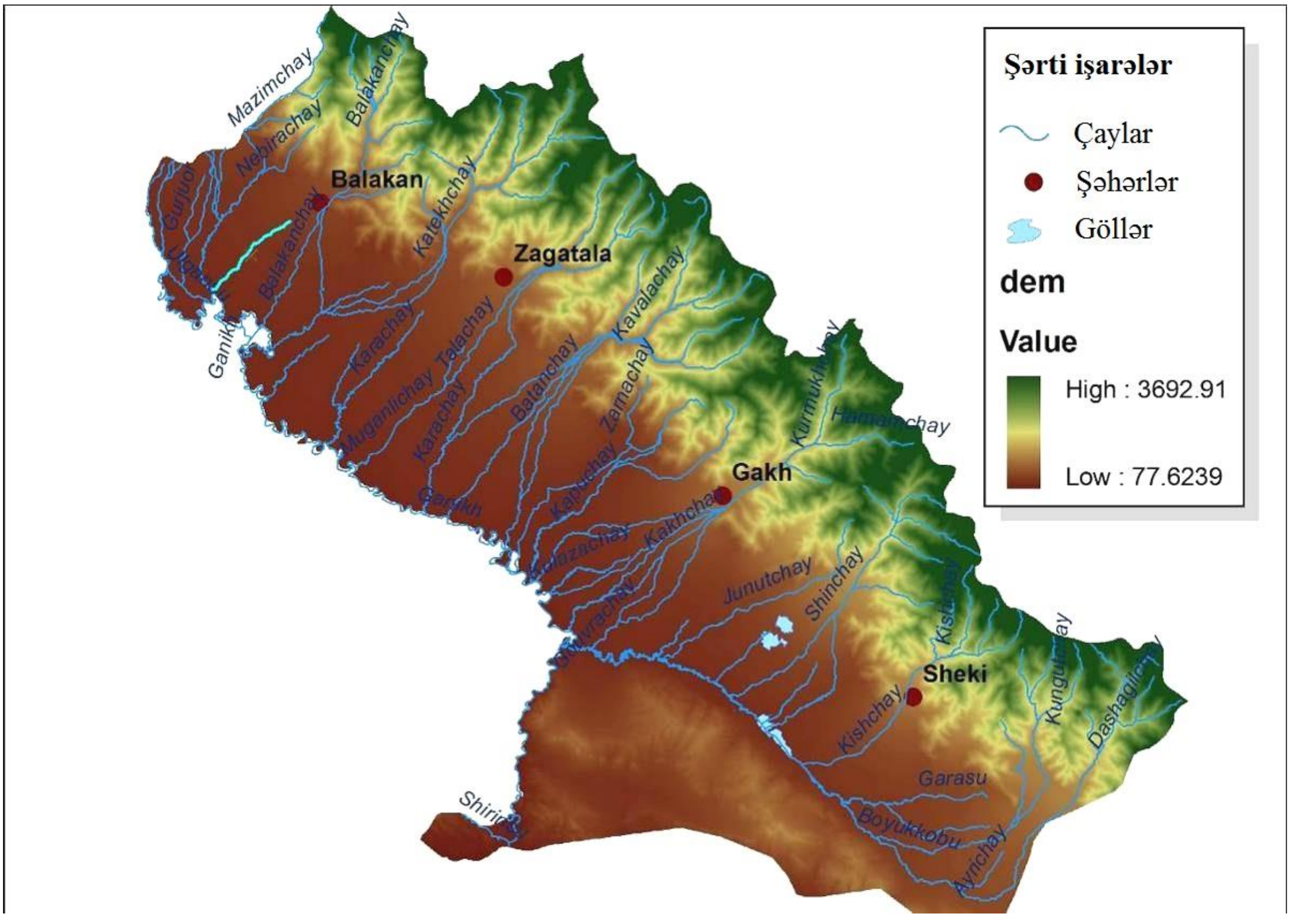

Figure 1.2: **Digital elevation map of Alazan/Ganikh river basin, with river network**

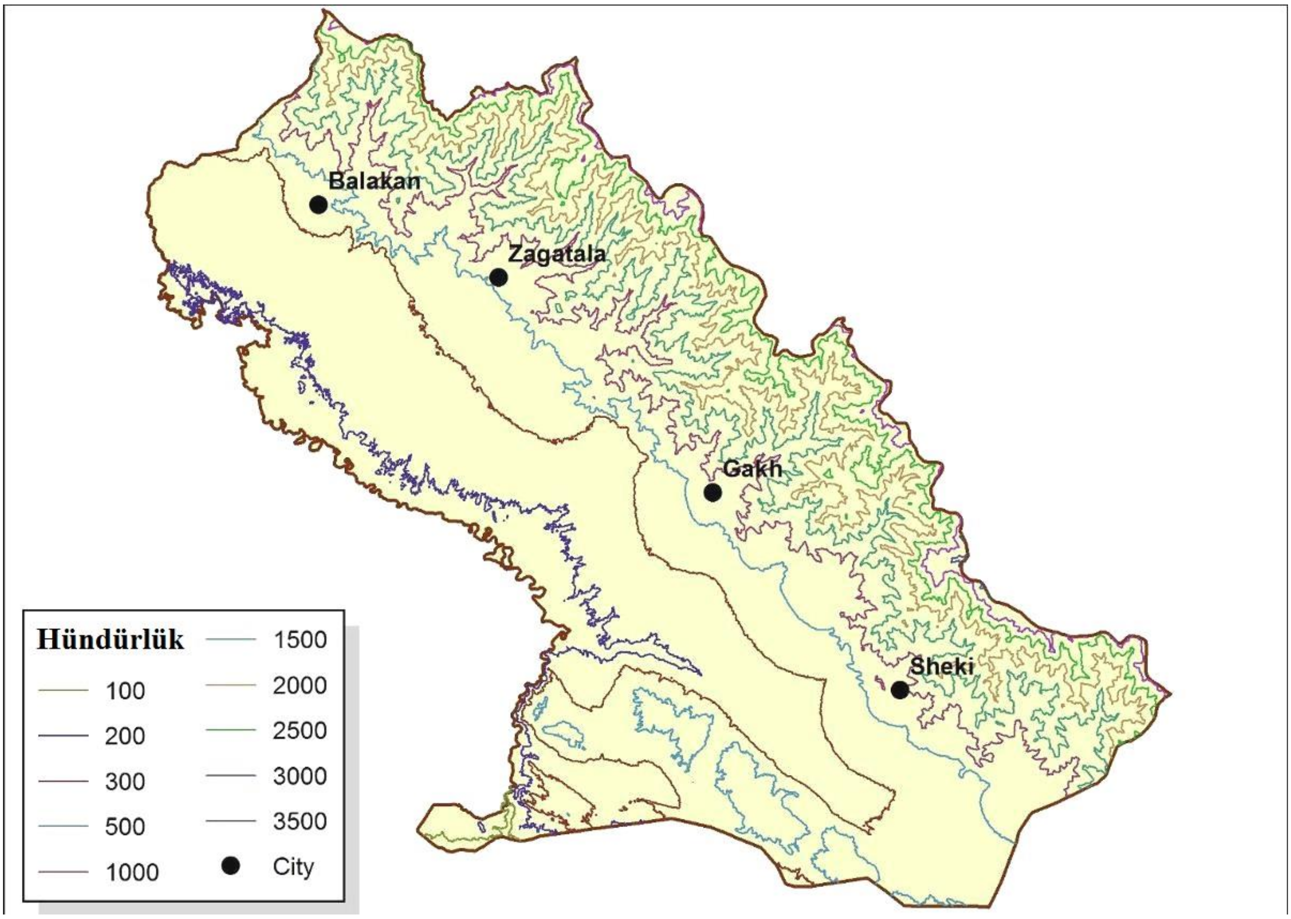

Figure 1.3: **Contour map of the Alazan/Ganikh river basin**

1.2. Climate and vegetation

The average annual temperature in the alluvial plain is 14 to16^{0}C while in the high mountains zone it is 0^{0}C. In the summertime the maximum temperature in plain is 37 to 40^{0}C, in the middle mountain is 27 to 30^{0}C, and in high mountains is 20 to 25^{0}C. In the wintertime the minimum temperature in plain is -14 to -18^{0}C and in high mountains it is -26 to -30^{0}C.

The potential evaporation is between 800 and 1000 mm in Alazan valley.

In Caucasus Mountains the maximum annual precipitation is 1400-1500 mm in the height of 2400 to 2800m. The average annual precipitation at different height intervals is shown in table 1.1.

Table 1.1:
Precipitation at different height, mm/year

Height from the sea-level, m								
200	600	1000	1500	2000	2500	3000	3500	4000
440	750	980	1200	1340	1400	1380	1270	1080

There are big differences in elevation, temperature and precipitation from the high mountains in the northeast to the alluvial plains in the southwest. These differences are reflected in similar big differences in the natural vegetation in the Alazan basin. From northeast (high mountains) to southwest (alluvial plain) the natural vegetation changes from mountain tundra via alpine meadows, oak and hornbeam forests to meadow plants mixed with bushes. The hilly south part of the basin, with low precipitation, high evaporation and no rivers from the mountains, is dominated dry steppe, see figure 1.4 and 1.5.

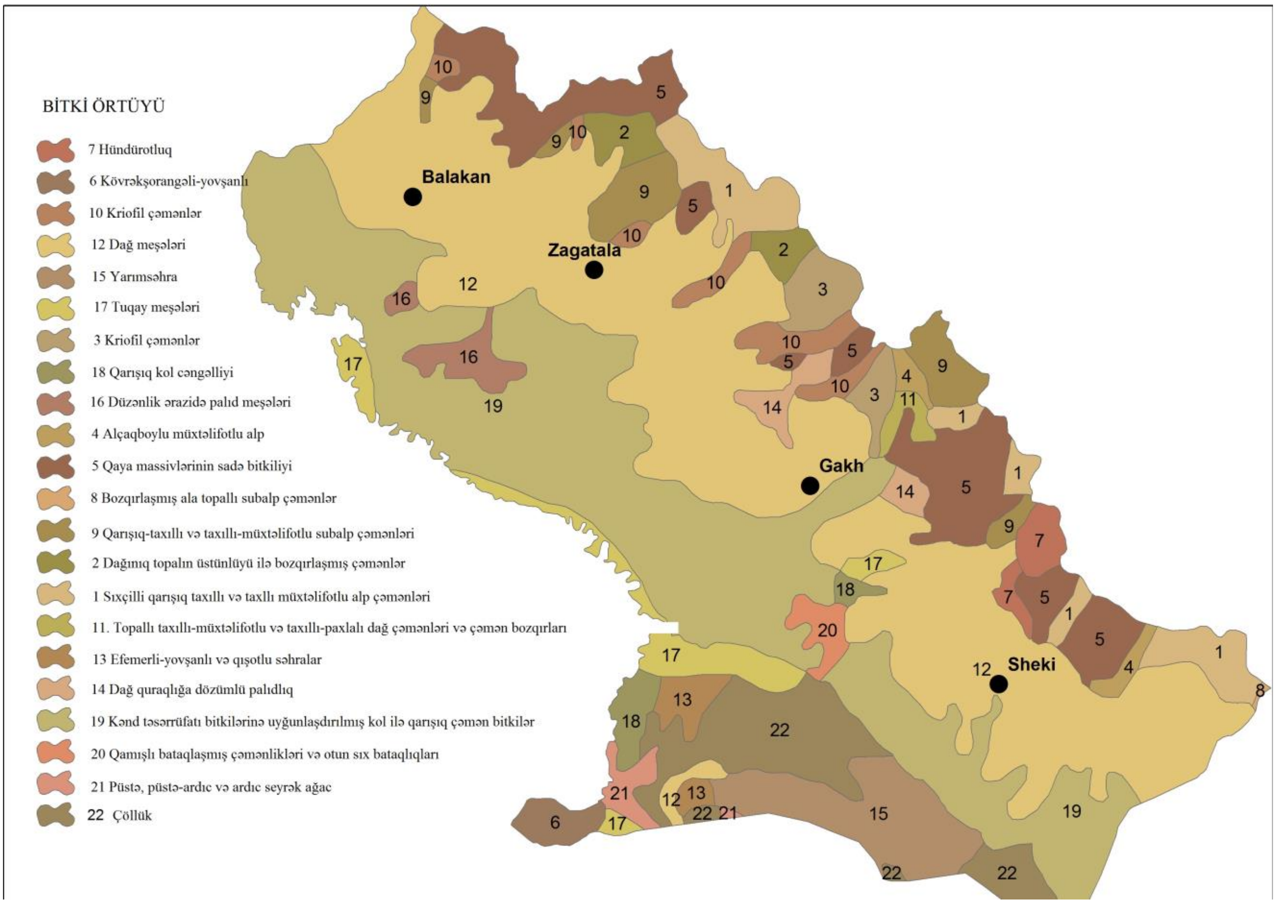

Figure 1.4: **The vegetation of the Alazan/Ganikh basin** .

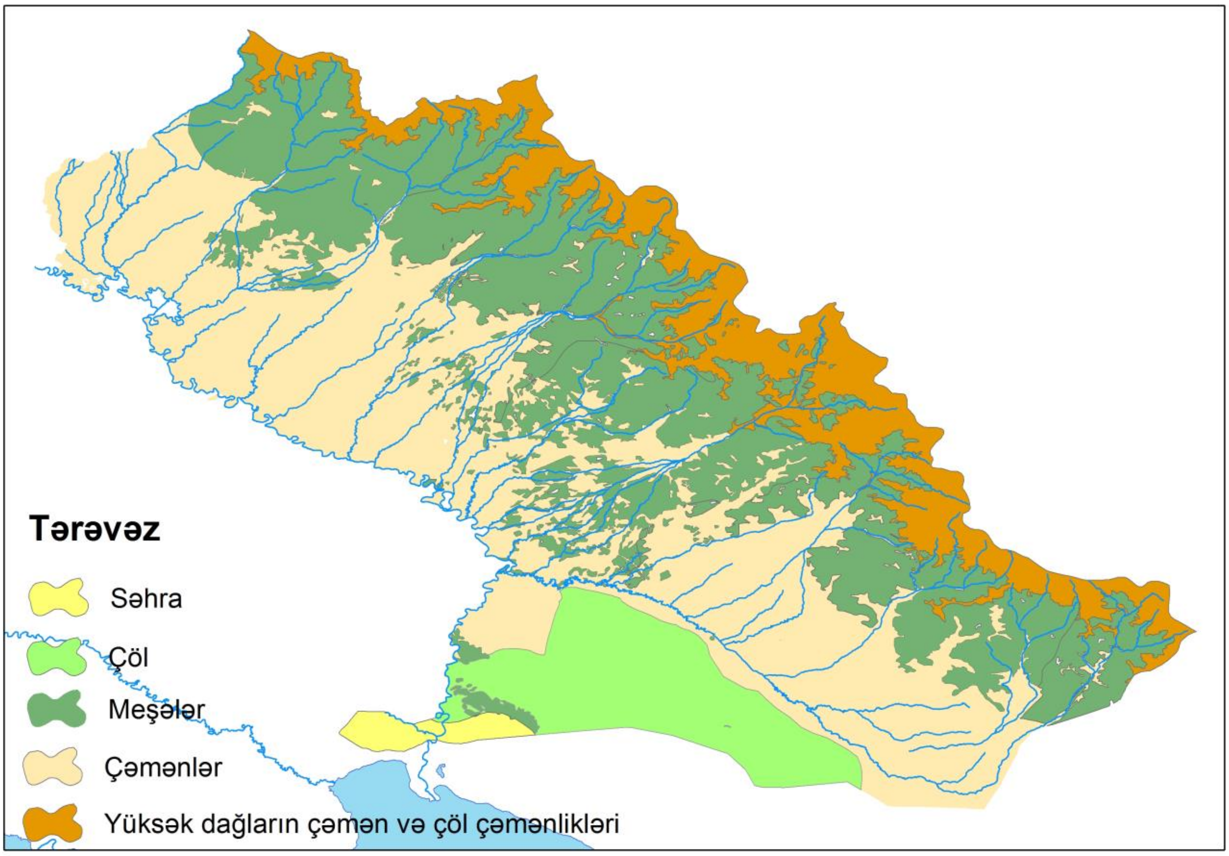

Figure 1.5: **The vegetation types of the Alazan/Ganikh basin (from Atlas of State Land and Cartography Committee of Azerbaijan 2010).**

Figure 1.5 shows that the low mountain zone is dominated by mountain forest and the alluvial plain by meadow plants mixed with bushes. In the dry southernmost part of the vegetation is dominated by semi desert and steppes.

1.3. River network

Figure 1.2 shows the river network. When the rivers from the mountains enters the floodplain they create a kind of inland delta, where the main river coming for the mountains branch out into several streams, one of them typically carrying the main part of the river water. As shown in figure 1.2 there are no permanent rivers in the dry southernmost part of the basin with low precipitation, high evaporation and no rivers from the Caucasus Mountains crossing.

The main tributaries of the Alazan/Ganikh River is shown table 1.2.

Table 1.2:
The main tributaries of Alazan

№	Name of river	Length of river, **km**	Area of the basin,**km²**
1	Balakan river (Balakanchay)	39	320
2	Katex (Katekhchay)	54	620
3	Tala (Talachay)	40	410
4	Kara (Karachay)	56	572
5	Kurmukh (Kurmukhchay / Kakhchay)	55	562
6	Shin (Shinchay)	39	306
7	Kish (Kishchay)	33	265
8	Ayrichay / Dashagilchay	134	1810

Figure 1.6 shows the basin divided into subcatchments.

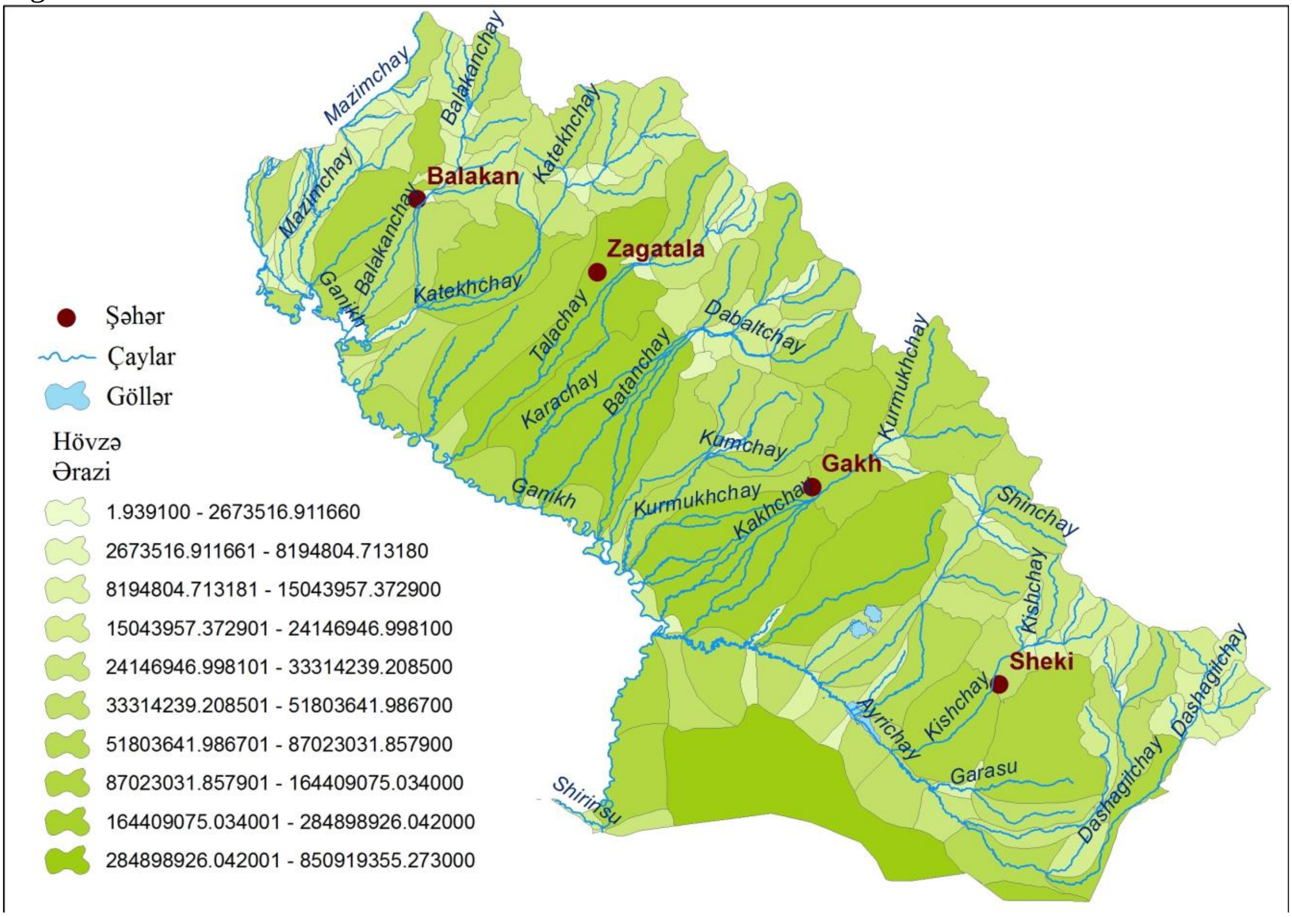

Figure 1.6: **The Alazan/Ganikh river basin, with river network divided into subcatchments**

The floodplain area or inland delta of the major tributaries is shown in table 1.3.

Table 1.3:
The floodplain part of the catchment of the major tributaries

№	Rivers	Floodplain part of catchment, km^2
1	Balakan	28
2	Katekh	12
3	Tala	31
4	Karachay	37
5	Kurmukh	36
6	Shin	68
7	Kish	31
8	Ayrichay/Dashagil (Upstream of Ayrichay)	170

The total area of the alluvial floodplain is 2013 km^2. Most the floodplain has fertile soil and drinkable resources of water.

1.4. River flow

Table 1.4 shows the yearly flow in m^3 pr. second of the main rivers in the basin as a mean over the period 1950 to 2007. Table 1.4 further shows the annual mean flow in the year with the flow close to average norm and also mean annual flow of the years with the lowest and the highest flow of that period.

Table 1.4:
Yearly flow and flow in the year with the lowest and the highest flow of the main rivers in the basin based on monitoring in the period 1950 to 2007, m3/s (some rivers have observation period for few years only within this period and flow is calculated for those years only)

№	Name of river	Water discharge in high flow year	Water discharge in low flow year	Average annual discharge
1	Balakan	9,0	3,3	5,6
2	Katekh	17,9	6,7	11,1
3	Tala	9,2	3,5	5,7
4	Karachay	5.3	0.6	2.2
5	Kurmukh	17,9	7,7	10,7
7	Kish (Tributary of Ayrichay)	5,8	2,4	3,7
6	Shin (Tributary of Ayrichay	9,1	3,8	5,7
8	Ayrichay	34,4	14,3	21,7
	Sum of tributaries of Ganikh in Azeri part of the basin (without Kish and Shin and small rivers where there is no flow information)	93.7	36.1	57
	Main tributaries in % of total flow	47.4	44.8	50.9
12	Ganikh	197,5	80,5	112,0

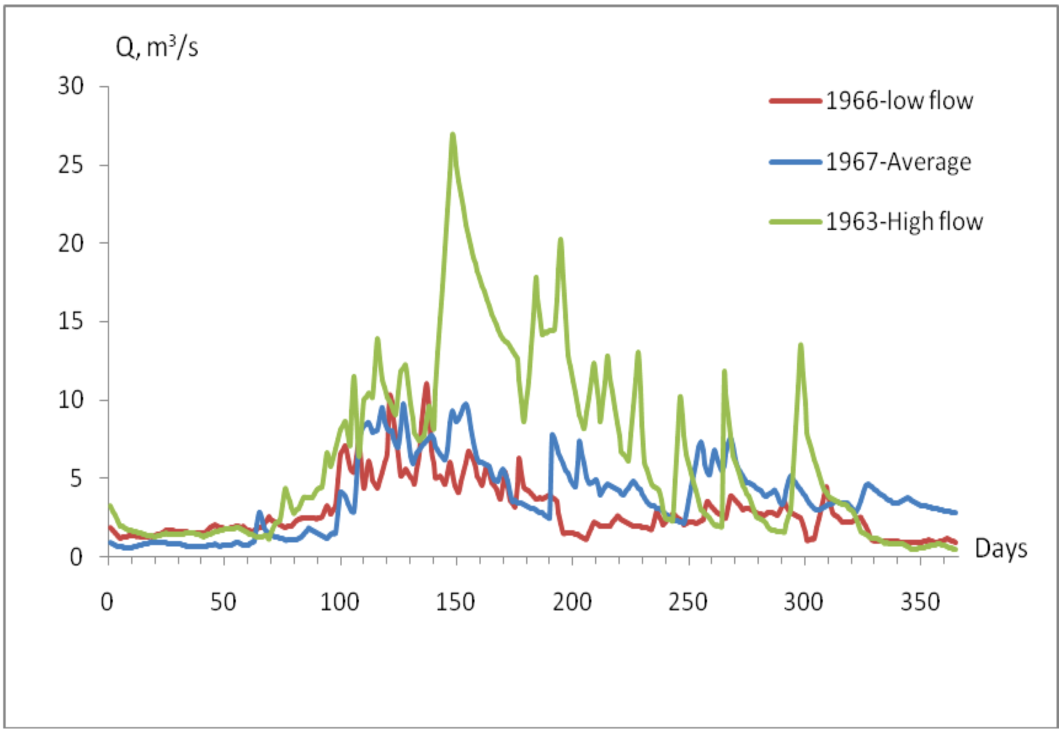

Figure 1.7: **The flow regime (hydrograph) of Tala (Talachay) River at the flow monitoring station in Zagatala for three years with different flow: a high flow year: 1963, a low flow year: 1966, and a year with yearly flow close to the average flow: 1967**

Figure 1.7 shows the flow regime of Tala River, one of the tributaries to Ganikh River.

The highest daily flow values typically occur in the spring and early summer. But in summer periods with heavy rain high daily flow values can also be monitored. The difference between the high flow year (1963), the low flow year (1966), and the year with yearly flow close to the average flow (1967) is mainly due to differences between the flow in the summer period as a result of differences between precipitation in the summer period.

2. Human activity

In this chapter we describe the present human activities in the basin as a basis for the evaluation in chapter 3 of their impact on surface waters.

2.1 Administrative units and population

Figure 1.1 and 2.1 shows the division of the basin into rayons (districts). The basin is dominated by Balakan, Zagatala, Gakh and Sheki rayons, but it also includes a small part of Oghuz and Samukh Rayons. Oghuz and Samukh Rayons are not included in the below calculations as they only occupy a small part of the basin, and these areas are not densely populated. Both Gakh and Sheki rayons stretches beyond the basin.

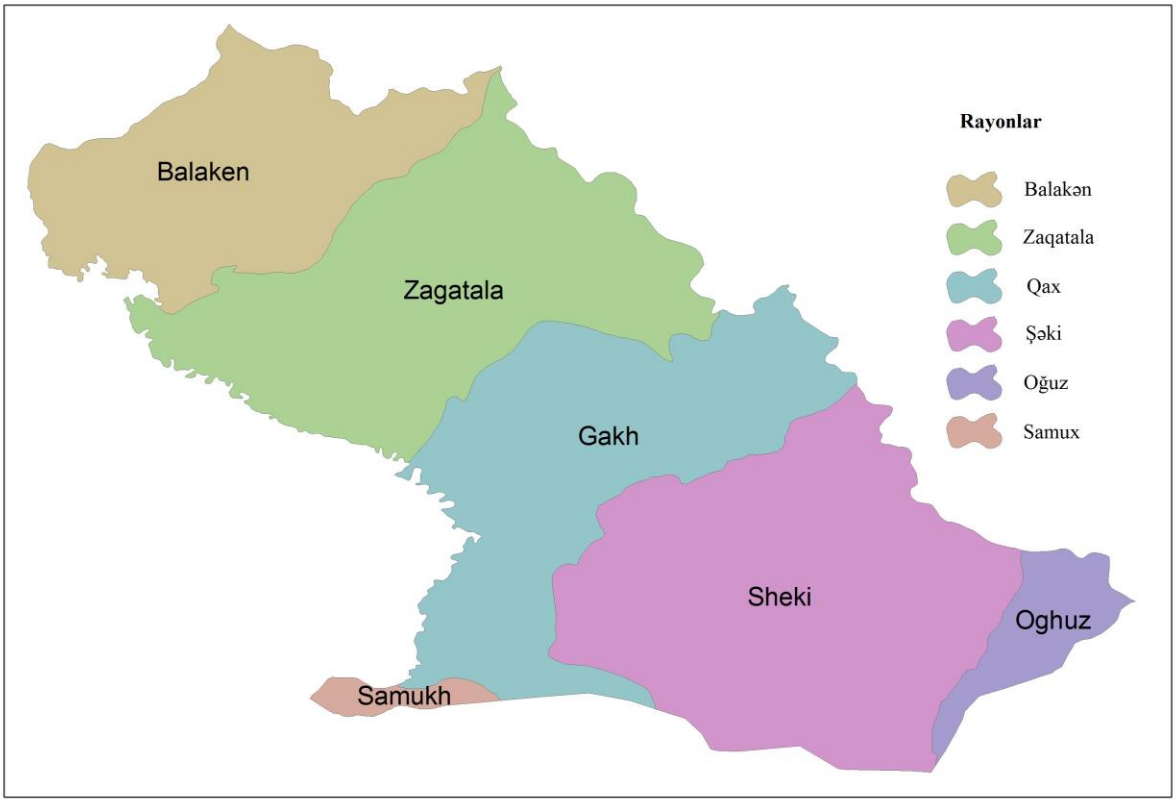

Figure 2.1: **The administrative units (rayons) of the Alazan/Ganikh river basin**

Nearly half a million people is living in the rayons of the Ganikh basin, or more precisely 425.700 or 4.9 % of the total population of Azerbaijan. Table 2.1 shows the distribution of the population.

Table 2.1:
Number of people living in the basin split on administrative units (rayons) and for each rayon inhabitants in the city and rural population (villages)

	Year										
Names of rayons	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008
Balakan	*70*	*79*	*84*	*85*	*85*	*86*	*86*	*87*	*87*	*87*	*88*
City	8	10	10	10	10	10	10	10	10	10	10
Villages	61	70	74	75	75	76	76	76	77	77	78
Gakh	*44*	*49*	*52*	*52*	*52*	*53*	*53*	*53*	*54*	*54*	*55*
City	11	12	12	12	12	12	12	12	12	12	12
Villages	33	37	40	40	40	41	41	41	42	42	42
Sheki	*139*	*153*	*159*	*160*	*161*	*162*	*163*	*165*	*166*	*167*	*169*
City	57	62	63	64	64	64	64	64	64	65	65
Villages	82	90	95	96	97	98	99	101	102	103	104
Zagatala	*93*	*103*	*108*	*109*	*109*	*110*	*111*	*112*	*112*	*113*	*114*
City	18	27	27	27	27	27	28	28	28	28	29
Villages	75	76	81	82	83	83	83	84	84	85	86

	Year										
Names of rayons	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008
Total	**346**	**383**	**403**	**405**	**408**	**410**	**413**	**416**	**419**	**422**	**426**
City	95	111	112	112	112	113	114	114	115	115	116
Villages	251	273	291	293	296	298	299	302	305	308	310

From table 2.1 it can be seen that more than two thirds of the population (approximately 72%) is living in the rural areas. I the period from 1990 to 2008 the population in the basin has increased by 19%. The population growth is decreasing, from 1.3% in 1995 0.8% in 2007.

In figure 2.2 the density of the population is shown by colours and all villages indicated. The highest densities are found in and around the 4 main cities: Balakan, Zagatala, Gakh and Sheki. These 4 cities are placed where the mountains meet the alluvial plain. But also the plain is densely populated, while there are relatively few villages in the mountainous area. The population density is also low in the dry hilly area is southernmost area of the basin.

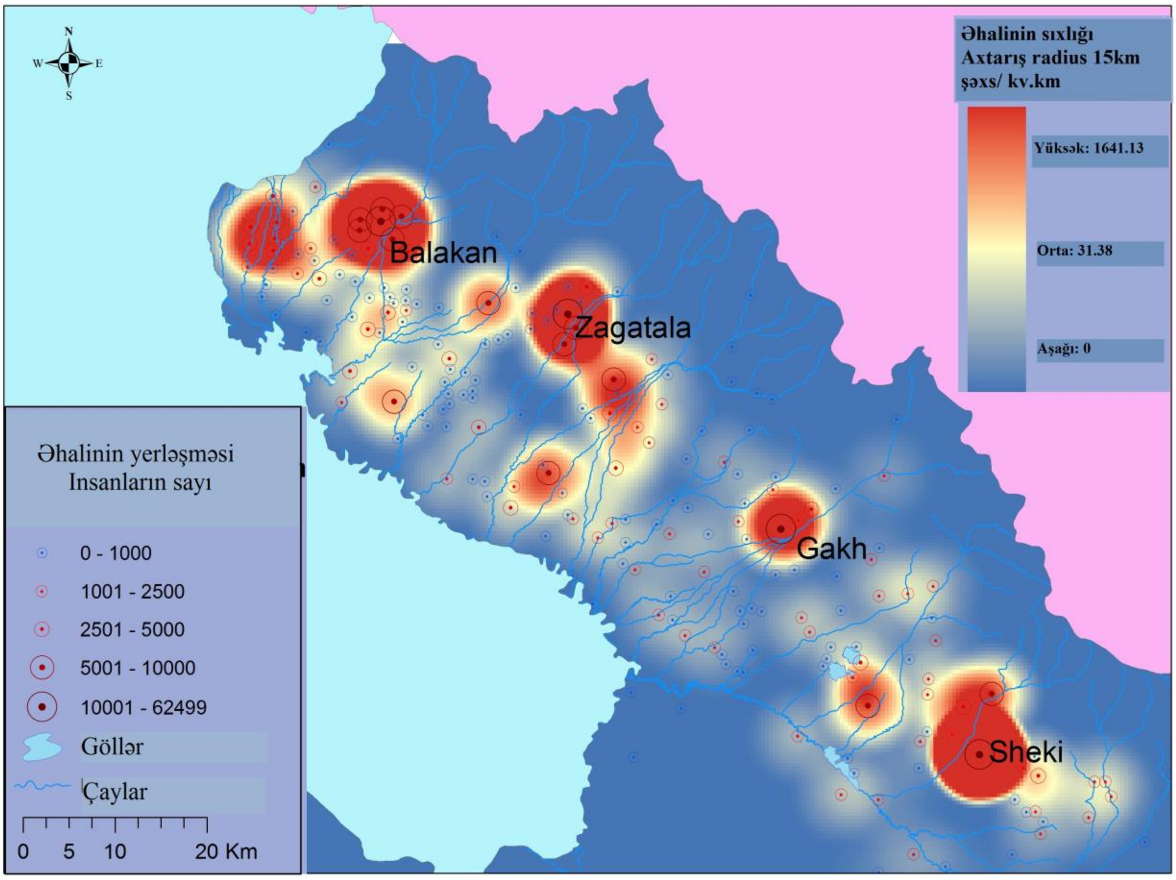

Figure 2.2: **The density of the population and villages of the Alazan/Ganikh river basin**

It is expected that by 2030 the total number of people in the basin will exceed 500 thousands. Water demand will raise both due to the population growth and due to the expected growth in income and this can be expected to affect the water supply situation and state of water resources in the basin and increase the need for IWRM in the basin.

2.2. Agriculture

Agriculture is dominating the economy and occupation in the basin.

Cereal grains including corn and wheat are important crops in the basin. Other important crops include sunflower, tobacco, mulberry for silk production, fruit and berry, wine and tea. The local honey is known across Azerbaijan.

In the following table of Azerbaijan State Statistic Committee the cultivated area in the 4 rayons is shown.

Table 2.2:
Cultivated area in the 4 main rayons, hectare - Azerbaijan State Statistic Committee

	Year						
Names rayons	2001	2002	2003	2004	2005	2006	2007
Balakan	9994	10124	9955	10050	10232	7959	9662
Gax	14058	16973	15881	16311	18343	15119	12946
Sheki	54833	57294	44710	58341	61453	59988	58435
Zaqatala	21058	23143	22837	25775	25474	22779	19585
Total	*99943*	*107534*	*93383*	*110477*	*115502*	*105845*	*100628*

Table 2.2 shows that Sheki rayon has more of half the total cultivated area of the 4 rayons. The data is not fully representative for the basin, as major part of Sheki rayon is outside the basin.

Livestock production is represented mainly by cattle, sheep-breeding, poultry-keeping, pig-breeding. Also bee keeping is an important economic activity.

Characteristic for the basin is sub alpine and alpine meadows, winter hut, long-term fodder crops and convenient natural climatic condition, which gives good conditions for of cattle-breeding.

Table 2.3:
Number of cattle in the 4 main rayons - Azerbaijan State Statistic Committee

	Year						
Name of rayon	2001	2002	2003	2004	2005	2006	2007
Balakan	33612	33991	34331	35258	35779	36741	37159
Gakh	33650	29800	26715	25144	26164	27060	27252
Sheki	53483	54158	56398	61133	64404	65423	71206
Zagatala	56500	56928	57183	57240	57282	57345	58241
Total	*177245*	*147877*	*174627*	*178775*	*183629*	*186569*	*193858*
Azerbaijan total:	*2,097,860*	*2,178,572*	*2,241,781*	*2,315,757*	*2,379,976*	*2,445,020*	-
% of AZ tot	8.4	6.8	7.8	7.7	7.7	7.6	

With an area of 14 % of the total area of Azerbaijan the basin has approximate 8% of the cattle of the country, table 2.3. There is a tendency to an increase in the number of cattle in the basin.

2.3. Industry, mining, raw materials

The industry in the basin is mainly based on agricultural production. At present 103 industrial enterprises is working in the 4 rayons of the basin. The industrial production is lower than before the collapse of the Soviet Union.

In 2000 the 4 rayons of the basin produced 2% of the total industrial production of Azerbaijan, but today the percentage is reduced to 0.3% and 15.4% of it falls to non-governmental sector. Also the number of workers working in the industry reduced from 2932 to 1730 person or 41% in the period from 2000 until today (data from Statistical Committee of Azerbaijan) which is connected with closing of old industrial enterprising and transferring of workers to agricultural activities.

Industry is represented mainly by food industry, light industry and construction enterprises. Food industry gives more than 70% of all industry production in the 4 rayons of the basin.

Meat, butter, cheese, fruit-vegetable, can factory, tobacco enterprises, different kinds of sweet enterprises represent food industry in the economical city centres. In last years production of non-alcoholic drink based on mineral waters, mineral and aerated water has increased.

In Zagatala rayon there is a tea factory, a tobacco processing plant, a large food combine and a silk cocoon drying plant.

There are good opportunities for increasing the production of building materials for construction.

The 4 rayons of the basin have opportunities to develop metallurgy and hydropower.

2.4. Hydropower and damming

Potential power of hydropower reserve in Ganikh river basin is 913 thousand kilowatt. And potential energy is 8 milliard kilowatt hour. But this energy almost is not used. Electricity is provided to all settlements by Mingechevir Hydropower Plant (HPP) situated on the Kura River. Only Sheki HPP is operational and 3 other HPPs on Ganikh river basin: Zagatala, Balakan, Gakh HPPs aren’t working.

Sheki HPS was built in 1936. Water is taken from Kish River. The capacity of the HPP is 1650 kilowatt; average annual long-term output is 6,30mln. kilowatt-hours. At present only one aggregate works in the station. This HPP provide nearly 500 houses with electric power.

Balakan HPP was built in 1925. At present it isn’t operational. Defined power is 280 kilowatt. Average long-term output is 1.32 kilowatt-hour.

Zagatala HPP was built in 1945 and stopped working in 15 August 1966. The capacity was 200 kilowatt and two aggregates worked. At present the building of station, water brought canal and other hydro technical installation are protected.

Saribash HPP is situated on the right branch of Kurmukh river-Kunakhaysu and its power was 1000 kilowatt and at present it isn’t operational. This HPP worked for a long time. After Mingechevir HPP was put into operation this and other little HPPs lost their importance.

At present there is Sheki HPP on Kish river-power is1660 kilowatt.

In future building of the following HPP is planned:
1. Ganikh HPP-200 thousand kilowatt.
2. Katekh HPP- 60 thousand kilowatt.

2.5. Waste disposal

Official (legal) waste disposal sites mostly are located near the cities in the Ganikh basin. In small villages in rural areas wastes are often disposed to surrounding areas.

The waste disposal of Balakan city is situated 2km south from city centre, 2.1 km from Balakan-Baku highway, and 400 m far from Balakan river deposit. Its area is 1 hectare. Its sides are fenced.

The waste disposal of Zagatala city works from 1950. Total area being 4 hectare, is situated in the south of city- on the left side of Zagatala-Danachi road far from settlement. Household wastes don't spread by the wind to the suburbs or is not taken away by the rain. But at present the waste does not have capacity to handle all household wastes from the area because of increasing of population.

The waste disposal of Gakh city is situated 2.5 km from city centre, on the right side of Gakh-Sheki road, and takes 0.15 hectare area called "Kilseburun" area. South side of waste disposal is isolated by mountain area, north side by a man-made trench.

The waste disposal of Sheki city is situated on the west flood-land of Kish River (5 hectare). The other part of the city disposes waste directly to the part of the river bed located in the city.

2.6. Car washing

Along the river banks in residential areas residents wash their cars in the river. Where there is access to shallow river sections for cars, people drive their cars into the river to wash them. This activity takes mainly place in the summer period.

2.7. Forest cutting

In Sheki region forests have been cut down legally and illegally. Now massive cutting of forest is stopped.

Some reforesting is also taking place. In the Gakh Forest Protection and Restore Institution in 2008 110 hectare cultural forest spring-autumn sowing and in 2009 48 hectare spring sowing was realized. In 2008 1.7 hectare, in 2009 1.8 hectare of sapling plantation was cultivated in Zagatala.

A Forest Protection and Restore Institution are situated in Zagatala.

In the first half of the current year 44 hectare of 125 hectare cultural forest sowing is fulfilled owing to spring sowing. The rest 81 hectare will be fulfilled in autumn. For this aim in 4.2 hectare saplings belonging to forest tree typing were begun to be cultivated, agro-technical service and protection which they need is realized.

In 1990 the total area of forest in Balakan was 358 sq. km. But in 2009 this number was reduced to 125 sq. km. In short period 232 sq. km forest area either was cut by breaking or this area or was taken out from national forest fund[2] and given to other organizations[3]. Instead in 2008 only 93 hectare forest area was planted in this region.

The total forest area in the basin was 178 sq. km or 24% of the basin area by the information of 90th. Now it is 148 sq. km (20% of the basin area), which means that about 20% of forest area is lost. The forest along the Ganikh River (Tugay forest) wasn't only cut but also damaged and destroyed and flooded.

2.8. Hydromorphological changes

Tributaries of Ganikh are the most flood and mudflow prone rivers of Azerbaijan, Floods and mudflow in rivers lead to destruction of infrastructure of surrounding territories, damage houses and agricultural areas. In order to minimize their negative consequences there are protective dams and other facilities located in the riverbanks.

Sections of Balakanchay, Talachay, Kishchay and other rivers are surrounded by dams within the areas of the towns and subject to hydromorphological changes.

There is a reservoir on Ayrichay River.

2.9. Mining

Mining activities are limited in Ganikh river basin even though the Sheki-Zagatala economical region is rich with the non-ferrous metals and raw material building resources.

Balakan-Zagatala ore region connecting Filizchay, Kasdag, Katekh, Sagator, Karabchay firestone-polimetal beds can be considered as perspective for mining industry.

Filizchay mining field is rich complex ore[4] and is the second richest bed in Eurasia. Ores of this bed contain such valuable elements as gold, bismuth, cobalt, potassium, selen, tellurium, copper, lead, silver and sulphur.

It is planned to attract industry exploration in Filizchay group beds. Initial calculations show that from this bed 25.4 thousand ton copper, 32.6 thousand ton lead, 80 thousand ton zinc, 1.05 ton gold, 85 ton silver and other non-ferrous and precious metals can be produced.

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[2] Forest fund is the forested area and belong to state property. There are also forests in the balance of Ministry of Agriculture.

[3] By decree of president area of Zagatala National Park was extended some areas have been taken from forest fund and connected to the new territory o National Park. Instead in 2008 only 93 hectare forest area was planted in this region.

[4] Complex ore is a soviet concept for an ore in which the principal valuable components are lead and zinc and the secondary components are copper, gold, silver, cadmium, bismuth, tin, indium, and gallium. In some complex ores, barite, fluorite, and sulfur associated with sulfide ores are of industrial value.

The basin is rich with clay, building stone, gravel, river stone and sand. Lime and lime stone resources is mainly situated on the foothills zone of the Caucasus Mountains, nearly 12% of all lime stone of Azerbaijan.

2.10. Trends in human activity

Population is increasing in the basin. Corresponding to that the volume of water used in the households, for irrigation, industry and drinking increases.

In the district centres of the region of the fertilizer storehouses are built and it means that usage of fertilizer can be expected to increase. The development of industry is weak. So there is les impact of industry on the river water.

Mining activities can also be expected to increase in the future.

Presently Sheki Silk Enterprises, milk and can enterprises are the most important industrial pollution sources. It is expected that major industrial evolution will take place in the basin in the near future.

Illegal forest cutting has descended and works on reforestation is carried out.

3. Pressures, nature of and how to assess the impact

This chapter discusses the impact of the pressures on water bodies of Alazan/Ganikh River basin. It is based on the description of human activities in the previous chapter. This chapter focuses on the assessment of the impact of each of the important pressures to make an expert judgment if it is significant or not.

The following pressures are selected for impact evaluation based on the description in chapter 2:

- Water abstraction for irrigation and household use
- Household wastewater
- Agriculture, crop production
- Agriculture, livestock production
- Industry, non-food production
- Car washing in rivers
- Industry, non-food
- Deforestation
- Hydromorphological changes
- Solid waste disposal

For each pressure it is concluded whether it is significant or not. A pressure is considered significant, when it on its own, or in combination with other pressures, leads to a failure to achieve the objective specified in the WFD (good status for the water body).

Identification of water significant pressures has to be based only on some knowledge of the size and impact of pressures and the vulnerability of receiving waters as very few monitoring data for the water bodies impacted by the pressure are available.

This chapter and the following chapters, evaluating the human impact on the rivers (water bodies) in the Alazan - Ganikh basin and proposing measures to improve the situation, needs to be more detailed and substantiated before it can be seen as a River Basin Management Plan that fulfils WFD/EU requirements.

The present draft plan is intended:
The present draft plan is intended:

- as an input to discussions on the present situation in the basin, where water quality problems are and what needs to be done to improve the situation,
- as an input to the design/update of monitoring programmes
- to give some guidance on what kind of pressure data that is needed in order to establish a targeted and cost-effective programme of measures.

As the purpose of the report is to pilot the WFD approach for setting up River Basin Management Plans, we have used the advice given by EU water directors in relation to the characterisation of river basins in line with the WFD: “Lack of data is not an excuse, demonstrate that you tried”.

3.1. Water abstraction

Irrigation has a long history in the Ganikh basin. Irrigation became more intensive from the second half of 20th century and irrigated areas in the river basin increased significantly in a short time.

At present irrigated area is 140 thousand hectare or ca. 30% of the total area of the basin. In 1950 the irrigated area was only 50 thousand hectare and which had grown gradually during and after the end of the Soviet period. This shows strong development of agricultural activities in the region as result of increase of population and also demand for agricultural products. Water use for the purpose of irrigation can accordingly be expected to increase in the future do to the population increase in the basin and in Azerbaijan as a whole.

The intensive development of irrigation in the basin (incl. its Georgian part) and deforestation have influenced the hydrological regime of the rivers of the region. Calculations indicate that in 1970-1986 the annual flow of Ganikh River decreased with approximately 9-11 m^3/s. In the following years descend of annual flow continued and reached 17 m^3/s in the station in Ganikh 1.7 km below the Ayrichay mouth.

People use water of Balakan and Katekh Rivers in **Balakan rayon** both for irrigation and for drinking. As no artesian nor subartesian well is drilled near the river, people use water from the river for drinking by filtering it.

Annually based on the official information provided in hydrological annual reports and water Cadastre of Azerbaijan only 16 mill. m^3 water are used for irrigation from Katekh, Balakan and Mazim rivers. (From Katekh river 4.2 mill. m^3 or 1 % of the average annual flow, from Balakan river 8 mill. m^3 or 5 % of the average annual flow and from Mazim river 3,8 mill. m^3 or 4 % of the average annual flow).

Much less water is used for drinking purposes than for irrigation. The villages abstract water for irrigation purposes through small canals and people use it based on queue principle.

Information about quantity of water taken from rivers of **Zagatala rayon** given in annual hydrological reports and also by reports of Amelioration JSC (The reliability of information isn't good as not all water intakes, including by individuals are taken into consideration):

For irrigation of agricultural lands:

1. For irrigation from left bank of Katekh river (rayon border) during a year -3,081 thousand m^3 or 1 % of the average annual flow,
2. From Tala river-5,903 thousand m^3 or 3 % of the average annual flow
3. From Mukhakh river-15,097 thousand m^3 or 5 % of the average annual flow.
4. From Qarasu-32,346 thousand m^3

Total -56,427 thousand m^3.

The water is mainly taken from Kurmukh River for irrigation in **Gakh rayon**. Water for irrigation is also abstracted from other small rivers. So 30,1 mln. m^3 water is taken from Kurmukh River or 9 % of the average annual flow, 46 mln. m^3 water is taken from other rivers in a year. Besides it is registered that 32 subartesian and 34 artesian wells are used for irrigation.

In the region for irrigation purpose 125,305 thousand m^3 water or 18% of the average annual flow is taken from Ayrichay and Shin rivers in the **Sheki Rayon**.

As large rivers, small and middle rivers are also used for main fields of economy-irrigation, industry and for households.

Increasing of the quantity of water abstracted for irrigation causes strong changes in the regime of water.

The main influences of human activity on Ganikh river basin (pressures) are followings:

- Changes to the natural flow regime of the rivers; including artificial drying of rivers as result of significant water intake;
- Deterioration of water quality and ecological condition;
- Construction of reservoirs (Ayrichay), canals and river bank alteration (within residential areas).

Conclusion

Water abstraction for irrigation and household use is considered a **significant pressure**.

3.2. Household wastewater

The Balakan River is clean when entering **Balakan city**, but after passing the city it gets polluted by discharge of the household solid wastes and wastewater.

5 storey buildings situated in the south of the bridge on Balakan River are not connected to the main sewer so waste water is flown to the dig wells only 10 metres far from right bank of the river from where it flow directly into the Balakan River.

A waste water treatment plant and a main sewer were built in the early 60ties, 4 km from north-west of city centre.

As the main sewer, which passes near Balakan River, is destroyed untreated waste water enters the river.

In 1965 waste water treatment plant and precipitation ponds were built for cleaning waste water from water of **Zagatala city**. It is now out of use. The main sewer has been under corrosion, it is often clogged.

Sewage system in **Gakh city** centre was built in 1970. The city centre does not have a sewerage system. The system is mainly considered for usage of central hospital. At present the waste water treatment plant does not work.

There is a waste water treatment plant for **Sheki city** (population 30,000) situated in the north of the city. It was built in 1963 with a monthly capacity is 36.95 thousand m^3. Another waste water treatment plant for Sheki was built in 1980 south-west of Sheki with a projected monthly capacity of 36 thousand m^3.

Waste waters per administrative rayons are given in table 3.1.

Table 3.1:
Waste waters discharged per administrative regions of Ganikh river basin (million cubic meter),by the information of State Statistical Committee. (The sign: - means that no data is available)

	year		
Rayon	2000	2005	2007
Balakan	-	-	0.5
Gakh	-	0.5	0.6
Sheki	0.3	0.4	0.5
Zagatala	0.2	0.6	0.6
Total	**0.5**	**2.5**	**2.2**

Table 3.1 indicates that the amount of waste water produced in the 4 rayons has increased in the period 2000 to 2007 probably due to increase of water use by population and enterprises (which wasn't active before 2000). Information from Balakan isn’t complete.

Waste waters also in some places are discharged to pits and affects ground waters.

People living in villages along the river discharge their household waste water to pits or the river without treatment. None of the villages has sewerage systems.

Hot hydrogen-sulphide water of Hamam River is used in bath house by people in summer and the Hamam River is polluted with the waste water from the bath houses. The most polluted part of the Hamam River is the section passing in Ilisu village, where the residents living along the river also discharge waste water.

Kurmukh River itself is polluted by the people living along Gaxbash village.

Conclusion
Discharge household waste water from villages along the river is considered a **significant pressure**.

3.3. Agriculture, crop production

At present farmers use fertilizer and probably to some extent pesticides as well (there is no concrete information about the use of pesticides). By information of local population last years mainly are used fertilisers rather than pesticides.

Generally, from 1992 pesticide has not been brought to the region from outside and there is no data on its application. The activity of former 'Chemical Union' (a state company who provided agriculture with fertilisers and pesticides) has been stopped since that time. There are no stockpiles of pesticides left from soviet times.

Bringing fertilizer and pesticides to the basin agriculture is done partly by the commercial organization "Agrolising" and partly by farmers.

At present a fertilizer storehouse capacity 50000 ton is being built in Sheki. Till present sorts of fertilizer of nitrogen, phosphorus, ammonium were used. At present people mainly use selitra fertilizer (Ammonia nitrogen). This fertilizer is bought from shops and is mainly used when the weather is dry.

The use of fertilizer and pesticide, so there is anthropogenic influence on the quality of river water. We must take into consideration that, in the centre of region fertilizer storehouse are being built and it means that year by year usage of fertilizer in agriculture will increase.

Conclusion
Loss of pesticides to surface waters by surface run-off etc. is considered a **significant pressure**.

3.4. Agriculture, livestock production

People usually use manure as fertiliser as a source of nutrients for crops. Some times manure is also disposed to near located river by residents. Livestock mainly belong to small farms and individual persons.

Conclusion
Live production and handling of manure from livestock is **not** considered a significant pressure.

3.5. Industry, food production

Processing of livestock products includes: meat, milk, cheese and butter. There is no special treatment facility for these enterprises/activities and the waste water enters to existing city sewage system or is discharged in near located water objects or into pits

Some industrial enterprises and also food producing facilities located in **Balakan city** discharge untreated waste water to the river. Most of the enterprises working in Soviet period (hazel, tobacco, fermentation and canneries) are no longer working.

The waste water of cannery situated 0.5 km down from **Zagatala city** is discharged to Tala River.

The waste water of milk plant situating 0.3 km down **Gakh city** is discharged to the Kurmukh River.

Conclusion
Waste water from food production industry is **not** considered a significant pressure.

3.6 Car washing

Along the river banks in residential areas residents wash their cars in the river. During this process oil products and petrol enter into water and their concentration in river waters increases. This mainly takes place in warm period of the year leading to an increase in the concentration of oil products.

Conclusion
Car washing in rivers is considered a **significant pressure**.

3.7. Industry, non-food

Untreated waters of 'Sheki-Silk' OSS, canneries, other industry enterprises, hospitals, educational centres, commercial organization, etc. make up annually 429.74 thousand m^3.

Dirty water of Sheki oil base and from residential areas located along Ayrichay and its tributaries is discharged directly to the river or to the branches of Ayrichay.

Conclusion
Pollution by industrial enterprises (Sheki silk company, cannery and other enterprises in Sheki) is considered a **significant pressure**.

3.8. Deforestation

Forests in the upper and approximately middle part of the river basin had been intensively cut in the 90ties after the collapse of the Soviet Union. Theoretical this causes some changes in the flow regime of the rivers: maximal water flow increases, and minimal water flow decreases. This has also happened in Ganikh River basin as well. The amount of water from springs decreased, and some of them dried out. As erosion process has become stronger in the deforested areas, the content of suspended solids in the water has increased.

Conclusion
Deforestation is considered a **significant pressure**.

3.9. Hydromorphological changes

Hydromorphological change of river beds in cities and villages and also the building dams lead to change of ecology of the river[5].

Conclusion
Hydromorphological changes are considered a **significant pressure**.

3.10. Solid waste

Household wastes are dumped from 3 different sides near Zilban village (located in the right bank of Ziban river). Ziban river is a small tributary of Tala river. Tala River than passes Zagatala city, from where also wastes also is disposed into it.

Household wastes pollute both banks-right and left one of branches of the river passing approximately 1 km through city.

Household wastes from settlements situated along the river are dumped to the river and the riverbanks, from where it enters to the river during high flow periods.

Conclusion
Solid waste disposal is considered a **significant pressure**.

3.11. Summary: list of significant pressures

As was determined above the significant pressures in the river basin are followings:

1. Water abstraction for irrigation (Surface and ground waters)
2. Deforestation
3. Solid waste disposal
4. Car washing in rivers
5. Discharge of waste waters from residential areas to rivers
6. Hydromorphological changes
7. Pollution by pesticides and fertilisers from agricultural fields

According to the above described significant pressures following impacts can take place:
Re. 1: Water scarcity and decrease of water discharges till the values below environmental flow. In summer some of rivers may dry as result.
Re. 2: As it is well known the deforestation lead to soil erosion and also reduction of infiltration of surface waters to ground, which results in reducing of water discharges in low flow periods
Re. 3, 4 and 5: Discharges of untreated waste waters and solid wastes and car washing in the rivers (when oil product directly may enter into river) lead to deterioration of quality of waters in the rivers
Re. 6: Morphological changes lead to significant deviation of ecological status of rivers compared to background conditions. For example fishes can't migrate because of reservoir construction on Ayrichay. Covering of river banks with concrete impacts the flora and fauna of the river.

[5] The concept of HMWB of the WFD is designed to address this situation. If a water body is designated as HMWB, it means that the hydromorphological change does not need to be addressed in the programme of measures.

Re.7: Water is polluted by organic chemicals entering from agricultural fields. This leads to damaging of river ecosystem and has negative health effect.

4. EVALUATION OF DATA FROM ENVIRONMENTAL MONITORING

The important precondition for the development of the river basin management plan (RBMP) is the availability of sufficient and trustworthy data required (i) to support identification and quantification of the impacts on the water bodies in the river basin, (ii) to characterize the state of the water bodies and identify water bodies at risk, (iii) to define the environmental objectives, and (iv) to verify whether or not the environmental objectives are met.

There are limited water quality and water quantity monitoring data available for the Alazan/Ganikh river basin as well as for the other four selected pilot river basins (Debed/Khrami, Aghstev, Aragvi and Ganjachay). Both the quality and the amount of the data available are far from sufficient to be able to adequately characterize the water bodies and determine the water quality status class to fit the requirements of the EU Water Framework Directive (WFD).

The main objectives of this section (Section 4) are:

- (i) to evaluate the existing monitoring data against the WFD requirements to identify the major gaps/deficiencies; and
- (ii) to illustrate the way how the existing data can be used in the WFD methodology context to make a judgment about the water quality status class using the modified ICPDR approach.

4.1 Biological monitoring of water quality

Biological monitoring of river water quality has never been undertaken the Alazan/Ganikh River basin as there has never been, and still there is no regulatory requirement for that. As the result neither institutional capacity nor technical expertise for biological monitoring has ever developed. Consequently, there is no baseline ecological data, no data to help to define ecological quality objectives, and no capability to generate such data in the short to medium term (3-5 years). Non-existence of the biological quality elements does not allow calculation of the Ecological Quality Ratios to define ecological quality status class of water bodies in the Alazan/Ganikh River basin. On the other hand, when sufficient physico-chemical quality elements are available and the data are trustworthy, it is possible to make a provisional assessment of the chemical quality status.

4.2 Chemical monitoring

For the assessment of the surface water quality the datasets from the national water quality monitoring database were used. The data were provided by the Ministry of Ecology and Natural Resources of Azerbaijan.
Nowadays, six surface water quality monitoring sites in the Alazan/Ganikh River basin are operational (see Map 4.2 below). The water samples for chemical analysis are being taken monthly.

About 40 physico-chemical elements are routinely measured to characterize the following conditions:

- Thermal condition
- Oxygenation conditions
- Acidification status
- Nutrient conditions
- Heavy metals

Specific organic substances like PAHs, pesticides, PCBs are not monitored at present in the framework of the national water quality monitoring programme. On the other hand, some grouped substances as Phenol Index, petroleum substances and surfactants are monitored but those water quality elements were not used for the assessment of the chemical quality status *(note: in the EU WFD are defined only single chemical substances to be monitored and used for the assessment of the chemical quality status).*

The concentration of chemical substances in surface water is influenced by both natural conditions and human activities. As it was described in Chapter 1 and 2, there is a spectrum of both natural conditions (geological, hydrological, precipitation) conditions and human activities to drive changes in the concentration of chemical substances. Based on the knowledge about the human impacts in the catchment area, it seems that the surface water quality is mainly determined by the oxygenation conditions (mainly influenced by the degradable organic pollutants originating predominantly from untreated household waste waters), nutrient conditions and the levels of heavy metals. Selected physico-chemical quality elements to determine the chemical quality status are presented in Table 4.1.

Table 4.1:
Selected physico-chemical quality elements

Component	Quality element	*Unit*
Oxygenation Conditions	BOD_5	*mg/l*
	O_2	*mg/l*
	NH_4	*mg/l*
Nutrient conditions	NO_3	*mg/l*
	PO_4	*mg/l*
Heavy metals	Cd	*μg/l*
	Cu	*μg/l*
	Pb	*μg/l*
	Ni	*μg/l*
	Zn	*μg/l*

A tentative assessment of the surface water quality status in the Alazan/Ganikh River is based on the datasets reported by the Ministry of Ecology and Natural Resources from the years 2008 and 2009. It was not possible to use the data reported prior to 2008 as these were inconsistent, showing big gaps and lacking details regarding analytical errors (e.g. detection limits, uncertainties)

4.2.1 Background concentration calculation

It is important to know the background (natural) concentrations of heavy metals in the river in order to assess the contribution of human activities into the total heavy metals load detected. Background concentrations were calculated using the statistical method based on theoretical log-normal distribution defined by two parameters (mean value μ and standard deviation σ). The following steps were conducted to calculate the background concentrations:

1. The Alazan/Ganikh River, 1.7 km from the mouth (Sampling site Ayrichai) was selected as a location, where concentrations of heavy metals were available from the independent source, the earlier NATO for Peace Project (*SfP Programme, Project: 977991 SfP"* www.kura-araks-natosfp.org/data) monitoring programme run from 2004 to 2007,
2. The whole data set was used to calculate statistical parameters,
3. One value, close to "0" was added to the original data sets (detection limit divided by 100),
4. All values in the data sets were re-calculated as log-values,
5. Both mean value μ and standard deviation σ are calculated from the log-values data sets to create the theoretical log-normal distribution functions,
6. Calculation of the given percentile in the range from 10 to 95-tile was done,
7. Estimation of the background concentration values was made from the log-normal probability curve, as percentile.

Following the above procedure the estimate of the background concentrations of heavy metals (Cr, Ni, Cu, Zn, As, Cd, Pb) in the Alazan/Ganikh River was made. The results are given in the Table 4.2 below.

Table 4.2:
Statistical characteristics of heavy metals concentrations for Alazan/Ganikh River used to estimate background concentrations

Parameter/Characteristic	Cd	Pb	As	Cu	Cr $_{total}$	Ni	*Zn*
Detection limit (µg/l)	*0,05*	*0,7*	*0,5*	*0,7*	*0,05*	*0,7*	*0,7*
Number of measurements	74	74	74	74	74	74	*74*
Mean (µg/l)	0,06	0,78	0,84	1,31	1,44	1,62	*13,0*
Maximum (µg/l)	0,1	1,2	1,4	3,2	2,9	3,9	*37*
Standard deviation (µg/l)	0,01	0,15	0,26	0,56	0,55	1,00	*8,6*
C40 (µg/l)	0,044	0,63	0,65	0,94	0,97	1,01	*8,0*
C50 (µg/l)	0,051	0,72	0,75	**1,12***	**1,21***	**1,25***	***9,8****
C60 (µg/l)	0,059	**0,83***	**0,88***	1,34	1,51	1,54	*12,1*
C70 (µg/l)	**0,068***	0,96	1,03	1,62	1,91	1,94	*15,1*
C95 (µg/l)	*0,13*	*1,73*	*2,03*	*3,52*	*5,06*	*5,00*	*38*

** Background concentration*

However, only concentrations of Cu were reported by the Ministry of Ecology and Natural Resources for the years 2008 and 2009, and they have appeared to be much higher than the calculated background concentration, but lower than the threshold value for good status (20 µg/l) as defined in the Technical Note "Water Quality Classification of the Surface Water Bodies in Pilot River Basin" (see Annex 1).

4.2.2 Determination of the water quality status class for the purposes of RBMP

As it was mentioned earlier, the water quality status class in the context of the EU WFD should be used to help to identify the water bodies at risk in the river basin and it should be based on the biological quality elements data. In the case of the Alazan/Ganikh River basin, there are only limited physico-chemical quality elements available, which were used to make a provisional assessment of the chemical quality status to facilitate discussion and to illustrate the RBMP methodology.

4.2.3 Scheme for determination of the water quality status class

The determination of the water quality status class of the Alazan/Ganikh River at six monitoring sites was done using the approach proposed in the technical note "Water Quality Classification of the Surface Water Bodies in Pilot River Basin" (see Annex ???). The approach is based on the modified ICPDR Classification system for oxygen/nutrient (with some corrections for dissolved oxygen) as presented below.

Table 4.3

ICPDR system to determine the water quality status class for oxygen/nutrient conditions (Source: TNMN Yearbook and database in 2006 (ICPDR 2008))

Quality classes*/ Parameters		**High**	**Good**	**Moderate**	**Poor**	**Bad**
Oxygen/Nutrient regime						
Dissolved oxygen	mg/l	8	6	5	4	< 4
BOD_5 (mg/l)	mg/l	3	5	10	25	> 25
COD_{Cr}	mg/l	10	25	50	125	> 125
Ammonium-N	mg/l	0,2	0,3	0,6	1,5	> 1,5
Nitrite-N	mg/l	0,01	0,06	0,12	0,3	> 0,3
Nitrate-N	mg/l	1	3	6	15	> 15
Ortho-phosphate-P	mg/l	0,05	0,1	0,2	0,5	> 0,5

In case of heavy metals, they have been subdivided into two groups. The first group included only heavy metals relevant for the Pilot River basin. The second group included heavy metals defined as Priority Substances under EU WFD in accordance with EC Directive 2008/105/EC on environmental quality standards in the field of water policy (see Table 4.4).

Table 4.4

Pilot River basin scheme to determine the water quality status class for heavy metals (total concentrations)

Quality classes*/ Parameters		**High**	**Good**	**Moderate**	**Poor**	**Bad**
Relevant substances per Pilot RB[a]						
Zinc	μg/l	bg[I]	100	200	500	> 500
Copper	μg/l	bg	20	40	100	> 100
Chromium	μg/l	bg	50	100	250	> 250
Arsenic	μg/l	bg	5	10	25	> 25
EU WFD Priority substances[b]						

	Unit	AA-EQS **	MAC-EQS***
Cadmium *(in dependence on the class of water hardness)*[II]	µg/l	≤ 0,08 (class 1) 0,08 (class 2) 0,09 (class 3) 0,15 (class 4) 0,25 (class 5)	≤ 0,45 (class 1) 0,45 (class 2) 0,6 (class 3) 0,9 (class 4) 1,5 (class 5)
Lead	µg/l	7,2	Not applicable
Mercury	µg/l	0,05	0,07
Nickel	µg/l	20	Not applicable

Source: [a]TNMN Yearbook and database in 2006 (ICPDR 2008) and[b] EC Directive 2008/105/EC for PS.

[I] bg – background/reference concentration

[II] Water hardness: class 1: <40 mg $CaCO_3$/l, class 2: 40 to <50 mg $CaCO_3$/l, class 3: 50 to <100 mg $CaCO_3$/l, class 4: 100 to <200 mg $CaCO_3$/l and class 5: ≥200 mg $CaCO_3$/l.

***AA-EQS – Average annual Environmental Quality Standard*

****MAC-EQS – Maximum annual Environmental Quality Standard*

The following steps should be followed to help decide about the water quality chemical status class:

1. Average annual concentration (AAC) should be calculated for each water quality parameter from the available data sets and for sampling site in the Alazan/Ganikh River basin.
2. Calculated AAC should be compared with the values in the scheme for oxygen/nutrient conditions and heavy metals (Zn and Cu) and put under water quality status classes.
3. If, the AAC is lower or equal to the 2^{nd} class (Good class), the sampling site for specific parameter is under good status. If it is not a case (AAC is higher to the 2^{nd} class), sampling site will be classified as failing to achieve good status.
4. For heavy metal that are identified as Priority Substances in EU WFD (Cd, Pb and Ni), AAC should be calculated for each heavy metal from the available data sets. *In case of concentration values of heavy metals below the detection limit, these should be used as 50% of the detection limit in calculating Average Annual Concentrations. If, there is more than 90% of measured concentration values below the detection limit the sampling site will be classified in class 1 for specific heavy metal.*
5. In case of Cd, it is advisable to consider water hardness as *mg $CaCO_3$/l*. Measured concentrations of Mg and Ca will be multiplied by 100,0872 that is M *$CaCO_3$* in g.mol^{-1} , and by coefficient 1,784 (that is ratio of M $CaCO_3$/ M CaO).
6. From the received classes of water hardness average annual water hardness should be calculated and used to decide about water quality status class for AAC for Cd. When applying MAC-EQS (Maximum annual Environmental Quality Standard), that water hardness class will be used, when maximum concentration of Cd was measured.
7. Calculated AAC for 4 heavy metals should be decreased by background concentrations (AAC – bg) and compared with AA-EQSs (Average annual Environmental Quality Standard), the same will be done in case of maximum concentrations, if applicable (compare with MAC-EQS).
8. If, the AAC is lower or equal to AA-EQS, the sampling site for specific heavy metal is in Good chemical status (achieving the Environmental Objectives as defined by EU WFD). If it is not a case, sampling site will be classified as failing to achieve good status.

4.2.4 Water quality status classes for the Alazan/Ganikh River

To illustrate the way how the existing data can be used in the WFD methodology context and to make a judgment about the water quality status class data from the Ministry of Ecology and Natural Resources for the years 2008 and 2009 were used and the following colours were used to characterize the state of the surface water:

Status	High	Good	Moderate	Poor	Bad

Results from the water quality status class determination exercise have shown that the Alazan/ Ganikh sampling sites corresponded to classes I (high status) and II (good status) for oxygenation conditions, nutrients conditions and Cu. Data on other four heavy metals were not available. The results are presented in Table 4.5.

Table 4.5
Results of the water quality status classes for the Alazan/Ganikh River (2008 - 2009)

Alazan/Ganikh River basin water quality status class for oxygen/nutrient regime (mg/l)								
River-Sampling Site	Year	Dissolved Oxygen	BOD_5	COD	Amonium-N	Nitrite-N	Nitrate-N	Ortho-Phospate-P
Alazan/Ganikh-Ayrichay	2008-2009	No Data	1,9	20,6	0,1	0,06	0,9	0,1
Belokanchay-Belokan	2008-2009	No Data	1,7	17,6	0,08	0,013	0,38	0,13
Katekhchay-Kabizdara	2008-2009	No Data	0,5	6,0	No data	No data	No data	No data
Talachay-Zaqatala	2008-2009	No Data	2,04	11,9	0,09	0,007	0,55	0,13
Gurmukhchay-Gakh	2008-2009	No Data	1,9	10,3	0,12	0,02	0,49	0,09
Ayrichay-Gipchaq	2008-2009	No Data	1,8	10,8	0,07	0,007	1,27	0,03

Alazan/Ganikh River basin water quality status class for heavy metals (µg/l)									
River-Sampling Site	Year	Zinc	Copper	Chromium	Arsenic	Cadmium	Lead	Nickel	Mercury
Alazan/Ganik - Ayrichay	2008-2009	No Data	14	No Data	No Data	No Data	No Data	No Data	No Data
Belokanchay-Belokan	2008-2009	No Data	16	No Data	No Data	No Data	No Data	No Data	No Data
Talachay-Zagatala	2008-2009	No Data	15	No Data	No Data	No Data	No Data	No Data	No Data
Gurmukhchay -Gakh	2008-2009	No Data	12	No Data	No Data	No Data	No Data	No Data	No Data
Ayrichay-Gipchaq	2008-2009	No Data	14	No Data	No Data	No Data	No Data	No Data	No Data

4.3 Hydrological monitoring

Hydrological regime of the catchment area is affected by several characteristics as precipitation, temperature regime, shape and density of the river network, length of the river, slope, soil conditions, hydrogeological conditions, vegetation, water reservoirs, river courses modifications and others. However, among the basic factors belong the climatic conditions as precipitation and evaporation. Hydrological monitoring would give the information on the hydrological regime of the river basin to support the biological quality elements when assessing the ecological status of the surface water bodies.

At present time, there is a network of nine hydrological stations in the Alazan/Ganikh River basin to carry out the hydrological monitoring. Water level is measured twice a day and river flow is calculated using the Q-H curve. Hydrometric measurements are conducted to update the Q-H curve. Information on location of the hydrological stations is given in Table 4.6 and on the map in figure 4.2.

Table 4.6
Operational hydrological stations in the Alazan/Ganikh River basin

№	Code	River-point	Latitude	Longitude	Location	Period of observation	Status by 2010
1	85287	Ayrichay-Bash Dashagil	47-25-00	41-12-00	122 km from river mouth	Since 1948	Operational
2	85290	Chkodurmaz-Mouth	47-18-00	41-16-00	0,4 km from river mouth	Since 1947	Operational
3	85291	Damarchık-Mouth	47-17-00	41-17-00	0,5 km from river mouth	Since 1947	Operational
4	85292	Gaynar-Mouth	47-15-00	41-17-00	0,5 km from river mouh	Since 1948	Operational
5	85288	Ayrichay-Mouth	46-45-00	41-17-00	Mouth,12 km down from Gipchag village	Since 1962	Operational
6	85282	Kurmukh-İlisu	47-03-00	41-28-00	0,5 km upper from Gakh city	Since 1937	Operational
7	85280	Tala-Zagatala	46-50-00	41-40-00	0,5 km upper from Zagatala city	Since 1948	Operational
8	85278	Balakan river-Balakan	46-26-00	41-45-00	0,5 km upper from Balakan	Since 1960	Operational
9	85258	Alazan/Ganikh-Ayrichay	46-43-00	41-16-00	0,7 km down Ayrichai flow in	Since 1950	Operational

Hydrological regime and river flow characteristics of the tributaries of the Alazan/Ganikh River might be characterized as the rainfall-snow type. Snow melting and rainfall can cause the flooding in the spring time and rainfall may cause also the significant flood waves in the summer and autumn period of the year. Winter time and late summer are typical with minimum river flow discharges.
In some rivers, as for example the Chkoturmaz, the Kunaxaysu and Qaynar, the water flow discharges can be reduced during the winter time till zero (consequence of freezing). At this time water intake should be regulated in order to secure environmental flow. These rivers can also be considered to be under risk of drying at the low flow period of the year (summer period).
Regarding the Alazan/Ganikh River itself, natural character of hydrological regime in Azerbaijan is believed to be affected by the water abstraction for irrigation purposes in the upstream part of the river basin in Georgia. However, there are no data available to confirm this,.
The hydrological data and information were provided by the Ministry of Ecology and Natural Resources of Azerbaijan (see Table 4.7). Long-term annual average discharge of the Alazan/Ganikh River in hydrological station Ayrichay is 240 m^3/s and such discharge corresponds to the specific runoff 20,7 $l/s/km^2$. The long-term annual average discharges of the tributaries where gauging stations are located varied in a range from 0,19 m^3/s (Hamamchay-İlisu) to 55 m^3/s (Ayrichay-Mouth).

Table 4.7
Long-term average monthly and annual water discharges (m3/s) for selected hydrological monitoring stations.

№	River – Station	Months												
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual average
1	Ayrichay-Bash Dashagil	0.023	0.02	0.19	4.1	9.9	15	9.4	9.8	6.2	2.1	0.26	0.05	5.2
2	Chkodurmaz-Mouth	0.002	0.001	0.007	0.2	0.93	3.7	1.8	0.63	0.29	0.077	0.002	0.001	0.42
3	Damarchık-Mouth	-	-	-	0.65	2.7	9.6	8.2	5.2	7.3	1.4	-	-	3.0
4	Gaynar-Mouth	0	0	0.018	0.30	1.2	2.9	1.6	0.58	0.85	0.036	0.002	0.001	0.48
5	Ayrichay-Mouth	2.3	3.6	5.1	23	73	150	120	52	58	42	10	3.8	55
6	Kurmukh-İlisu	-	-	-	4.9	26	27	22	11	11	5	-	-	-
7	Tala-Zagatala	0.93	0.91	1.88	5.55	7.67	7.38	4.76	3.63	4.55	4	2.29	1.4	3.75
8	Balakan-Balakan	0.06	0.13	0.33	2.4	4	4.9	5.1	2.6	3.6	2.8	0.32	0.17	2
9	Alazan/Ganikh-Ayrichay	17	24	70	360	570	810	400	200	230	170	41	22	240

Critical period for the surface water ecosystems is the low flow period, when water quality may be easily deteriorated and when the river morphology can create the obstacles for aquatic fauna (migration, survival). Therefore, it is important to know the components of the runoff and to take such measures that keep the conditions for the most vulnerable aquatic flora and fauna. One of the method to separate the runoff can be used is BFI (Base-Flow Index, the ratio of base flow to total flow volume for a given year) a deterministic procedure proposed in 1980 by the British Institute of Hydrology. Although the method may not provide the exact base flow as a more sophisticated analysis may be needed, the index has been found to be consistent and indicative of a base flow (Local minimum method was used for runoff separation), which can be defined as a background river flow mainly maintained by seepage from the nearest body of groundwater.

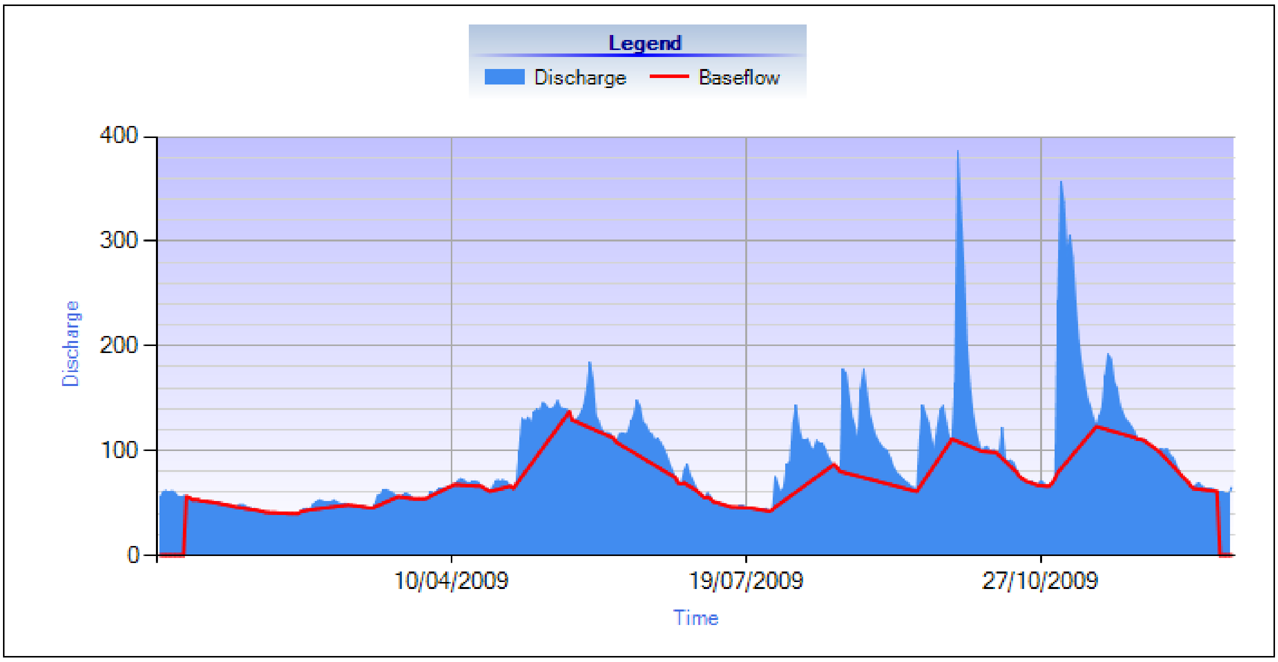

Figure 4.1: **Runoff components separation based on BFI methods (Alazan/Ganikh – Ayrichay, 2009)**

On the Fig. 4.1 is an example of base-flow calculation by using BFI method for Alazan/Ganikh – Ayrichay hydrological station. The base-flow was calculated as percentage of the total yearly flow. The higher the baseflow is compared to the total yearly flow, the less vulnerable the river is to water abstraction for the specific year. In this particular year 2009 the BFI is 0,86 that is high value and indicate low vulnerability to the water abstraction upstream Ayrichay hydrological station. However, it would be useful to know more on the relation between the baseflow and the total yearly flow changes for the longer time period (covering both wet and dry periods). The more stable this is from year to year the less vulnerable the river is to water abstraction on the long term.

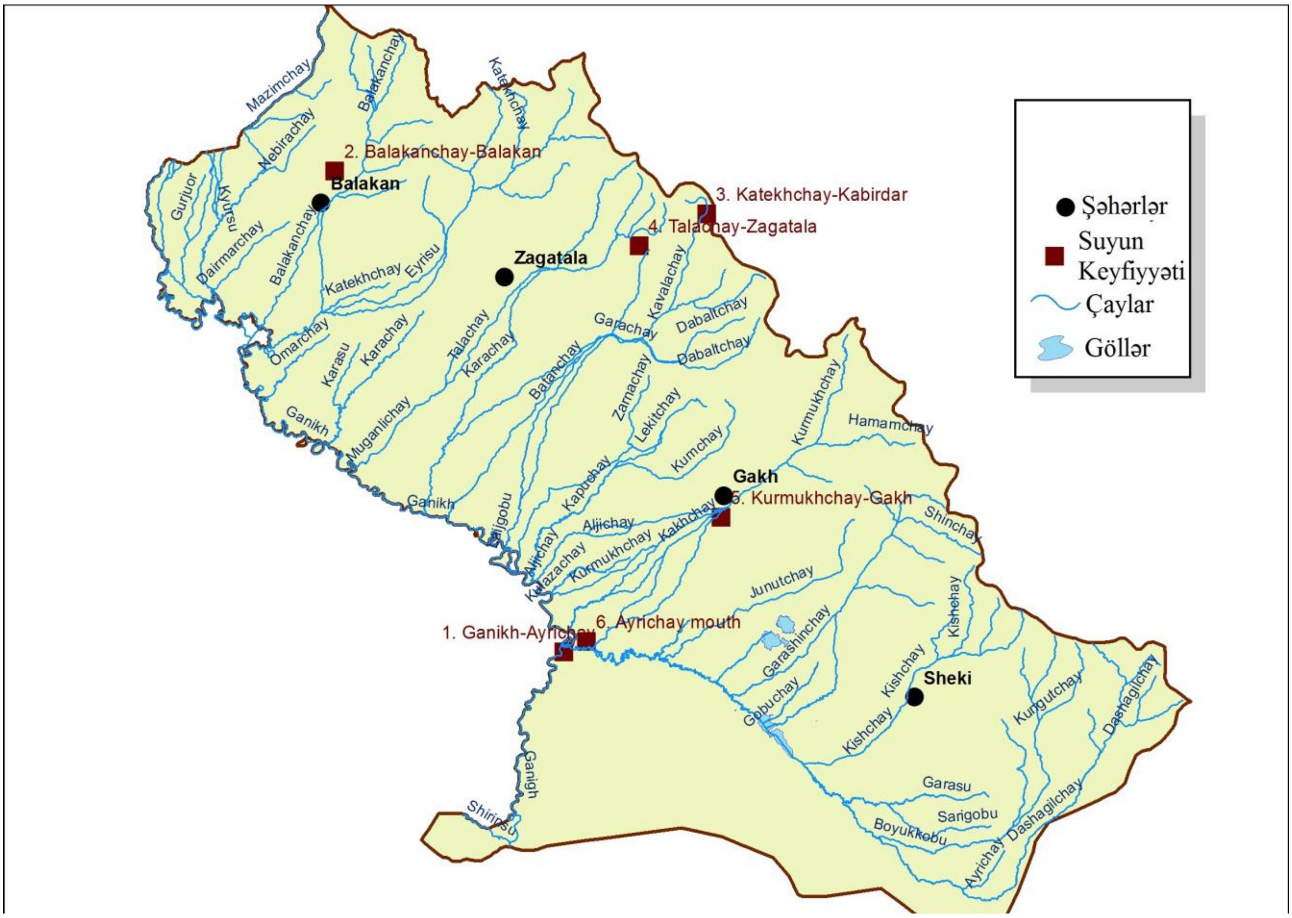

Figure 4.2: **The map of monitoring sites of water quality in the Alazan/Ganikh River basin in Azerbaijan**

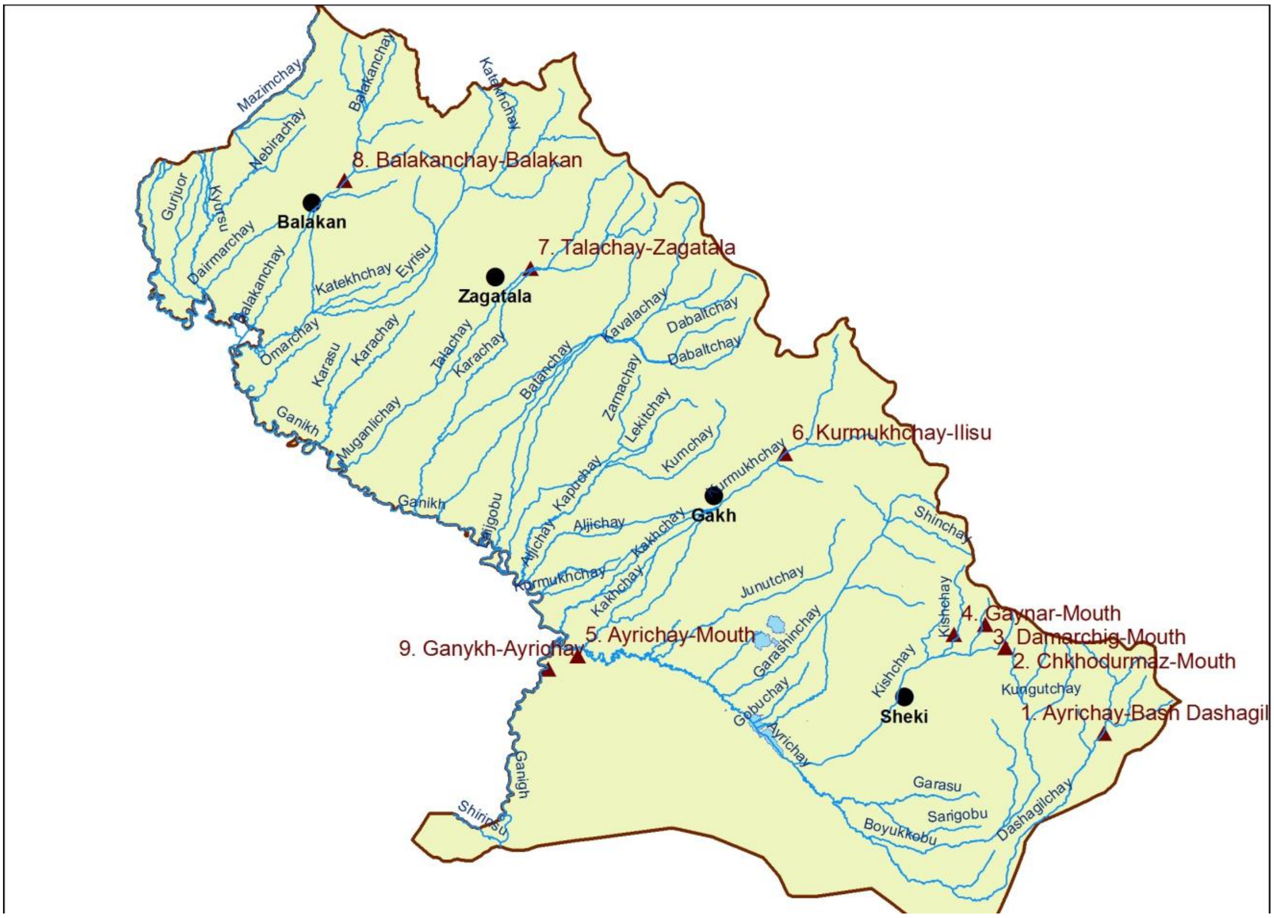

Figure 4.3: **The map of the operational hydrological stations (designated by the red triangles) for water quantity monitoring in the Alazan/Ganikh River basin in Azerbaijan**

5. WATER BODY DELINEATION

5.1 Criteria and procedure

Here and afterwards the term “water body” is used in accordance to the provisions of EU WFD Article 2.3.1 and Chapter 3 of WFD CIS Guideline Document №2. The main purpose of the delineation of water bodies is:

1. As the administrative unit used to set up measures to improve the status (only for water bodies at risk);
2. As the basis for designing a WFD compliant monitoring programme.

The logic behind the delineation of water bodies are the following: A river or a lake can not possess the same natural conditions as a whole. As a consequence, they differ with regard to the sensitivity of the ecosystem to human pressures (in the WFD logic this difference in sensitivity is addressed in the surface water body typology). Further the anthropogenic impact is different for different sections of rivers. Therefore, it is not efficient applying the same planning and management objectives, requirements and tasks, e.g. for the entire river. It is necessary to delineate the surface waters first into categories (rivers, lakes, transitional and coastal waters) and further into discrete sections, so called “water bodies” for the purpose of water management.

According to EU WFD concept, one of the criteria for the delineation of surface water bodies is the water body type characterized by different vulnerability of their ecosystem. However due the very few data on river ecology and lack necessary ecological knowledge of river, in this work all rivers are assigned to one type. Similar all reservoirs and lakes are assigned to one type.

The first step of water bodies’ delineation is the identification of the appropriate criteria. The EU WFD suggests the following groups of delineation criteria: physical (hydromorphological), biological and human impact on the ecosystem (significant pressures). The group of factors presented below cause quantitative and qualitative alterations of water resources and can be used as criteria for delineation.

1. Topography of the river basin (field, plain, valley, mountainous)
2. Main junctions of significant river flows (as hydrological factor)
3. Large settlements, industrial enterprises, zones of intensive agriculture
4. Hydro-morphologic factors, including level of modification of the natural flow of a river or lake

Re. 1 and 2: Geographic or hydromorphological characteristics can significantly impact on surface water ecosystems and their vulnerability due to anthropogenic activities. Such characteristics can also differentiate surface water bodies. For example, the confluence of part of the one river with another river can clearly mark a distinct geographical and morphological boundary of water body.

Re. 3: At the same time, the surface water body shall not belong to different quality classes of surface waters. It should belong only to one class. When there is an impact of human activity on water quality the boundary of water body will be the "meeting" point of two different quality classes.

Re. 4: Hydro-morphologic factors are reflected in the delineation of artificial and heavily modified water bodies.

5.2 Artificial water bodies (AWB)

"Artificial water body" means a body of surface water created by human activity (WFD, Article 2.8). It is only possible to delineate an AWB where no water body has existed before the human activity creating the water body.

No artificial water bodies have been identified in the Alazan/Ganikh River basin.

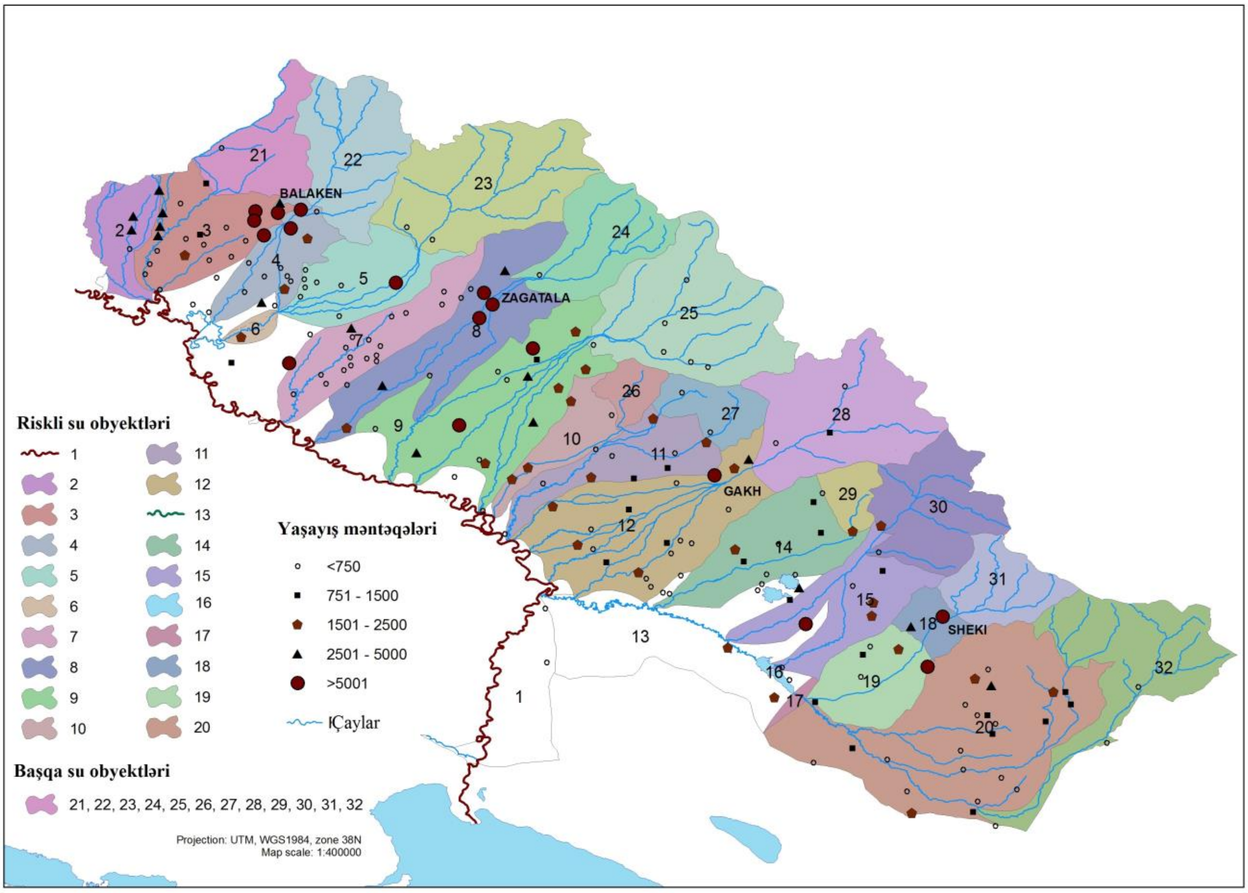

Figure 5.1: **Water bodies in Alazan/Ganikh river basin**

5.3 Heavily modified water bodies (HMWB)

"Heavily modified water body" means a body of surface water which, as a result of physical alterations by human activity, is substantially changed in character (WFD, Article 2.9).

Two water bodies (no 16 and no 17) are identified as candidates for HMWB in the Alazan/Ganikh River basin: Ayrichay reservoir and Ayrichay upper reservoir.

5.4 Water bodies at risk (WBR)

According our expert judgement there are 20 water bodies is at risk (WBRs) in the Alazan-Ganikh basin. These water bodies are situated in the densely populated alluvial plain part of the basin, figure 5.1 and table 5.1.

16 of the 20 WBRs are the cone ("delta like") sections of the small tributaries to Ganikh (WB no 2-12, 14-15 and 18-20) on the alluvial plain, two of the main river: Ganikh (WB no 1) and its main tributary Ayrichay (WB no 13). The last two WBRs are the upper and lower part of the reservoir on Ayrichay.

The 16 WBRs are constituted of the lower cone (“delta like”) parts small tributaries to Ganikh (WB no 2-12, 14-15 and 18-20) are under risk due to the following significant pressures:
1. Water abstraction for irrigation (Surface and ground waters)
2. Deforestation
3. Solid waste disposal
4. Car washing in rivers
5. Discharge of waste waters from residential areas to rivers
7. Pollution by pesticides and fertilisers from agricultural fields

The main river: Ganikh (WB no 1) and its main tributary Ayrichay (WB no 13) are under risk due to the following significant pressures:
1. Water abstraction for irrigation (Surface and ground waters)
5. Discharge of waste waters from residential areas to rivers
7. Pollution by pesticides and fertilisers from agricultural fields.

Table 5.1:
Water bodies at risk in Alazan/Ganikh basin

No	Name of water body at risk	Significant Pressure(s) causing the risk
1	Ganikh on the territory of Azerbaijan	1 Water abstraction for irrigation (Surface and ground waters) 5. Discharge of waste waters from residential areas to rivers 7. Pollution by pesticides and fertilisers from agricultural fields
2-12	2 - Ulgansu river mouth (Below magistral road Balakan- Lagodekhi till mouth); 3 - Mazimchay (Below magistral road Balakan- Lagodekhi till mouth); 4 - Balakanchay (Balakan city till mouth); 5 - Katekhchay(Below Gatekh village till Kortala village); 6 - Katekhchay (below Kortala village (where water from Balakanchay enters Katekhchay) till mouth); 7 - Karasy (below magistral road Sheki-Lagodekhi till mouth); 8 - Talachay (Zagatala city till mouth); 9 - Batanchay (below Yukhri Chardakhlar village till mouth); 10 - Zarnachay (below Lekit village till mouth); 11 - Kumchay (below Kum village till mouth); 12 - Kurmukchay (below Gakh city till mouth)	1. Water abstraction for irrigation (Surface and ground waters) 2. Deforestation 3. Solid waste disposal 4. Car washing in rivers 5. Discharge of waste waters from residential areas to rivers 7. Pollution by pesticides and fertilisers from agricultural fields

No	Name of water body at risk	Significant Pressure(s) causing the risk
13	Ayrichay (below Ayrichay reservoir till mouth)	1. Water abstraction for irrigation (Surface and ground waters) 5. Discharge of waste waters from residential areas to rivers 7. Pollution by pesticides and fertilisers from agricultural fields
14-15	14 - Junitchay (Below Bash Layisgi village till mouth); 15 - Shinchay (Below Shin village till mouth)	1. Water abstraction for irrigation (Surface and ground waters) 2. Deforestation 3. Solid waste disposal 4. Car washing in rivers 5. Discharge of waste waters from residential areas to rivers 7. Pollution by pesticides and fertilisers from agricultural fields
16	Ayrichay reservoir (HMWB)	1. Water abstraction for irrigation (Surface and ground waters) 3. Solid waste disposal 5. Discharge of waste waters from residential areas to rivers 6. Hydro morphological changes 7. Pollution by pesticides and fertilisers from agricultural fields
17	Ayrichay upper reservoir	1. Water abstraction for irrigation (Surface and ground waters) 3. Solid waste disposal 4. Car washing in rivers 5. Discharge of waste waters from residential areas to rivers 6. Hydro morphological changes 7. Pollution by pesticides and fertilisers from agricultural fields
18-20	18 - Kishchay upper Sheki below residential area; 19 - Kishchay below Sheki; 20 - Ayrichay upper Kishchay	1. Water abstraction for irrigation (Surface and ground waters) 2. Deforestation 3. Solid waste disposal 4. Car washing in rivers 5. Discharge of waste waters from residential areas to rivers 7. Pollution by pesticides and fertilisers from agricultural fields

Below we provide a short description of each water body at risk:

Water body 1: Ganikh on the territory of Azerbaijan
The section of Ganikh from Azeri border till mouth of Mingechevir water reservoir is situated in the Ganikh valley covered by Ganikh - Ayrichay plain. In this section of basin summer precipitation is low compared to the upstream part of the basin, and the natural vegetation is steppe.

The flow regime of the river is heavily impacted by water abstraction for irrigation, and the river runs with lower flow in the summer. The water quality is impacted by household waste waters and pesticides.

People in the villages along the tributary rivers discharge their household waste into the river, but our judgement is that the polluting substances in the household waste are too degraded and diluted to pose a risk for this WBR.

The following 16 WBRs are all situated in the alluvial section of basin where summer precipitation is low compared to the upstream part of the basin, and the natural vegetation is steppe:

- **Water body** 2: Ulgansu River mouth (Below magistral road Balakan- Lagodekhi till mouth)
- **Water body** 3: Mazimchay (Below magistral road Balakan- Lagodekhi till mouth)
- **Water body** 4: Balakanchay (Balakan city till mouth)
- **Water body** 5: Katekhchay (Below Katekh village till Kortala village)
- **Water body** 6: Katekhchay (below Kortala village till mouth)
- **Water body** 7: Karasu (below magistral road Sheki- Lagodekhi till mouth)
- **Water body** 8: Talachay (Zagatala city till mouth)
- **Water body** 9: Batanchay (below Yukhri Chardakhlar village till mouth)
- **Water body** 10: Zarnachay (below Lekit village till mouth)
- **Water body** 11: Kumchay (below Kum village till mouth)
- **Water body** 12: Kurmukhchay (below Gakh city till mouth)
- **Water body** 14: Junitchay (below Bash Layisgi village till mouth). The section of Junitchay river from Bash Layisgi till Ayrichay river is situated in the Junitchay
- **Water body** 15: Shinchay (Below Shin village till mouth)
- **Water body** 18: Kishchay upper Sheki below residential area .The section of Shinchay river from Shin village till Ayrichay river is situated in the Shinchay valley
- **Water body** 19: Kishchay below Sheki
- **Water body** 20: Ayrichay upper Kishchay

The flow regime of the 16 water bodies is heavily impacted by water abstraction for irrigation and deforestation, and the river runs with lower flow in the summer. The water quality is impacted by household waste waters, pesticides and car washing in rivers.

People in the villages along the tributary rivers discharge their household waste into the rivers and solid waste disposal is also considered a significant pressure for the 16 water bodies.

Water body 13: Ayrichay (below Ayrichay reservoir till mouth)
The section of Ayrichay River from Ayrichay reservoir till mouth is situated in the Ayrichay valley covered by Ganikh - Ayrichay plain. In this section of basin summer precipitation is low compared to the upstream part of the basin, and the natural vegetation is steppe

The flow regime of the river is heavily impacted by water abstraction for irrigation and deforestation, and the river runs with lower flow in the summer. The water quality is impacted by household waste waters and pesticides partly from tributary rivers, partly from the areas along the river.

People in the villages along the tributary rivers discharge their household waste into the river, but our judgement is that the polluting substances in the household waste are too degraded and diluted to pose a risk for this WBR.

Water body 16: Ayrichay reservoir (candidate for HMWB)
Reservoir is created artificially to use water for irrigation. The area is close to semi desert zone. Water from reservoir is abstracted for irrigation. Some pesticides from surrounding areas may reach the reservoir.

Some people working near the reservoir discharge their household waste into the reservoir. The water body is also eutrofied by the nutrients from the wastewater discharged to the tributaries of the reservoir.

Figure 5.2: **Water body no 16 Ayrichay reservoir and water body no 17 Ayrichay upper reservoir (HMWBs), from Google Earth.**

Water body 17: Ayrichay upper reservoir (candidate for HMWB)
The section of Ayrichay River from mouth of Kishchay River till Ayrichay reservoir is situated in the Ayrichay valley covered by low mountains. In this section of basin summer precipitation is below than in the basins of tributary rivers, and the vegetation is close to steppe.

As can be seen from figure 5.2 Ayrichay upper reservoir is nearly filled with sediment from Ayrichay.

The flow regime of the river is heavily impacted by water abstraction for irrigation, and the river runs with lower flow in the summer. The water quality is impacted by household waste waters, pesticides and car washing in rivers.

People in the villages along the tributary rivers discharge their household waste into the river and solid waste disposal is also considered a significant pressure for water body N 17.

5.4 Other water bodies

"Other water bodies" of Alazan/Ganikh River basin, that are not identified as being at risk (in terms of quality or quantity), have been delineated according to criteria, mentioned in the EU WFD and EU WFD Common Implementation Strategy Guidance Document on "Identification of Water Bodies".

To minimize the administrative burden which is a result of having too many WBs in Aghstev River basin these "other" water bodies are identified according to the following principles mentioned in the EU WFD Common Implementation Strategy Guidance Document No. 2 - "Identification of Water Bodies":

- Small rivers can be included as part of a larger river water body of the same type.
- Small rivers:
  (1) belonging to the same type,
  (2) influenced by the same pressure category and level and
  (3) having an influence on another well delimited water body,
  may be grouped.

We have identified 12 “other” water bodies not at risk in Alazan/Ganikh basin, figure 5.1 and table 5.2.

Table 5.2:
Other water bodies in Alazan/Ganikh basin (water bodies not at risk)

	Water body
21	Mazimchay (From source of river till magistral road Balakan- Lagodekhi till mouth)
22	Balakanchay (From source of river till Balakan city)
23	Katekhchay (From source of river till Gatekh village)
24	Talachay (From source of river till Zagatala city)
25	Batanchay (From source of river till Yukhri Chardakhlar village)
26	Zarnachay (From source of river till Lekit village)
27	Kumchay(From source of river till Kum village)
28	Kurmukhchay (From source of river till Gakh city)
29	Junitchay (From source of river till Bash Layisgi village)
30	Shinchay (From source of river till Shin village)
31	Kishchay (From source of river till Sheki city)
32	Ayrichay (From source of river till Bash Kungut village)

The precipitation in the catchments of these 12 water bodies is higher than in alluvial plain and the catchments are mainly covered by forest.

The flow regime of the river is a bit (but not significantly) impacted by water abstraction for irrigation. The water quality isn't significantly impacted by household waste waters and pesticides. People in the villages along the river discharge their household waste into the river, but our judgement is that the amount of waste is too small to pose a risk for this WB.

To summarise: Human activity in the catchments isn't high and there is no significant pressure for the 12 water bodies.

6. PROGRAM OF MEASURES

The purpose of the Programme of Measures (PoM) is to secure that WBRs are no longer at risk after the implementation of the measures. The PoM is both pressure specific and water body specific. It addresses the specific pressures causing the each of the WBRs to be at risk.

The measures needed to improve the environmental status of the water bodies at risk is described below for each of the significant pressures:

1. Water abstraction for irrigation (Surface and ground waters)
2. Deforestation
3. Solid waste disposal
4. Car washing in rivers
5. Discharge of waste waters from residential areas to rivers
6. Hydromorphological changes
7. Pollution by pesticides and fertilisers from agricultural fields

Some very rough estimates of investment costs (one-time setup cost of a plant or project) for the proposed investments in sanitation and an estimate of running costs for solid waste management are presented in the last sections of this chapter.

These estimates can only be considered as indicative, as more precise estimates will require a detailed analysis (feasibility study) of each investment, which is outside the scope of this project.

6.1 Water abstraction for irrigation and household use

The process of designing measures to secure good status in the water bodies at risk due to water abstraction for irrigation and household use goes through five steps;

1) Setting separate requirements for minimum flow for all WBRs;
2) Detailed analysis of the present use of water and identification of possibilities to optimise the use;
3) Designing measures to meet the minimum flow requirement for al WBRs;
4) Socioeconomic evaluation of the measures;
5) Revision of objectives for WBRs if it is considered disproportionately costly or socially unacceptable to implement the measures (political evaluation).

There are too many gaps in the present data and information available on flow regime and water use to make it possible to make the analysis outlined above within the Kura project.

6.2 Household and urban wastewater

For WBRs at risk due to significant pressure from household wastewater we have used the approach outlined in the Urban Wastewater Directive to design measures.

The first step is identifying agglomerations including the towns and villages where discharge of wastewater is a significant pressure to water bodies.

According to Urban Wastewater Directive, "Agglomeration" means an area, where the population and/or economic activities are sufficiently concentrated for urban wastewater to be collected and conducted to an urban wastewater treatment plant or to a final discharge point.

Four agglomerations have been identified in the Alazan/Ganikh River basin:

1. Balakan
2. Zagatala
3. Gakh
4. Sheki

Determination of settlements to be included in the Balakan, Zagatala, Gakh and Sheki agglomerations was done in accordance with the “Guidance on How to Define Agglomerations Under the Urban Wastewater Treatment Directive 91/271”[6] and "Rural Wastewater Treatment in Hungary"[7]. Based on these two references the criteria for inclusion of a settlement into the given agglomeration are as follows:

- Population density - minimum 30 people/ha (indicative number),
- Time to reach the wastewater treatment facility - less than 6 hours (taking into consideration the changes of the daily flow),
- For 1 km of sewage collector the minimum number of customers - 120 people.

For each of the four agglomerations the main town plus nearby settlements are included as outlined in table 6.1.

Table 6.1: Agglomerations in Alazan/Ganikh basin

Settlements and towns	Distance from the proposed UWWT plant (km)	Area, ha*	Number of inhabitants	Population density, inhabitants/ha
Balakan agglomeration				
Gullar	9.61	1166	5794	4.96
Magamalar	8.6	1737	4572	2.63
Tulu	5.89	1820	8100	4.45
Garakly	3.7	1553	3672	2.36

[6]) http://www.mmediu.ro/proiecte_europene/01_integrare_europeana/02_POS_mediu/01_Axa_1/Regionalizare/Definirea%20aglomerarilor%20(Romania).doc
[7]) http://www.meif.org/uk/document/download/gazdag.pdf

Settlements and towns	Distance from the proposed UWWT plant (km)	Area, ha*	Number of inhabitants	Population density, inhabitants/ha
Balakan	7.41	432	10335	23.9
Total	-	6708	32473	4.8
Zagatala agglomeration				
Jar	8.7	1565	3436	2.19
Yukhari Tala	3.7	3212	8246	2.56
Ashagi Tala	1.3	3326	6786	2.04
Zagatala	5	1439	21251	14.76
Total	-	9542	39719	4.2
Gakh agglomeration				
Gakhbash	10.9	2320	1420	0.61
Meshabash	2	2630	1660	0.63
Gakh	6	1300	12200	9.38
Total	-	6250	15280	2.4
Sheki agglomeration				
Kish	11	2037	7000	3.43
Okhud	9	2110	2160	1.02
Gokhmukh	6.1	2306	1340	0.58
Sheki	4.67	2927	64800	22.13
Total	-	9380	75300	8.0

*: The area is for the administrative area with the same name as the settlement, and the calculated population density does not represent the population density of the settlement.

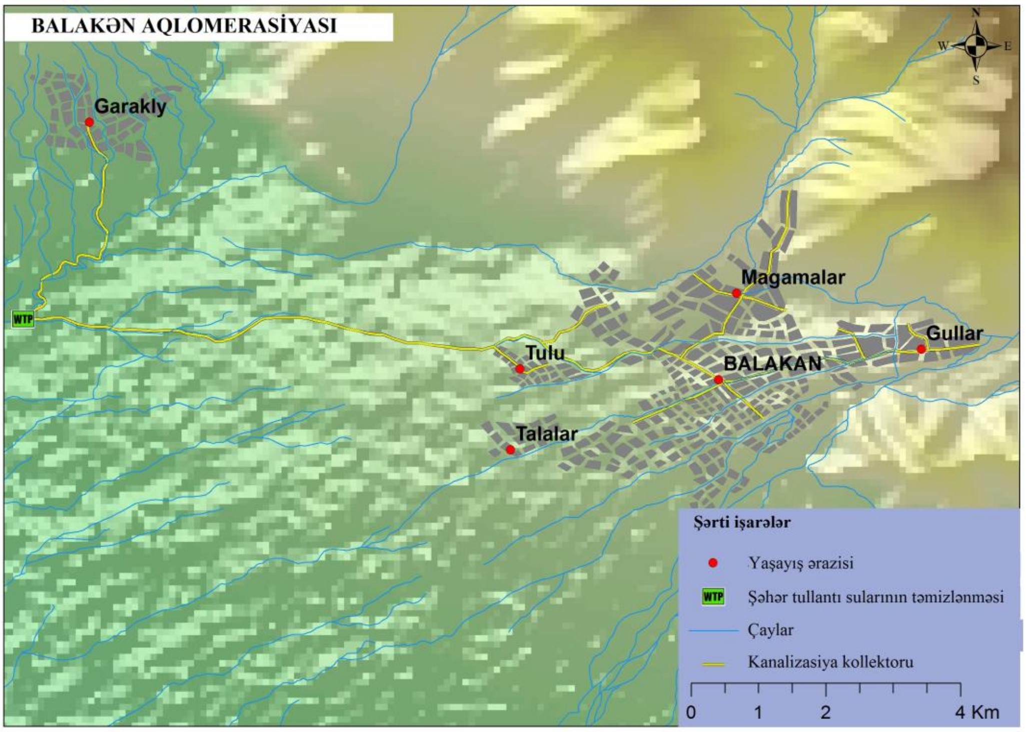

Figure 6.1: **Balakan agglomeration**

For Balakan agglomeration it is proposed to construct wastewater treatment plant on the bank of River Mazimchay, west of the city. The agglomeration includes the big settlement Garakly, and is discharging wastewater to Water body no 3: Mazimchay River.

There are a sewage network and sewers only in the Central District of the town. A wastewater network and a treatment plant were designed in late 1980s for the so-called New District of Balakan, where a hospital and industrial plants are located; and the construction even started but later was terminated due to the overall crisis in the country's economy following the breakdown of the Soviet Union. The other districts of the town are actually villages of Gullar, Garakly and Magamalar with a total population of 17,100, consuming drinking/technical water from the Balakan water supply system. These districts have no sewage network whatsoever. [8]

Under the Asian Development Banks input to the Water Supply and Sanitation Investment Program for Azerbaijan it is planned to provide financing for WSS infrastructure in Balakan[9]. The project is expected to increase water supply coverage and the number of metered connections to piped networks; reduce system leaks to ensure 24-hour supply of pressurized, safe drinking water; and improve the disposal and treatment of wastewater.

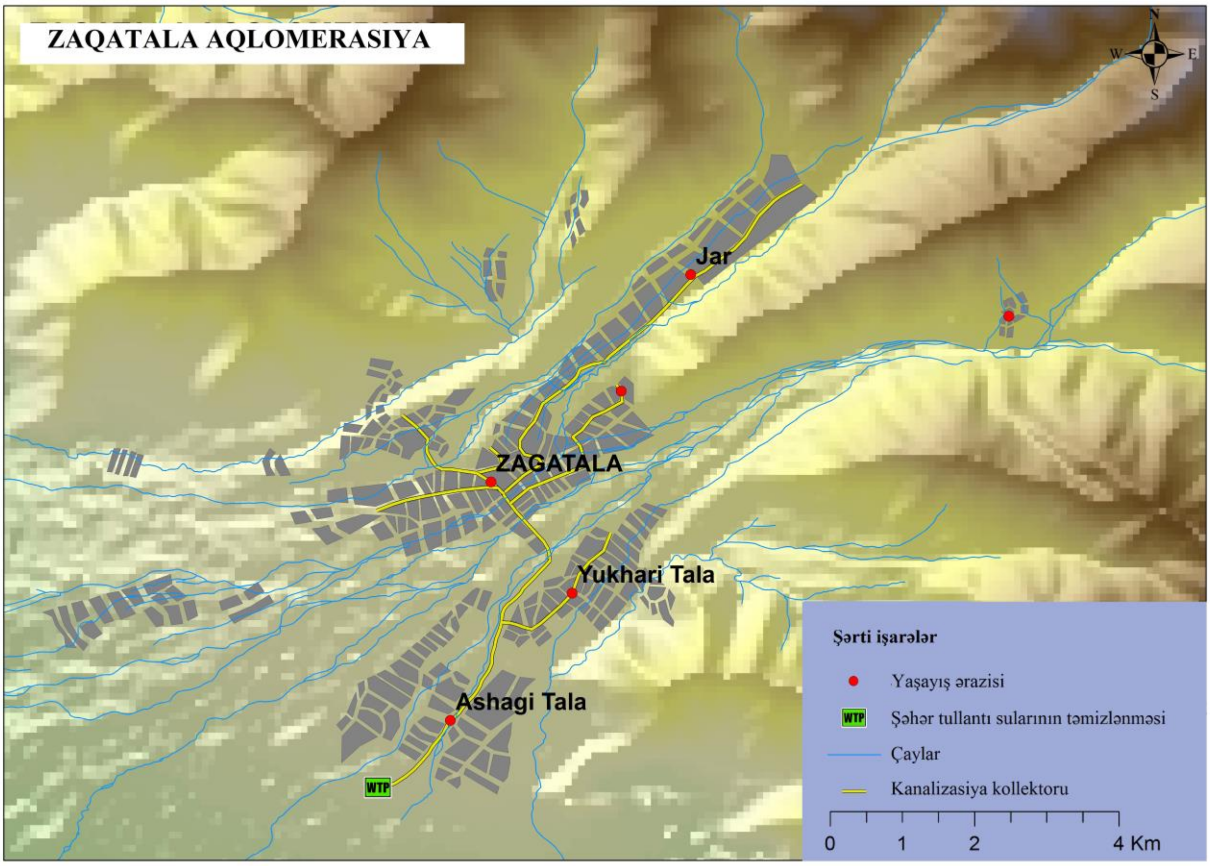

***Figure 6.2:* Zagatala agglomeration**

[8] USAID: PREFEASIBILITY EVALUATION WATER, WASTEWATER, AND SOLID WASTE BELOKAN, AZERBAIJAN, http://www.awp.am/pdf/Report/English/2003/WaterManagementintheSouthCaucasusFinalReportENG.PDF

[9] http://www.adb.org/Documents/RRPs/AZE/42408-AZE-RRP.pdf

For Zagatala agglomeration it is proposed to construct wastewater treatment plant on the bank of River Talachay, south of the city. The agglomeration includes three settlements and is discharging wastewater to Water body no 8: Talachay River.

Under the World Banks input to the Water Supply and Sanitation Investment Program for Azerbaijan it is planned to provide financing for WSS infrastructure in Zagatala[10]. The objective of the project is to improve the availability, quality, reliability, and sustainability of water supply and sanitation (WSS) services. This objective will be achieved through: (a) rehabilitation and reconstruction of water supply and sanitation infrastructure in the rayons; and (b) implementation of a comprehensive Institutional Modernization Component to strengthen the WSS sectors capacity to manage water supply and sanitation services in an efficient, effective, and sustainable manner.

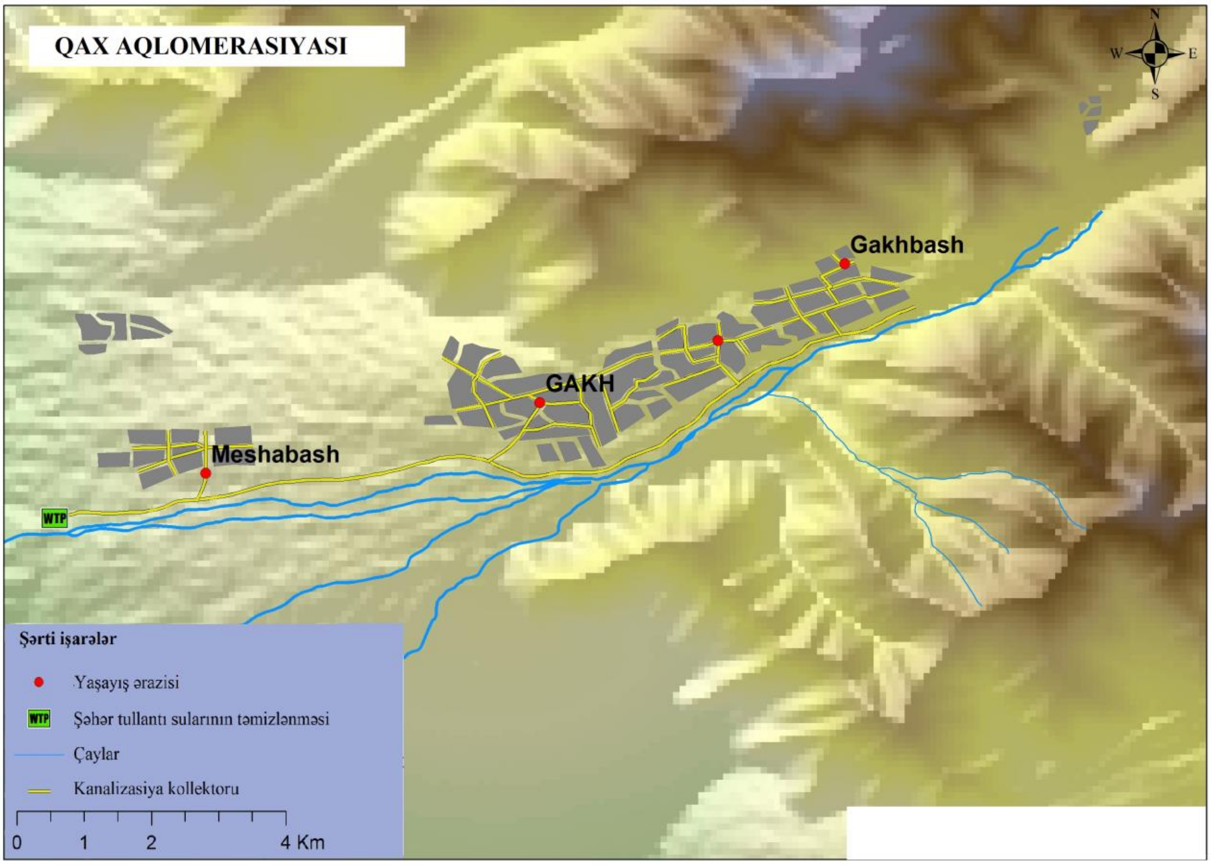

Figure 6.3: **Gakh agglomeration**

For Gakh agglomeration it is proposed to construct wastewater treatment plant on the bank of River Kurmukhchay, downstream the settlement Meshabash west of the city. The agglomeration includes two settlements and is discharging wastewater to Water body 12: Kurmukhchay River.

According to the Gakh Water Canal Company, the existing wastewater system was constructed in the end of the 1960s and the beginning of 1970s. The existing wastewater system serves about 30

[10] http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2007/03/23/000104615_20070326102759/Rendered/INDEX/Integrated0Saf1et010Appraisal0Stage.txt

per cent of the city, and the other part uses septic tanks or ditches. Most of the wastewater is discharged in a stream or in the Kurmukhchay River without treatment. A small portion reaches the treatment plant through the main collector, which is located to the west of the city. In order to improve the wastewater system, a thorough reconstruction and rehabilitation is necessary. Wastewater from the city is not treated. [11]

Similar as for Zagatala is foreseen to provide funding under the World Banks input to the Water Supply and Sanitation Investment Program for Azerbaijan.

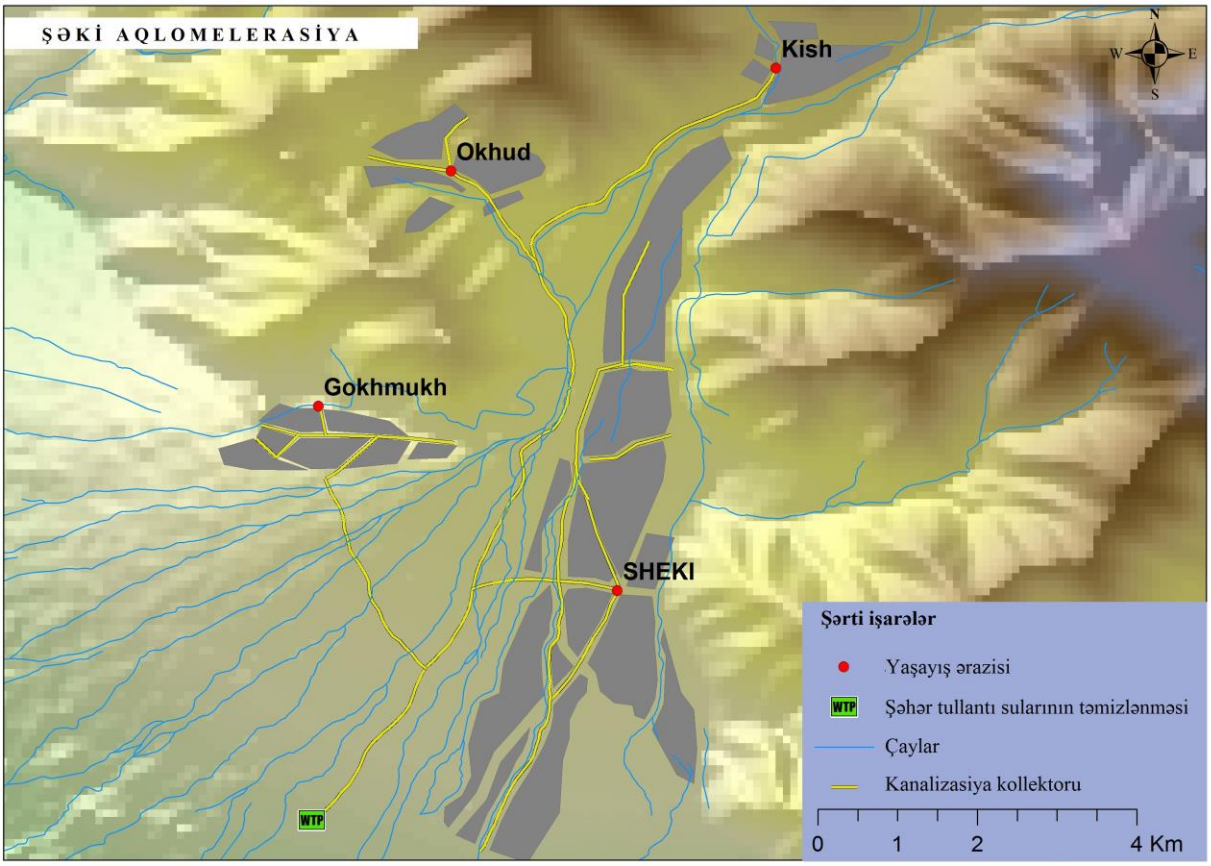

Figure 6.4: **Sheki agglomeration**

For Sheki agglomeration it is proposed to construct wastewater treatment plant on the bank of River, south west of the city. The agglomeration includes three settlements and is discharging wastewater to Water body no18: Kishchay River.

German Kreditanstalt für Wiederaufbau (KfW) agency's Open Program has provided a loan to rehabilitate water supply facilities in Sheki. An initial agreement has been reached with between ADB (Japan Special Fund) and KfW to coordinate or possibly cofinance a WSS project in the town of Sheki[12].

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[11] USAID: PREFEASIBILITY EVALUATION WATER, WASTEWATER, AND SOLID WASTE GAKH, AZERBAIJAN,
http://www.awp.am/pdf/Report/English/2003/WaterManagementintheSouthCaucasusFinalReportENG.PDF
[12] http://www.adb.org/Documents/TARs/AZE/R230_01.pdf

For all 20 WBR household wastewater is identified as a significant pressure. Building and operating WWTPs for the four main towns of the basin with nearby settlements will mean that WBR 3, 8, 12 and 18 are no longer under risk due to discharge of household wastewater. It will further reduce the pressure from household wastewater on WB no 1: Ganikh on the territory of Azerbaijan, WB no 13: Ayrichay (below Ayrichay reservoir till mouth), WB no 16: Ayrichay reservoir, WB no 17: Ayrichay upper reservoir and WB no 17: Kishchay below Sheki.

Evaluating the impact of household wastewater on the WBRs, not fully addressed by the WWTPs for the 4 agglomerations, will require a more detailed site specific evaluation of the present handling of household wastewater WBRs than has been possible to implement during the present project. Further it will require detailed monitoring of the impact of household wastewater on the river and the reservoir (WFD compliant monitoring).

6.3 Car washing in rivers

At present no legislation regulates car washing in rivers. Pollution from this activity would be avoided if a legal act prohibiting the activity was adopted and enforced.

6.4 Solid waste disposal

Present landfill operations for Balakan and Gakh are described in USAID reports[13] [14].

The waste disposal of Balakan is located at a distance of 2 km to the south from Balakan on the left bank of the Balakanchay River about 400 m from the river channel. Currently the disposal site is mainly used for the disposal of household waste because there is actually no industrial waste in the town as the existing industrial enterprises are no longer functioning. The site is not fenced, there is no security and guards, and no sanitary control is provided over the site operation. The waste is chaotically disposed to the site.

The landfill for Gakh is located south of Gakh at the distance of 2.0 km along the Kurmukhchay River (the distance from the landfill to the river is 120 meters). The landfill area is not fenced and the operation does not follow the established norms. The landfill is not protected and there is no sanitary control.

The pressures from solid wastes in Ganjachay river basin is related to the (lack of) waste management in the settlements and towns.

The amount of waste disposed should be reduced by implementing measures to reduce, reuse (e.g. reusable bottles) and recycle (e.g. metal, glass, plastic) as much of the solid waste as possible in line with the EU policy on solid waste.

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[13] USAID: PREFEASIBILITY EVALUATION WATER, WASTEWATER, AND SOLID WASTE BELOKAN, AZERBAIJAN,
http://www.awp.am/pdf/Report/English/2003/WaterManagementintheSouthCaucasusFinalReportENG.PDF

[14] USAID: PREFEASIBILITY EVALUATION WATER, WASTEWATER, AND SOLID WASTE GAKH, AZERBAIJAN,
http://www.awp.am/pdf/Report/English/2003/WaterManagementintheSouthCaucasusFinalReportENG.PDF

But regardless on how effective the authorities, citizens and enterprises are in reducing, reusing and recycling, there will always be a rest fraction of the waste which has to be disposed.

It is proposed that a sanitary landfill for Goy-Gol region is established and the waste disposal site of Ganja City is reconstructed to fulfil the requirements of a sanitary landfill, alternative to construct one sanitary landfill where all solid waste from the basin is disposed.

Sanitary landfills[15] are sites where waste is isolated from the environment until it is safe, see figure 6.2.

Figure 6.2: Sanitary landfill design[16]

Four basic conditions should be met by any site design and operation before it can be regarded as a sanitary landfill:

1. Full or partial hydrogeological isolation: if a site cannot be located on land which naturally contains leachate security, additional lining materials should be brought to the site to reduce leakage from the base of the site (leachate) and help reduce contamination of groundwater and surrounding soil. If a liner - soil or synthetic - is provided without a system of leachate collection, all leachate will eventually reach the surrounding environment. Leachate collection and treatment must be stressed as a basic requirement.

[15] From: http://web.mit.edu/urbanupgrading/urbanenvironment/sectors/solid-waste-landfills.html
[16] From PP-Presentation: Municipal Solid Waste Treatment Technologies and Carbon Finance, World Bank, Carbon Finance Unit, Thailand, Bangkok, January 24, 2008

2. Formal engineering preparations: designs should be developed from local geological and hydrogeological investigations. A waste disposal plan and a final restoration plan should also be developed.
3. Permanent control: trained staff should be based at the landfill to supervise site preparation and construction, the depositing of waste and the regular operation and maintenance.
4. Planned waste emplacement and covering: waste should be spread in layers and compacted. A small working area which is covered daily helps make the waste less accessible to pests and vermin.

More detailed proposal for the number and locations for the sanitary landfills in the area should be made during the elaboration of waste management plans[17].

6.5 Deforestation

It is proposed that a plan for reforestation is made for the basin.

Reforestation should restore the natural vegetation cover in the areas, where human activates has resulted in deforestation, and

- which are vulnerable for soil erosion,
- where reforestation will support recharge of important aquifers,
- where reforestation will change the flow regime of rivers back to a natural situation (decreasing the number and severity of landslides, mudflows and flooding and increasing the minimum flow),
- where the reforested areas can provide important forest services for the local population and make the area more attractive for tourists.

The reforestation shall result in forests with the same biodiversity as the original forest.

Activities which should be included in a reforestation project:

A. Map the original vegetation cover in the basin.
B. List the benefits of reforestation that the project will focus on (criteria for reforestation).
C. Identify the areas where reforestation will be most beneficial based on identified criteria.
D. A prioritised reforestation plan.
E. Raise awareness in the local population on the benefits of forests.
F. Planting and protecting the new forested areas.

6.6 Hydromorphological changes

It is proposed that Water body no16: Ayrichay reservoir and Water body no17: Ayrichay upper reservoir are assigned ad Heavily Modified Water Bodies (HMWB), thereby accepting the damming of Ayrichay River.

This does on the other hand not mean that pollution (eutrophication) of the two water bodies can be accepted, they have to fulfil god ecological status.

[17] For EU member states waste management plan is a compulsory strategic document that describes how waste management objectives will be achieved. It should cover waste management and waste prevention and recovery, and aims to limit the environmental impact of waste on human health and the environment, and establish an integrated and adequate network of disposal facilities taking account of best available techniques.

6.7 Supplementary measures

The Water Framework Directive requires 2 types of measure, to be included in the PoM:

A. Basic measures which is mainly technical interventions as a minimum needed to reach good status in the water bodies at risk.
B. Supplementary measures which include institutional, awareness, legislation, research, economic instruments, education, demonstration projects etc.

The sections 1 to 6 of this chapter focus on basic measures.

Implementation of supplementary measures covering the topics mentioned above is also crucial for the improvement of the status of the water bodies at risk.

In the below section it is proposed to launch a donor project on agriculture covering some of the topics covered under the WFD concept of supplementary measures.

6.8 Introduction of Good Agricultural Practices

Very little is known about the present agricultural practices and the loss of nutrients and pesticides to surface waters and a result of agricultural activities. As a reduction environmental impact from agriculture requires a more efficient use of costly resources (nutrients, pesticides, water for irrigation), introduction of Good Agricultural Practices (GAP) to reduce the environmental impact will probably result in more efficient farms with a better economic performance.

It is proposed to launch a donor project on GAP in the Alazan-Ganikh basin. This donor project could be a transboundary project covering all 5 pilot basins of the Kura project.

A list of activities can be included in such a project:
1. Getting an overview over present agricultural practices, including use of pesticides, nutrient management, irrigation, grazing.
2. Identification of agricultural practices impacting surface and groundwater (significant agricultural pressures).
3. Identification of Good Agricultural Practices (GAPs) improving farm economy and minimising agricultural impact on water bodies.
4. Identification of demonstration farms.
5. Implementation of GAPs on demonstration farms.
6. Farmers trained in GAPs using demonstration farms in the training.
7. Awareness raising on GAPs, farmers, the public etc.

It is estimated that a donor project on GAP for all the 5 pilot basins of the Kura project could be implemented in 4 years for a budget of 6 mill. Euro inclusive investments in pilot farms.

6.9 Cost estimates for agglomerations: sewerage and UWWTP

A cost estimate for construction cost for sewerage and waste water treatment plant for the 4 agglomerations is made by Azersu. The estimate made by Azersu is compared with estimates based on data from Bosnia and Herzegovina and Slovakia in table 6.2.

Table 6.2: Cost estimate, agglomerations

	PE	Cost, million EUR		
		WWTP	Sewage collection network	Total
Balakan agglomeration				
NWSSP* estimate (Azersu)	30,000	5,9	12,8	18,7
Experience from Bosnia-Herzegovina	27,700	3,4	9,5	12,9
Experience from Slovakia**	27,700	6,0	7,0	13,0
Zagatala agglomeration				
NWSSP* estimate (Azersu)	40,000	6,3	17,3	23,6
Experience from Bosnia-Herzegovina	35,250	4,2	11,8	16,0
Experience from Slovakia**	35,250	7,5	10,0	17,5
Gakh agglomeration				
NWSSP* estimate (Azersu)	12.200	4,5	11,2	15,7
Experience from Bosnia-Herzegovina	17,580	2,2	6,2	8,4
Experience from Slovakia**	17,580	4,0	5,0	9,0
Sheki agglomeration				
NWSSP* estimate (Azersu)	80,000	8,3	19,3	27,6
Experience from Bosnia-Herzegovina	70,600	7,6	21,1	28,7
Experience from Slovakia**	70,600	14,0	18,0	32,0

Notes*: *: National Water Supply & Sanitation Project, Azerbaijan*
*** Slovak prices are for mechanical, biological treatment including nitrogen removal*
n.a.: Not available

The costs of renovation and extension of the sewerage system and building the WWTP is dependent on the location and the situation in the country. The calculations based on experiences from Bosnia-Herzegovina and Slovakia is based on average unit costs and does not take into consideration the specific local situation. The three independent calculations give an indication of the size of the costs. They also show that the renovation and extension of the sewerage system counts for the major part of the investments.

The total running costs has not been estimated. The major part of the total running costs (operation, maintenance and running costs related to the investment costs (interest and depreciation)) will be the related to operation and maintenance (generally less than half the cost of water supply and sanitation is related to investments).

6.10 Cost estimates for solid waste

An indicative level of the costs for collection, transfer and disposal of solid waste is somewhere around 7 Euro pr. person pr. year for the Ganjachay basin[18]. As the amount of waste produced pr. person is heavily dependent on income and this number is based an estimated yearly income of 700 Euro pr. person pr. year as a mean in the basin. The figure of 7 Euro pr. person pr. year includes owning, operation, maintenance, and debt service, and assuming no equipment provision through grants.

7. GAPS IN KNOWLEDGE AND RECOMMENDATIONS HOW TO FILL THEM

The process of characterizing the basin, evaluation human activities in the basin, and the analysis of the pressures and impacts revealed several major data gaps. The gaps include expertise gaps and data/information gaps.

The most crucial is the gaps in knowledge infrastructure for WFD RBM in areas as:

- technical expertise in the sectors that is needed to draft RBMPs including ecology,
- technical knowledge and knowledge in the EU approach to water management,
- very limited experience among experts in working interdisciplinary (working together with experts with other technical expertise in teams during the drafting of the WFD RBMP),
- scientific work in universities, research and scientific institutions is to a limited extent addressing the issues relevant for establishing River Basin Management Plans in line with the WFD methodology.

On top of that it there is very little information available on the status of the environment and the human activities which potentially can impact the environment.

On top of that it there is very little information available on the status of the environment and the human activities which potentially can impact the environment.

7.1 Gaps in knowledge infrastructure

Expertise in relevant technical issues

There is limited technical expertise available in all the sectors needed to assess the environmental impact of economic activities and to draft RBMPs. The gaps in available expertise include lack of relevant expertise in ecology.

Knowledge of WFD and other EU directives in the water sector

There is little use in Azerbaijan of the EU approach to water management, limited knowledge of the EU directives and of the approach of EU in relation to environmental issues (e.g.: polluter pays, precautionary principle, prevention, integrated approach, ecosystem approach etc.).

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[18] Based on: http://www.unep.or.jp/ietc/Publications/spc/Solid_Waste_Management/Vol_I/31-AppendixD.pdf

To facilitate the access to EU Water Framework Directive methodology the Kura Project has translated following key documents translated to Georgian, Armenian and Azeri, printed and delivered to the Beneficiaries and is available for the Kura project homepage:

1. EU Water Framework Directive;
2. EU Floods Directive;
3. WFD Technical Guidance: Identification of Water Bodies;
4. WFD Technical Guidance: Analysis of Pressures and Impacts;
5. Introduction to Biological Monitoring of Water Quality.

Further the project has elaborated the following documents:
- Analysis of the Baseline Situation in the Kura Aras Basin
- Monitoring Guidelines for Decision Makers
- Public Participation Guidelines for Decision Makers
- Good Laboratory Practice Guidelines for Sampling and Analysis

These documents are available in local languages from the Kura project homepage.

Experience in working interdisciplinary

To establish RBMPs in line with the EFD expect from different fields need to work together in teams during the drafting of the WFD RBMP. We have learned that limited experience is available in Azerbaijan in working interdisciplinary.

7.2 Gaps in data and information

In the course of development of this draft river basin management plan, some major data gaps were identified. If more data had been available they could significantly change the thinking, streamline the expert judgments made on the nature and impact of several pressures and largely help in development of cost-effective program of measures to achieve the objectives for the water bodies at risk.

The main data gaps, identified in the course of development of this draft report include the following categories:

- Ecology of the basin;
- Data on human activities, including land use data;
- Compliance assurance (data from self control, and inspection of enterprises);
- Physical-chemical and hydro-morphological monitoring (very few stations, limited coordination of the two types of monitoring);
- Quality assurance of data;
- Biological monitoring (not existing);
- Groundwater monitoring (not existing).

Gaps in knowledge of human activities

An important gap is the limited availability of general and reliable statistical information.

Land use data in the basin is scarce, uncoordinated and not systemized.

Permitting and compliance assurance (self control by the enterprises, control and inspection by authorities to check that the enterprises not violate their permit and enforcement by the authorities if the enterprise does not comply) is weak. We have not been able to get access to permits and to data from compliance assurance.

Water use (abstraction and discharge)

For water abstraction we need to know how much is abstracted, where, when and how. For point sources discharges we need to know how much is discharged, where, when plus the amount of or concentration of pollutants in the discharge. These site specific (not aggregated) data has not been available.

Agriculture, crop and livestock production

Agriculture impacts water quantity and quality in the basin mainly by:

1. Use of water for irrigation,
2. Loss of nutrients (from chemical fertilizer and animal manure) and
3. Loss of pesticides to surface and ground water.

No reliable monitoring exists in Azerbaijan for collecting and analyzing pesticide and fertiliser use information (type, quantity, technology used for spreading, when it is used and geographical areas) in crop production.

The quantity of water used for irrigation purposes is not measured. Information on the use of chemical fertilizer, number of livestock, handling of manure and water used for livestock production is not available.

Industry

There exists little information on industries by rayons and towns, and no specific data on the environmental impact is available. .

Solid waste

General and outdated information could be collected from different sources on solid waste disposal locations and conditions. No monitoring is conducted and no functional database storing relevant data exists.

Deforestation

No updated information on deforestation exists in Azerbaijan.

Transport

Negative impact from transport can be evaluated from pollutant spillages related to accidents, spillage of oil, use of salt as de-icer, use of herbicides and engine exhausts. No relevant data is available in Azerbaijan to assess the impact from transport.

Gaps in knowledge of impact of human activities

To evaluate the impact of human activities requires knowledge in four areas:

1. the extent or size of the activity (see above section: Gaps in knowledge of human activities);

2. the pressure from the activity (amount of pollutant in relation to the extent or size of the activity, see above section);
3. the nature of the impact (how does the pollutant released during the activity impact ecosystems);
4. the vulnerability of the ecosystems impacted by the activity.

Also for two last areas there is limited knowledge available in Azerbaijan.

Gaps in knowledge of environmental status

The information on the ecology of the Alazan/Ganikh basin, particularly water ecology is very scarce.

The gaps in the present monitoring programmes include:

- very few stations, both for chemical and hydromorphological monitoring;
- chemical and hydromorphological monitoring are not coordinated and corresponding chemical and flow measurements not available;
- no biological monitoring;
- limited quality assurance of data.

Water quantity and quality monitoring

To evaluate the impact of human activities we need knowledge of water quantity and quality throughout the basin.

Regular water quality monitoring activities are implemented at few stations in the Alazan/Ganikh basin, chemical and hydromorphological monitoring are not coordinated, biological monitoring does not exist, the quality control/quality assurance of the data are questionable and data are not easily accessible.

7.3 Recommendations, knowledge infrastructure

It is recommended that the strengthening of knowledge infrastructure for WFD in Azerbaijan includes:

- improving technical expertise (training existing experts and establishing curricula for the education/recruitment of new experts) in all the sectors that is needed to draft RBMPs (hydrologists, geologists, biologists, chemists, agronomists, economists, engineers with knowledge of wastewater treatment and main industrial sectors, etc.),
- these experts shall both have technical knowledge and knowledge in the EU approach to water management,
- these experts needs to be trained in integrated planning: working together with experts with other technical expertise in teams during the drafting of the WFD RBMP,
- the building of knowledge infrastructure for WFD RBM should include scientific work in universities, research and scientific institutions and education of new experts for RBMP/IWRM.

7.4 Recommendations, data and information

Knowledge of human activities

Water use (abstraction and discharge)

Setting up monitoring for urban and household wastewater discharge – at least conducting general data collection survey and chemical sampling is a major recommendation for assessment of impact on water bodies.

Agriculture, crop and livestock production

Monitoring system must be set for collecting pesticide use information, measuring quantity of water used for irrigation purposes and livestock production and collecting information on number of livestock and handling of manure.

GIS based databases must be developed to store collected data to enable site specific analysis. Data must be shared easily among government agencies and be accessible.

Industry

Having access to site specific information on the production capacity and environmental impact for the industry in Alazan/Ganikh basin is important to make assessment of pressure and impact on water bodies from industries.

We recommend development of GIS of all industries in Azerbaijan (food and other industries) containing updated information on production volume and treatment of production leftovers.

Mining (including old tailing dams)

Data on mining industries and sand/gravel abstraction can be collected and stored in the GIS of industries proposed in the previous section. Areas of mining deposits should be digitized in polygon GIS layer for better illustration of ongoing mining activities; volume of production and environmental impact must be shown.

Solid waste

Our recommendation is to set up monitoring of waste disposal including (but not limited to) collecting the following information: geographical location of waste disposal site, legal status (official or unofficial site), area, responsible body, type of waste, current status.

Deforestation

Information on woodcutting industries can be including in the GIS database of industries discussed above.

Remote sensing is required to conduct the survey of deforestation areas. Data must be collected using aerial photography and digitized into GIS.

Monitoring programmes

Adding water quality and quantity monitoring stations in different locations (starting from locations in water bodies at risk) is most important recommendation for filling out data gaps. Collecting sufficient water quantity and quality data is also required for further monitoring of the effect of measures taken according to PoM for each water body at risk.

A new WFD compliant monitoring programme should be designed for the basin. The programmes should integrate chemical, hydromorphological and biological monitoring. The programme should be based on the basin characterization elaborated in line with the WFD, and address all water bodies.

Good Laboratory Practice should be fully implemented in the Laboratory of the National Environmental Monitoring Department in a structured way that in the end of the process fulfils the requirements for an accreditation in line with international standards.

As a part of the introduction of Good Laboratory Practice quality assurance/quality control elements should be introduced during the whole monitoring process at the of the Laboratory of the National Environmental Monitoring Department (sampling, analysis, data processing and reporting) to avoid any misinterpretations and confusions about the data

The Laboratory of the National Environmental Monitoring Department should start with improvement of the conditions and capacities to introduce the monitoring of the biological quality elements into the monitoring programmes

Training and international cooperation

We recommend using the programmes established by the EU for capacity building as this would be a very efficient way to build capacity for River Basin Management in line with the WFD. The relevant EU programmes include the following:

- TAIX (Technical Assistance and Information Exchange)[19]
- Twinning (The Twinning programme aims to help beneficiary countries to develop modern and efficient administrations, with the structures, human resources and management skills needed to implement the EU acquis.)[20]
- Tempus (purpose: to modernise higher education in EU neighbours)[21]
- Erasmus Mundus (modernisation of education)[22]

ANNEX I - Pilot Water Quality Classification Scheme of the Surface Water Bodies in Pilot River Basins

[19] TAIEX is a quick and flexible tool, which assists partner administrations in their efforts to understand, harmonise or implement rules and regulations over a wide range of subjects. It also identifies possible issues for future joint working between the EU and its neighbours. http://ec.europa.eu/europeaid/where/neighbourhood/overview/taiex_en.htm

[20] Twinning is a European Commission initiative that was originally designed to help candidate countries acquire the necessary skills and experience to adopt, implement and enforce EU legislation; http://ec.europa.eu/europeaid/where/neighbourhood/overview/twinning_en.htm

[21] Tempus supports the modernisation of higher education and creates an area of co-operation in countries surrounding the EU. http://ec.europa.eu/education/external-relation-programmes/doc70_en.htm

[22] Support in the fields of in the fields of education and training, citizenship, youth, audiovisual and culture. http://eacea.ec.europa.eu/erasmus_mundus/programme/programme_guide_en.php

1. Introduction

Note
This document does not have the purpose to replace the surface water quality Classification schemes existing in the project countries, but it aims to help beneficiaries to assess the surface water quality status in Pilot River Basins, in a way that facilitates the link to the pressures and subsequent the establishment of the Programme of Measures (PoM) in line with the WFD methodology

For the assessment of water resources, preferably monitoring data and other information allowing quantitative estimation of ecological conditions and trends and evaluation of effectiveness of the water management measures and policies are used. However, raw monitoring data should be transformed and presented in the understandable and effective way for the decision making process. Such information may be received from the classification in water quality classes based on the monitoring data.

According the WFD, the main European policy is to restore the ecological status of the surface waters. Only for priority substances general EU standards for water quality have to be established according the WFD. Member Countries shall establish classification schemes adapted to the natural characteristics of water body types. Classification system is focussed on the biological water quality elements. Chemical water quality elements are according the WFD used to support the ecological water quality assessment of surface water bodies. Classification systems based on the different water uses (Maximum Allowable Concentrations) no longer fit with this policy.

As it was found in the previous activities of the EU Kura River project, assessment and classification approaches of the river water quality in the project countries are different and results are not comparable. In all three EU Kura project countries, approach based on Maximum Allowable Concentrations is officially applied to assess the surface water quality in monitored rivers. There is a great need in the Kura River region for a WFD compliant assessment of surface water quality, which will be based on five quality classes, adequate to European policy.

It was decided to prepare the Classification system, to assess the surface water quality status in the Pilot River Basins, where River Basin Management Plans was to be elaborated. The most important part of the proposed classification system is the principles for the classification based on chemical monitoring data. The parametric values for determining the borders between the quality classes can be adjusted according to experiences gathered during monitoring. Development of the background/reference concentrations for heavy metals, will be as organic part of this Classification system, as well.

Based on the requirements of the EU water policy and current situation in the Kura River region, it is expected that, the proposed Classification system will contribute:

- to harmonization of the surface water quality targets (i.e. a common definition of the 'good' quality status) for all surface water bodies in Pilot River basins,
- to promoting assessment method for identification of water bodies at risk to achieve Environmental Objectives (later to establishment of Programme of Measures).

Furthermore, this Classification system is intended to be readily understood by users and casual observers.

Classification system is based on the following:

- since no results of biological monitoring are available, only chemical water quality parameters were used,
- water quality parameters were selected based on the existing pressures in the Kura River basin and present data availability in the EU Kura River project countries (oxygen/nutrient regime parameters – organic pollution and eutrophication, heavy metals - pollution from mining activities, specific organic substances – diffuse pollution from using pesticides and other activities),
- water quality parameters representing heavy metals and specific organic substances were subdivided into two groups:
    - *Relevant for Pilot River Basin*
    - *EU WFD Priority Substances*
- water quality classes were used as defined in EU WFD, and threshold values for individual classes were used from Danube River Classification Scheme (*ICPDR, 2008) and Slovak Technical Standard (Phenols and Petroleum hydrocarbons),*
- EU WFD Priority Substances parameters will be assessed in accordance with approach defined in *EC Directive 2006/0129 (COD) for Priority Substances,*
- principle "One out, all out", will be used to classified water bodies (at risk to achieve "Good Status"),
- statistical method in combination with geological expert judgement is used to estimate the background/reference concentrations for heavy metals (assuming, given river basins geochemical environment is quasi-homogenous body),
- water quality parameters from National water quality databases will be used for assessment (known origin and quality of data sets).

2. Purpose

The main aim of this Working paper on Water Quality Classification of the surface water bodies is to support the process of preparation of draft sub-catchment River Basin Management Plans for 5 Pilot basins as identified by the EU Kura project and beneficiaries. More specifically, Classification system:

- should be used to assess the water quality status of the surface water bodies,
- to give more insight on the identification of the water bodies at risks (to fail Environmental Objectives defined by EU WFD),
- facilitate linking the water quality with the impact of the pressures and subsequent support the establishment of the PoM.

3. Selection of water quality parameters

Water quality parameters were selected to cover the main water related issues in the Kura River basin and on the data availability. These parameters were as follows:

Oxygen/Nutrient regime - *dissolved oxygen, BOD5, COD-Cr, ammonium, nitrite, nitrate and ortho-phosphate concentrations,*

Heavy metals (total)

Relevant substances per Pilot River Basin – Zn, Cu, Cr and As
EU WFD Priority substances – Cd, Pb, Hg and Ni

Specific organic substances

Relevant substances per Pilot River Basin – phenols, petroleum hydrocarbons, lindane, heptachlore

EU WFD Priority substances – DDT total , p,p-DDT, hexachlorocyclohexane

4. Classification system

"Environmental quality standard (EQS)" means the concentration of a particular pollutant or group of pollutants in water, sediment or biota which should not be exceeded in order to protect human health and the environment (EU WFD).

AA-EQS *is the EQS expressed as an annual average value, protective against long-term (chronic) pollution on aquatic organisms.*

MAC-EQS is the EQS expressed as a maximum allowable concentration, protective against short-term (acute) pollution peaks on aquatic organisms. (EC Directive 2008/105/EC) see

(http://www.kuraarasbasin.net/EU_KuraAras_webpage/Main_Events_files/EC%20Directive%202008_105_EC%20on%20environmental%20quality%20standards%20in%20the%20field%20of%20water%20policy.pdf)

As it was already mentioned earlier existing water quality standards on both EU and Member States levels were used in development of the Classification schemes (no standards were developed from scratch) for selected groups of water quality parameters. The standards used in ICPDR Classification system for oxygen/nutrient regime parameters were used (with small correction in dissolved oxygen) (see Table 1).

Table 1 Pilot River basin Classification scheme for oxygen/nutrient regime

Quality classes*/ Parameters	**Unit**	**High**	**Good**	**Moderate**	**Poor**	**Bad**
Oxygen/Nutrient regime						
Dissolved oxygen	mg/l	8	6	5	4	< 4
BOD_5 (mg/l)	mg/l	3	5	10	25	> 25
COD_{Cr}	mg/l	10	25	50	125	> 125
Ammonium-N	mg/l	0,2	0,3	0,6	1,5	> 1,5
Nitrite-N	mg/l	0,01	0,06	0,12	0,3	> 0,3
Nitrate-N	mg/l	1	3	6	15	> 15
Ortho-phosphate-P	mg/l	0,05	0,1	0,2	0,5	> 0,5

Source: TNMN Yearbook and database in 2006 (ICPDR 2008)

In case of heavy metals, they have been subdivided into two groups. The first group of heavy metals was created by those which are just relevant for the Pilot River basin. Here, similarly to the oxygen/nutrient regime ICPDR Classification system was used. In the second group heavy metals defined as Priority Substances under EU WFD were included and classified in accordance with *EC Directive 2008/105/EC* (see Table 2).

Table 2 Pilot River basin Classification scheme for heavy metals (total)

Quality classes*/ Parameters	**Unit**	**High**	**Good**	**Moderate**	**Poor**	**Bad**
Relevant substances per Pilot RB[a]						
Zinc	µg/l	bg[I]	100	200	500	> 500
Copper	µg/l	bg	20	40	100	> 100
Chromium	µg/l	bg	50	100	250	> 250
Arsenic	µg/l	bg	5	10	25	> 25
EU WFD Priority substances[b]						
	Unit	**AA-EQS** **		**MAC-EQS*****		
Cadmium *(in dependence on the class of water hardness)*[II]	µg/l	≤ 0,08 (class 1) 0,08 (class 2) 0,09 (class 3) 0,15 (class 4) 0,25 (class 5)		≤ 0,45 (class 1) 0,45 (class 2) 0,6 (class 3) 0,9 (class 4) 1,5 (class 5)		
Lead	µg/l	7,2		Not applicable		
Mercury	µg/l	0,05		0,07		
Nickel	µg/l	20		Not applicable		

Source: [a]TNMN Yearbook and database in 2006 (ICPDR 2008) and[b] EC Directive 2008/105/EC for PS.

[I] bg – background/reference concentration

[II] Water hardness: class 1: <40 mg $CaCO_3$/l, class 2: 40 to <50 mg $CaCO_3$/l, class 3: 50 to <100 mg $CaCO_3$/l, class 4: 100 to <200 mg $CaCO_3$/l and class 5: ≥200 mg $CaCO_3$/l.

Several specific organic substances are measured in the Kura River basin, both as sum parameters and as individual substances. Therefore, only those which were found listed in the protocols of analysis are included in the Classification scheme for specific organic substances (see Table 3).

Table 3 Pilot River basin Classification scheme for specific organic substances

Quality classes*/ Parameters	**Unit**	**High**	**Good**	**Moderate**	**Poor**	**Bad**
Relevant substances per Pilot RB						
Phenol index[c]	mg/l	0,01	0,02	0,1	0,5	> 0,5
Petroleum hydrocarbons[c]	mg/l	0,01	0,05	0,1	0,3	> 0,3
Heptachlore	µg/l	0,05	0,1	0,2	0,5	> 0,5
Lindane[a]	µg/l	0,05	0,1	0,2	0,5	> 0,5
EU WFD Priority substances[b]						
	Unit	**AA-EQS** **		**MAC-EQS*****		
DDT total	µg/l	0,025		Not applicable		
para-para-DDT	µg/l	0,01		Not applicable		
Hexachlorocyclohexane	µg/l	0,02		0,04		

Source: [a]TNMN Yearbook and database in 2006 (ICPDR 2008), [b]EC Directive 2008/105/EC) for PS and [c]Slovak Technical Standard STN 7221 Classification of surface water.

**Quality classes as defined in the WFD:*

> ***high status**: little or no sign of anthropogenic disturbance*
>
> ***good status:** slight changes compared to the natural condition*
>
> ***moderate status:** moderate changes compared to the natural condition*
>
> ***poor status:** biological communities deviate substantially from those normally associated with the surface water type under undisturbed conditions*
>
> ***bad status:** large portions of biological communities normally associated with the surface water type under undisturbed conditions are absent*

***AA-EQS – Average annual Environmental Quality Standard*

****MAC-EQS – Maximum annual Environmental Quality Standard*

5. Background concentrations of heavy metals

The assessment of heavy metals from human-made activities on surface waters is difficult due to the natural enrichment of metals in surface material and topsoil as a result of the influence of mineralized bedrock in the region. Therefore, it is required to make some examination of the study area (Pilot River basin) with respect the natural conditions of heavy metals contents in the surface waters, which also reflect the geological diversity of the region. This investigation/monitoring should be done presumably at the least anthropogenically influenced background sites in the Pilot River basins (reference sites).

5.1 Methods to develop background concentrations

The background values of heavy metals for the purpose of this document may be defined as both spatial and time characteristic concentrations of the heavy metals in surface waters without any anthropogenic influences. There are several methods and approaches to establish or to calculate such background values. Some of them are as follows:

- Estimation of the background concentration values of heavy metals in natural areas without, or at least minimal anthropogenic impacts,
- Estimation of the background values from the sediments of lakes, floodplain areas and soils,
- Geochemical methods,
- Statistical methods,
- Combined methods and others.

As the most convenient method to be used in this part of the project was selected statistical method in combination with correction made by geochemical expert judgement. The first three methods will need more expert knowledge, time and financial resources, which are beyond the scope of this project.

5.2 Statistical method and geological corrections

One of the statistical method, which can be used to estimate the background concentrations of heavy metals, is theoretical log-normal distribution defined by two parameters (mean value μ and standard deviation σ). This method is simple and stable, and do not need large time series of the water quality data. Current commercial statistical software can be used, or also program made in MS Excel, if more calculations are needed.

Following steps will be made to estimate the background concentrations of heavy metals in the Pilot River basin:

8. Selection of the sampling sites with natural, or minimal anthropogenic influence, where heavy metals concentrations are available,
9. Whole data sets are used to calculate statistical parameters,
10. One value, close to "0" is added to the original data sets (detection limit divided by 100). This value will approach distribution function close to "zero" concentration.
11. All values of data sets will be re-calculated as log-values,
12. Both mean value μ and standard deviation σ are calculated from the log-values data sets,
13. Calculation of the given percentile in the range from 50 to 90-tile for original data sets will be done,
14. Estimation of the background values from the log-normal probability curve, as percentile, where sudden concentrations arisen appeared (see Fig.) and corrections made by the expert judgement, compared to the geochemical conditions, if necessary.

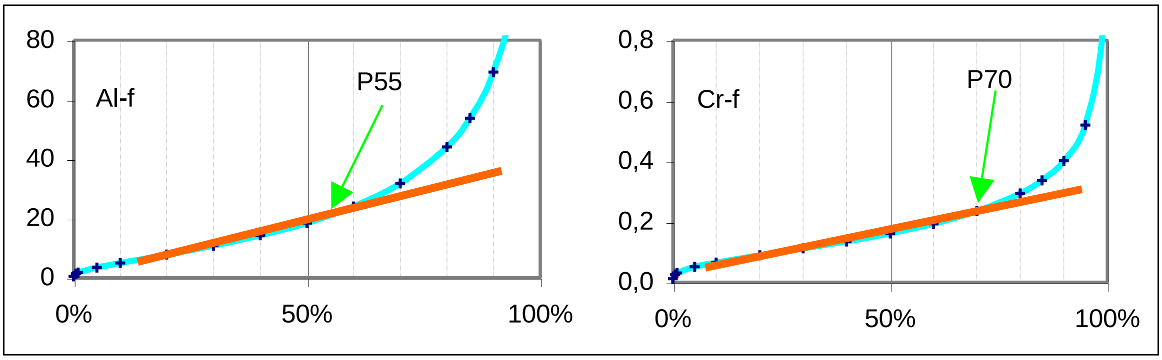

Figure 1 Estimation of the percentiles as background concentrations (Pekarova, 2008)

6. Assessment of the water quality status

6.1 Oxygen/Nutrient regime

Input data to assess the surface water status related to oxygen/nutrient regime will be used from the official databases of the EU Kura River project. The following steps will be done to classify the surface water (see Scheme 1).

9. Average annual concentration (AAC) will be calculated for each water quality parameter from the available data sets and for each sampling site in the Pilot RB.
10. Calculated Average annual concentrations will be compared with the values in the Classification scheme for oxygen/nutrient regime (Table 1) and put into classes.
11. If, the AAC is lower or equal to the 2nd class (Good class), the sampling site for specific parameter is in Good status (achieving the Environmental Objectives as defined by EU WFD). If it is not a case (AAC is higher to the 2nd class), sampling site will be classified as failing to achieve good status.
12. Based on the results from the previous point 3, water body represented by the sampling site will be presented on the GIS Map (see Table 4).

Table 4 Colour-coded classified surface water body to be presented on the GIS Map

Status Classification	Colour Code

High	Blue
Good	Green
Moderate	Yellow
Poor	Orange
Bad	Red

6.2 Heavy metals

Input data of heavy metals, Ca and Mg (to calculate the hardness), for classification of the water quality status with regards heavy metals contents, will be taken from the official databases of the EU Kura River project countries, where it is expected that certain quality of data is ensured. The assessment will be done separately for the part of heavy metals, which are just Relevant for the Pilot RB and those, which are on the WFD List of Priority substances (see Scheme 2).

Relevant substances per Pilot RB (Zn, Cu, Cr and As)

1. Average annual concentration (AAC) will be calculated for each heavy metals from the available data sets and for each sampling site in the Pilot RB. *In case of concentration values of heavy metals below the detection limit (or Limit of Quantification), these will be used as 50% of the detection limit in calculating Average annual concentrations. If, there is more than 90% of measured concentration values below the detection limit the sampling site will be classified in class 1 for specific heavy metal.*
2. Calculated Average annual concentrations will be corrected for background concentrations (AAC - bg) and subsequently compared with the values in the Classification scheme for heavy metals (Table 2) and put into classes.
3. If, the AAC is lower or equal to the 2^{nd} class (Good class), the sampling site for specific heavy metal is in Good status (achieving the Environmental Objectives as defined by EU WFD). If it is not a case, sampling site will be classified as failing to achieve good status.
4. Based on the results from the previous point 3, water body represented by the sampling site will be presented on the GIS Map (see Table 4).

EU WFD Priority substances (Cd, Pb, Hg and Ni)

1. Average annual concentration (AAC) will be calculated for each heavy metal from the available data sets and for each sampling site in the Pilot RB. *In case of concentration values of heavy metals below the detection limit, these will be used as 50% of the detection limit in calculating Average annual concentrations. If, there is more than 90% of measured concentration values below the detection limit the sampling site will be classified in class 1 for specific heavy metal.*
2. In case of Cd, it is necessary to classify the water in sampling site specifically for hardness as $mg\ CaCO_3/l$. Measured concentrations of Mg and Ca will be multiplied by 100,0872 that is M $CaCO_3$ in $g.mol^{-1}$, and by coefficient 1,784 (that is ratio of M $CaCO_3$/ M CaO).
3. From the received classes of water hardness Average annual water hardness will be calculated and this class will be used to classify AAC for Cd. When applying MAC-EQS, that water hardness class will be used, when maximum concentration of Cd was measured.

4. Calculated AAC of 4 heavy metals will be decreased by background concentrations (AAC – bg) and compared with AA-EQSs (Table 2), the same will be done in case of MAC, if applicable (compare with MAC-EQS).
5. If, the AAC is lower or equal to AA-EQS, the sampling site for specific heavy metal is in Good chemical status (achieving the Environmental Objectives as defined by EU WFD). If it is not a case, sampling site will be classified as failing to achieve good status.
6. Based on the results from the previous point 5, water body represented by the sampling site will be presented on the GIS Map as water body failing to achieve good status (red colour) or as delineated water body achieving "Good Status" (blue colour).

6.3 Specific organic substances

Similarly to heavy metals, specific organic substances are going to be classified in two ways. The first group which is just relevant for the Pilot River basin and the second one are those chemical substances which are on the WFD List of Priority substances (see Scheme 3).

Relevant substances per Pilot RB (phenols, petroleum hydrocarbons, lindane, heptachlore)

1. Average annual concentration (AAC) will be calculated for each water quality parameter of this group from the available data sets and for each sampling site in the Pilot RB. *In case of concentration values of the parameters are below the detection limit (or Limit of Quantification), these will be used as 50% of the detection limit in calculating Average annual concentrations. If, there is more than 90% of measured concentration values below the detection limit the sampling site will be classified in class 1 for specific water quality parameter of this group.*
2. Calculated Average annual concentrations will be compared with the values in the Classification scheme for heavy metals (Table 3) and put into classes.
3. If, the AAC is lower or equal to the 2nd class (Good class), the sampling site for specific heavy metal is in Good status (achieving the Environmental Objectives as defined by EU WFD). If it is not a case, sampling site will be classified as failing to achieve good status.
4. Based on the results from the previous point 3, water body represented by the sampling site will be presented on the GIS Map (see Table 4).

EU WFD Priority substances (DDT total, p,p-DDT, hexachlorocyclohexane)

1. Average annual concentration (AAC) will be calculated for each parameter of this group from the available data sets and for each sampling site in the Pilot RB. *In case of concentration values of specific chemical substance are below the detection limit, these will be used as 50% of the detection limit in calculating Average annual concentrations. If, there is more than 90% of measured concentration values below the detection limit the sampling site will be classified in class 1 for specific chemical substance.*
2. Calculated AAC of the parameters will be compared with AA-EQSs (Table 3), the same will be done in case of MAC, if applicable.
3. If, the AAC is lower or equal to AA-EQS, the sampling site for specific heavy metal is in Good chemical status (achieving the Environmental Objectives as defined by EU WFD). If it is not a case, sampling site will be classified as failing to achieve good status.
4. Based on the results from the previous point 3, water body represented by the sampling site will be presented on the GIS Map as water body failing to achieve good status (red colour) or as delineated water body achieving "Good Status" (blue colour).

7. Conclusions

One of the basic steps to provide the information on water quality for decision making process is to prepare the appropriate assessment system. Classification of the surface water bodies should be one of the approaches. Due to fact, that in the Kura River basin countries there are no common classification systems used, it was decided to prepare the simple Classification system for surface water for selected number of water quality parameters. This Classification system is specifically targeted to be used in the 5 Pilot River Basins for pressure-impact analysis, the WBR identification and subsequently in the establishment of the PoM for the pilot basins of the EU Kura River project.

This Classification system was based on EU WFD to follow the EU water policy as much as possible, and the existing systems in EU Member States and ICPDR (Danube River).

Following surface water quality parameters were included into the classification schemes:

Oxygen/Nutrient regime *- dissolved oxygen, BOD5, COD-Cr, ammonium, nitrite, nitrate and ortho-phosphate concentrations,*

Heavy metals (total)
Relevant substances per Pilot River Basin – Zn, Cu, Cr and As
EU WFD Priority substances – Cd, Pb, Hg and Ni

Specific organic substances
Relevant substances per Pilot River Basin – phenols, petroleum hydrocarbons, lindane, heptachlore
EU WFD Priority substances – DDT total , p,p-DDT, hexachlorocyclohexane

Estimation of the background/reference concentrations of the heavy metals will be done by the Statistical method (Log-normal distribution) with expert corrections on geochemistry of the pilot areas.

This classification system will be used just for the purpose of the EU Kura Rive project, and do not have any implications with classification and assessment system used on national levels in the region.

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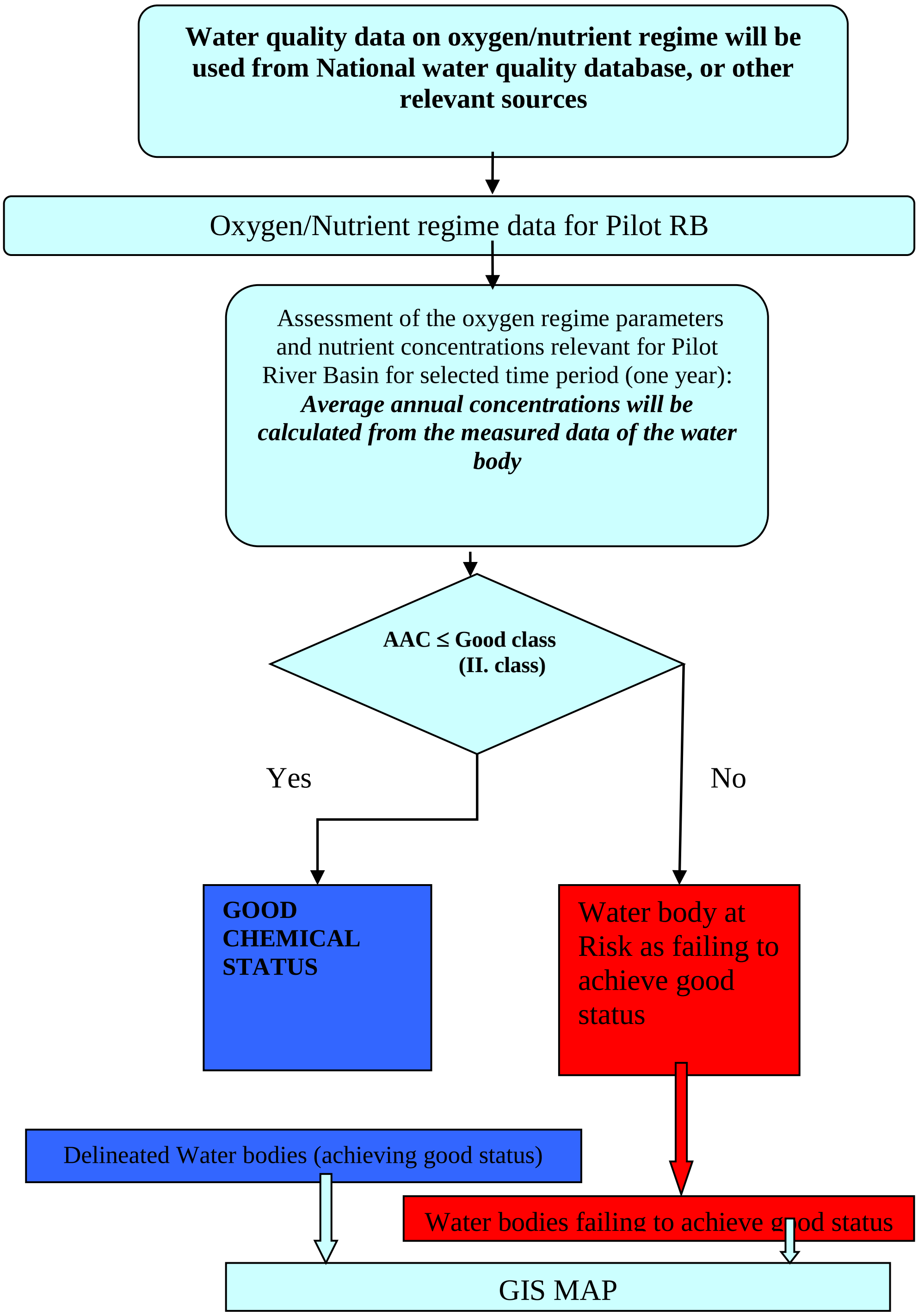
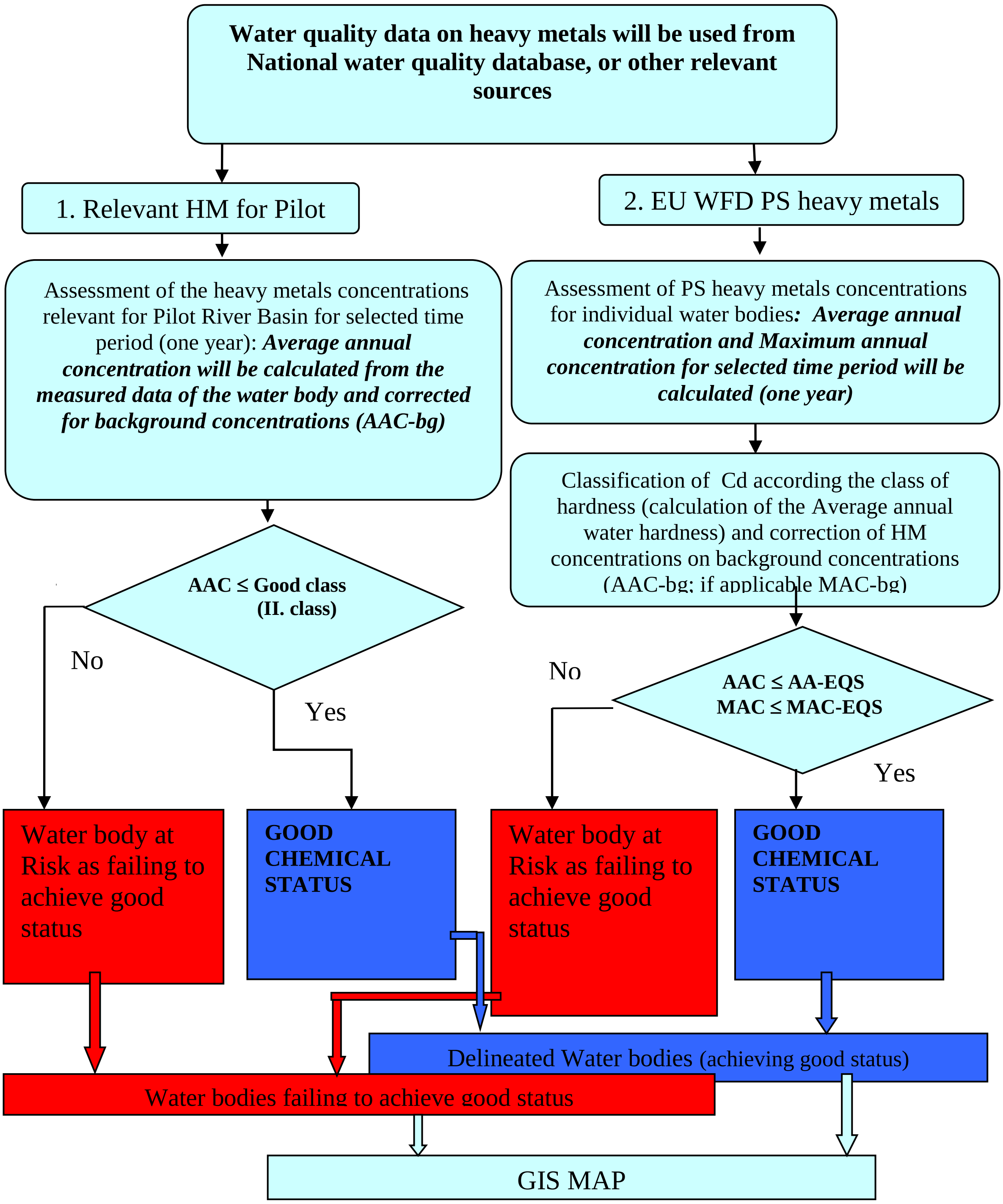
Scheme 1 Classification approach for oxygen/nutrient regime parameters of surface water bodies



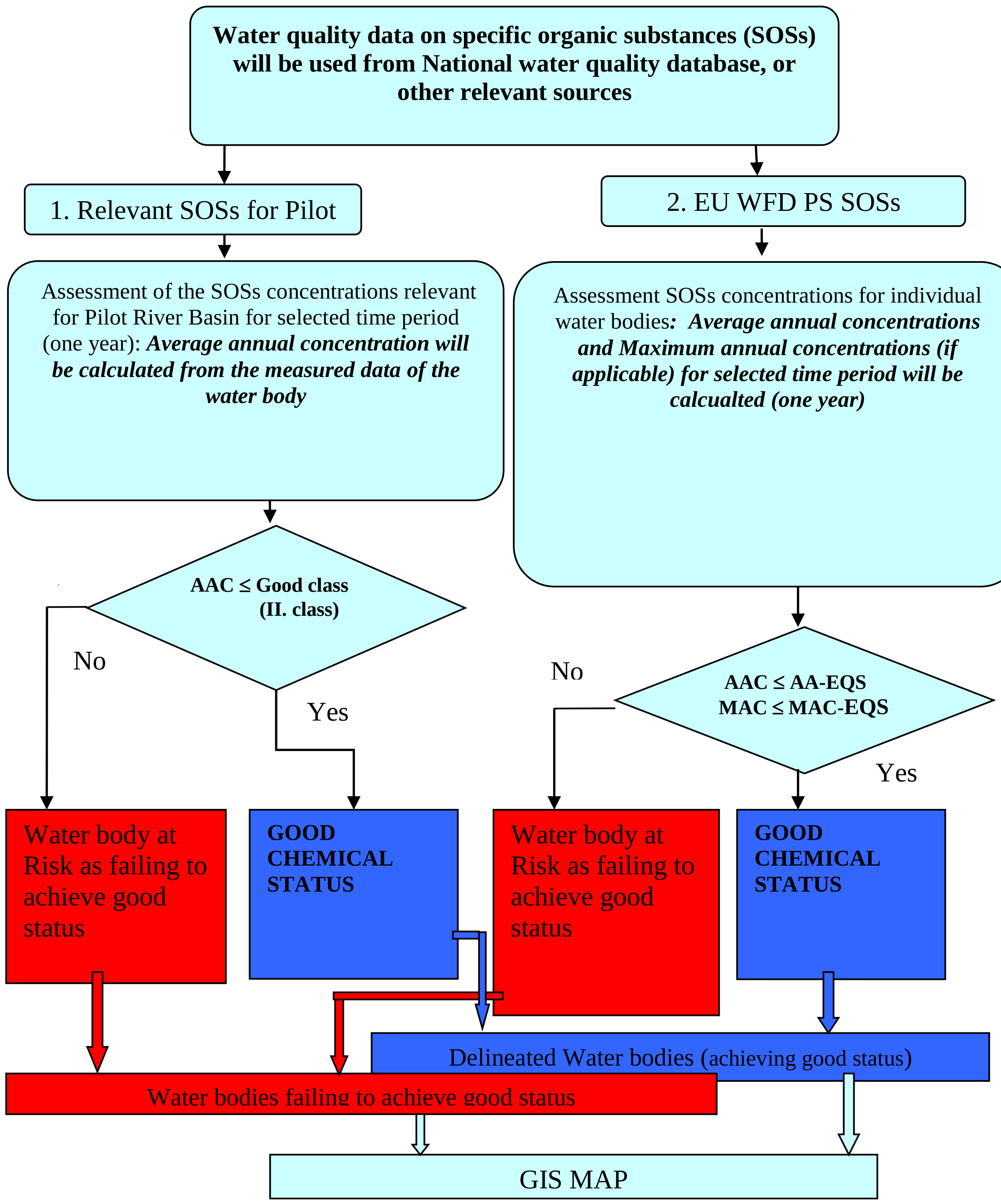
Note: blue and red colour is used just to differentiate between achieving and failing to achieve good status of surface water bodies.

Scheme 2 Classification approach for heavy metals of surface water bodies



Note: blue and red colour is used just to differentiate between achieving and failing to achieve good status of surface water bodies.

Scheme 3 Classification approach for specific organic substances of surface water bodies



Note: blue and red colour is used just to differentiate between achieving and failing to achieve good status of surface water bodies.