Environmental Protection of International River Basins Project

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Deliverable 3 - Develop programmer of measures, including preparation of proposal on construction of water reservoir near river to regulate water resources

WATER RESOURCE USE STUDIES IN SELECTED TRANSBOUNDARY TRIBUTARIES (ZAYAMCHAY AND GOSHGARCHAY) IN THE CENTRAL KURA PILOT BASIN OF AZERBAIJAN COMBING IWRM AND WFD OBJECTIVES THROUGH ESTABLISHMENT OF ENVIRONMENTAL FLOWS AND EQOS

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Contents

ABBREVIATIONS

1. EPIRBP – Environmental Protection of International River Basins Project
2. EU – European Union
3. GIS – Geographic Information Systems
4. GW – Ground waters
5. HPPs – hydropower plant
6. IRBMP- Integrated River Basin Management Plan
7. IWRM- Integrated Water Resources Management Plan
8. MENR- Ministry of Ecology and Natural Resources
9. NHD- National Hydrometeorology Department
10. NEGE- National Geological and Engineering Geological Expedition
11. OJSC- Open Joint Stock Company
12. PoM – Programme of Measures
13. SW – Surface Waters
14. ToR- Terms of Reference
15. WFD – Water Framework Directive
16. Cap-Net- UNDP International Network for Capacity Development in Sustainable Water Management

INTRODUCTION

In this report more detailed analyses of water demands and use issues have been conducted and modern approach on improved water allocation planning by use of IWRM principles have been applied for water management in Zayamchay and Goshgarchay rivers basins.

This report is about programmer of measures , including preparation of proposal on construction of water reservoir near river to regulate water resources

The project beneficiaries and stakeholders who will need to be consulted during implementation of this project include:

- Ministry of Ecology and Natural Resources
- State Water Resources Agency, under the Ministry of Emergency Situations
- National Environmental Monitoring Department, under the Ministry of Ecology and Natural Resources
- National Hydro-meteorology Department, under the Ministry of Ecology and Natural Resources
- Hydro-geological Expedition, under the Ministry of Ecology and Natural resources
- Azerbaijan Amelioration and Water Farm OJSC
- Azersu JSC on Drinking Water Supply and Sanitation
- Water users in the pilot areas
- All other stakeholders and general public of Zayamchay and Goshgarchay river basins.

Has been conducted water economy balances for each of rivers. The water balance compose such components as surface water flow ground water inflow , water use data and etc. Included into equations are also ecological flow amounts for each of rivers for different locations.

According to established watermanagement objectives developed water allocation shcemes, which is based on consideration as a first priority the environmental flow values and human water consumption and also water demand management for priority sectors in different sections of Zayamchay and Goshgarchay rivers..

In order to meet flow requirements of ecosystems, population water demand, and integrate water users across the basin within the water allocation plan covering 2015-2035 has been identified number of pilot projects to conduct study of feasibility of basin wide priority measures to be implemented in coming years. As each year depending of increase of population, climatic changes and for other reasons impact on water resources are increasing therefore planned measures take into account these impacts and need to be implemented immediately to meet IWRM requirements.

5. MAIN WATER MANAGEMENT OBJECTIVES

It is logical that IWRM should be focused on a set of basic **water resources management functions**. This includes a description of the basic water resources management functions and introduces water management objectives as a way for performing these functions.

According to Cap-Net Program(www.cap-net.org) main water management objectives and their implementation indicators should be like those given in Table 35

Table 35. Minimum Indicator Set for Water Resources Management

Function	Water Management Objectives	Progress indicator	Unit/ definition
WATER ALLOCATION Allocating water to major water users and uses, maintaining minimum levels for social and environmental use while addressing equity and development needs of society.	Major water users are known and are managed through a licensing (or permit) system.	1. Number of surface and groundwater users licensed according to the regulations.	Number. Number of licenses issued. May be further subdivided by use.
	Water allocation is in line with sustainable use, economic efficiency and social equity principles.	2. Water allocation criteria include use efficiency, economic benefit and social goals.	Review. Examine allocation criteria for compliance with IWRM principles.
		3. % of time environmental and social reserve is maintained in major water courses.	%. Number of records from water resource monitoring stations with flows lower than the reserve divided by the total records x 100. A determination of the reserve is required.
MONITORING Implement effective monitoring systems that provide essential management data and identify and respond to infringements of laws, regulations and permits.	The water allocation system is effective and permits are being complied with.	4. Proportion of water allocation permit holders complying with permit conditions.	%. From monitoring visits the number not complying with conditions divided by the total number of visits.
		5.	
	Knowledge of water resource availability is a basis for management.	6. Number of water resource monitoring stations producing reliable data.	Number. Number of stations with reliable data records.
		7. Total water storage capacity.	Mm^3. The water storage capacity in artificial storage structures above a minimum size (say

Function	Water Management Objectives	Progress indicator	Unit/ definition
			5,000 m^3).
		8. % groundwater monitoring stations with declining water levels.	%. Comparison of water levels over a 5 year period.
ECONOMIC AND FINANCIAL MANAGEMENT Applying economic and financial tools for cost recovery and behavior change to support the goals of equitable access and sustainable benefits to society from water use.	Water use efficiency improving through use of economic and financial instruments.	9. Charges and fees for water allocation favor the poor and promote efficient water use.	Review. Examine for the application of economic and financial tools in water allocation.
		10. Bill collection ratio.	%. Total revenue divided by the total amount billed.
INFORMATION MANAGEMENT Provide essential information necessary to make informed and transparent decisions for development and sustainable management of water resources in the basin.	Essential data is processed and packaged as information at the right level for specific managers and stakeholders to support transparent decision making and to gain commitment and political support for the decisions made.	11. Data base is established in formats compatible with other river basin organizations.	Review. Data base is transferable across basins in the country and for transboundary systems.
		12. Water management information is available to managers and other stakeholders as required.	Review. Examine availability of basin information and reports on water resource management indicators.
STAKEHOLDER PARTICIPATION Implement stakeholder participation as a basis for decision making that takes into account the best interests of society and the environment in the development and use of water resources in the basin.	Effective cooperation between government agencies with responsibilities for water management or water use in the basin.	13. Number of meetings of Government agencies with water interests to consult and collaborate on water management.	Number. Number of formal or ad hoc meetings at interagency level.
	Stakeholder participation is institutionalized in the management of the river basin.	14. Formal stakeholder structures established with clear roles and responsibilities in water resources management.	Review. Examine basin water management structure for stakeholder organizations and allocated management roles.
		15. Basin stakeholders (male	Number.

Function	Water Management Objectives	Progress indicator	Unit/ definition
		and female) represented in decision making bodies at all levels.	Representatives from stakeholders serving in government water management structures.

Water management objectives for Water Allocation in the basin are:

- Assess available water resources and environmental and human water needs
- Ensure major water users are known and are managed through a licensing or permit system.
- Implement water allocation in accordance with sustainable use, economic efficiency and social equity principles.

In river basins such as Zayamchay and Goshgarchay, where there is water scarcity, or will be in the future, there is a need to regulate the water usage to ensure sustainable, equitable and efficient utilization of the resource. The regulation of the water resources is normally made through a **permit or licensing system**, which enable the government or state authorities to allocate the resources taking into account all stakeholder interests, including the environment.

According to international practices water allocation is about allocating water to users and uses while maintaining necessary levels for basic human needs and the environment. In water scarce regions, equitable and reasonable utilization of the water resources is one of the key parts of IWRM and is normally expressed explicitly as a water governance principle in international and national water laws and policies.

Equity in this sense does not mean that everyone should be given an equal amount of water. It means that everyone has fair opportunities to access, use and control of the water resources. It also means that everyone must take the responsibility for the negative side effects of abstracting water so that no part of the society will be disadvantaged.

In regions of water scarcity or competition the first water resources management objective linked to allocation is therefore to have a water permit system in place to enable the authorities to control water usage. This allocation system or procedure is also the appropriate vehicle to implement other water management objectives related to equity and efficiency.

The first water management objective identifies the need for an allocation system and the second water management objective prescribes some of the criteria that should be used when making allocation decisions.

One of the fundamentals of water allocation is that any form of abstraction, transfer, storage or other influence on a natural stream has effects in the entire downstream river system.

To analyze the effects of a new requested activity in a river for authorization purposes, the whole river system must therefore be analyzed as one unit.

In Cap-Net Program(www.cap-net.org) is clearly described below elements of system analyze indicating that the main principles that have to be understood by the RBO and have to be educated to the stakeholders are:

1. Water allocation has to take into account the temporal variation of river runoff;
2. Water allocation must be made on the appropriate scale;
3. Water allocation is influenced by the assumed future socio-economic development, especially in water-scarce regions; and
4. Water allocation is in almost all cases based on uncertain input data and can therefore not provide guarantees.

System analysis is to compare all water demands in a river basin with the water availability in the system, both for existing and future water conditions, as well as with current and possible future water infrastructure.

When analyzing a water permit application it is therefore essential to choose the **correct scale**. This scale has to be chosen so that effects of the water abstraction on downstream stakeholders are not overlooked but at the same time keeping the system small enough to be workable and understandable. Again for individual stakeholders, the explanation that his/her abstraction is only one of many and that the accumulated effects of all abstractions may be affecting others located very far away is important to accept water allocation decisions.

Groundwater resources are an important part of the system analysis. Although normally small compared to surface water resources, the availability of groundwater does not vary as much with the seasons. During dry periods, which govern the allocated amount of water, the contribution from groundwater may be significant.

An essential part of the system analysis is to predict the future socio-economic development. In general terms, the more development, the more water demand although improved economic conditions also provides for water demand management. The assumed economic development thus directly influences how much water can be allocated to guarantee a sustainable situation also during future conditions. Since socio-economic development is very difficult to forecast, the normal procedure is therefore to do system analysis under different **scenarios.** This means that the decision on water allocation also has to include a choice of which scenario of economic development to adopt.

The basic information that needs to be included in an application for a water permit and which provides the base for the approving process is:

- Where is the water abstracted and from what source;
- How much and when is water abstracted;
- How is water abstracted; and
- What is the abstracted water used for.

In cases of Zayamchay and Goshgarchay rivers with water scarcity if there is a purpose to abstract large volume of water or if a significant storage is to be built with large outtakes and altering of the river regime a full system analysis must probably be made covering all downstream river reaches.

As a minimum a hydrological assessment must be made for all water permit applications where the abstraction is compared with the available water resources taking into account water use for basic human needs and environment.

The next step involves a comparison with the available water resources taking all other outtakes into account. This analysis involves prioritization, reliability of supply and certification issues of water and is therefore much more complicated. This step is where the water management objective of equity and social priorities is addressed.

Allocation mechanisms should be applied that promote efficient use and favor uses that have greater impact on social and economic development. These criteria may be more difficult to apply initially but will become necessary as water resources become more limited.

The setting of criteria for water allocation should include all the above issues; prioritization, reliability of supply and efficiency of use. At the same time it must be simple enough to be applicable and understandable for the stakeholders.

In development of the water allocation plan first of all there is need to take into consideration environmental and social aspects of water use and then analyze different use by involvement of stakeholders from entire basin to be sure that water allocation to users is carried in equitable and efficiency way.

According to Cap-Net IWRM(www.cap-net.org) tool following elements might be included into river water allocation plan:

- Natural flow in the considered area
- Available water resources
- Information about upstream flow abstraction
- Water for human needs
- Ecosystem flow requirements
- Water yields
- Information on water use and users in the section
- Climate change impacts
- Downstream water discharge

Main water scarcity is observed in downstream of rivers, where is taking place water abstraction for different purposes. In upstream of rivers water abstraction isn't high and doesn't have significant impact on water status. Therefore it is reasonable to pay more attention at water allocation plans for areas of Zayamchay river below Yanigli village and for Goshgarchay river below Sarkar village, where there is problem of significant flow reduction in these area as result of water abstraction and requirements of environmental flow isn't met.

Water allocation plan first should be drown based on available water resources, flow needs for ecosystem and human consumption and then other user can be prioritized for water allocation.

AS National Water Supply and Sanitation Program and also draft water strategy is aimed to be cover near 15-20 years therefore it would be reasonable to develop efficiency water allocation plan for similar period of time. Therefore summing all above requirements main water management objectives by 2035 in Goshgarchay and Zayamchay river basins should be provision of efficiency water allocation plan by 2035 taking into account resources availability , prioritized water uses, that takes into account such important elements as ecosystem and human water needs, downstream and upstream relationship and etc. To reach goals below tasks need to be implemented:

- Assessment of all available surface and ground water yields and water demand of different sectors, including environmental flow of rivers and rechargeable capacity of ground waters (2016-2018)
- Development of water allocation criteria taking into account social, environmental and economic aspects, including cost effectiveness of water use and downstream water needs (2016-17).
- To respond to main flow requirements for rivers to estimate possibility of use of local ground waters instead of transferring it from river by different means to large distance (2016-2017)
- Development and enforcement of permit and licensing system(2016-2025)
- Rehabilitation of existing water infrastructure to provide efficiency water supply and reduce water losses(2017-2020)
- Application of best available technology, modern irrigation methods and good agricultural practices to save water(2016-2035)
- Assessment of need and construction of new water abstraction and storage infrastructure based on cost effectiveness criteria (2017-2025)
- Development of water supply and sanitation system for large settlements in the 2 river basins(2017-2030)
- Treatment and reuse of waste waters entering from waste water treatment plants(2016-2035)
- Develop and implement IWRM plans which takes into account availability of water resources, is based on demand management from social, economic and environmental aspects, consider possible trends of water use connected with climate change, population increase, agricultural and economic development (2016-2035)

According to these water management objectives in following sections are described possible water allocation plans and also Programme of Measures for their effective implementation.

6. CURRENT AND FUTURE WATER DEMAND AND ALLOCATIION

According to description in Chapter 4 Annual increase of population in Zayamchay and Goshgarchay river basins makes 0.5 % percent. This may lead to average 10 % population increase in total by 2035. Industrial development also takes place in the region. Main industrial water use takes place in Goshgarchay river basin, but it doesn't have significant impact on water resources quantity of rivers. Small industries are connected to household water supply systems and therefore their demand is included in above 10% human water demand increase.

As mentioned in previous chapter total irrigated area as around 9.7 th. lands in Zayamchay river basin and 5.0 th. ha in Goshgarchay river basin. Water demand to irrigate these lands is about 53.3 **mln. cub.m**. and 27.5 **mln. cub.m**.subsequently according to ADB assessment.

It should be noted that after collapse of former soviet union part of irrigated lands weren't used in agriculture for some economic and technical reasons. But as mentioned in previous chapter area sown for agricultural products are has increased last years and in future agricultural development programs it is expected to extend areas of vineries , grain and vegetables in lands allocated to farmers, which currently used in different purposes or aren't used in agriculture(economy.gov.az).

In different state programs it is supposed to improve state of irrigation network, use modern irrigation technologies and methods to provide efficiency water use and reduce losses. This is expected to be done in coming years/agro.gov.az/.

It should be noted that available water yields should be taken into account when developing of agriculture as it is expected water resources reduction in both rivers which is about 5% now compared to 1990 and by 2035 may reach 10%. Therefore water demand shouldn't exceed water yields available by 2035.

Presuming that in future additional irrigation water needs will be covered by use of water saved in result of implementation of above measures and there will be no need to abstract extra water from surface and ground water sources to irrigate new lands and also water transfer to Tovuz region (from Zayamchay river) will not be increased then current and future water demands in 2 river basins and available surface water resources can be described according to table 36

Table 36 Current and future water demands in Zayamchay and Goshgarchay river basins.

River	Period	Water demand					Available surface water resources	Difference between available waters and water demands
		Irrigation water demand	Human water demand	Water transfer	Ecosystem water demands	Total		
Zayamchay River	Current	53,3	5,80	74,5	36,90	170.5	174,73	4,23
	2035	53,3	6,45	74,5	36,90	171.15	165,59	-5,56
Goshgarchay River	Current	27,5	4,16		11,35	43.01	48,89	5,88
	2035	27,5	4,57		11,35	43.42	46,68	3,26

As one can see from table above currently water demand can be met even only by abstraction of surface waters from rivers if efficiency use of available resources is carried. In this case in order to meet water demands in low flow season(years) there will be need to construct water reservoirs for seasonal

flow regulation or use additional amounts of ground waters in low those seasons (or years) to cover water demands all year-round.

As mentioned before , because of water losses and also uncontrolled water use current water abstraction is higher than water demand and this in turn causes reduction of amount of water, left in river to the level lover than environmental flow(Table 37).

Therefore current state of water allocation system doesn't allow to cover water demand now and in the future even in spite of the fact that currently in addition to use of surface waters certain amount of ground waters also are used to meet current water needs.

Actual irrigation water abstraction from Zayamchay and Goshgarchay rivers and ground water sources (108.1 mln. cub.m and 68.5 mln. cub.m subsequently) which almost 2 times exceed current irrigation water demand. In addition to this water transfer from Zayamchay river by pipes and canals to different areas of Tovuz and Shamkir regions makes 74,6 mln. cub.m.

Current use of surface waters is given in table below

Table 37 Current and future (2035) surface water use in Zayamchay and Goshgarchy river basins to meet water demand

River	Period	Surface water use				
		Available resources	Irrigation water use, water transfer and uncontrolled water use	Human water Consumption	Water left in river	Ecosystem water demands deficit
Zayamchay River	Current	174,73	144,23,	5,36	25,14	-11,76
	2035	165,59	144,23	6,45	14,91	-21,99
Goshgarchay River	Current	48,89	12,6	1,95	25,94	13,34
	2035	46,68	12,6	1,95	23,73	11,73

As one can see from the table current water abstraction from rivers is higher than above demands and is close to rivers water yields available fro use by different sectors (after covering of environmental and human water needs). As mentioned above in order to manage all year-round water demand there is need to construct reservoirs to distribute water from high flow seasons or years to low flow seasons or years. If modern irrigation methods aren't applied and infrastructure isn't rehabilitated to reduce losses and increase water use efficiency then in result of further reduction of water resources by impact of climatic changes there will be difficult to cover water demands in near future.

Also if there will be some new lands to be added into agricultural circulation then extra irrigation water will be required. This also may lead to additional difficulties in managing of increasing agricultural water demands in conditions of impact of future climatic changes. In this regards in parallel with the use of the amount of water, saved in the result of above actions there will be need to use additional amount of water from ground water sources. Available ground water resources and their use currently and in future(without increasing of irrigation water demands) s given in Table 38 .

Table38 Current and future(2035) ground water use in Zayamchay and Goshgarchy river basins to meet water demand

River	Period	Ground water use				
		Available resources	Irrigation	Human water Use	Ground water Transfer	Remained resources
Zayamchay River	Current	123	51,1	0,40	10.0	61,6
	2035	115	51,1	0,40	10.0	55,5
Goshgarchay River	Current	107	47,5	0,51	-	58,9
	2035	102	47,5	0,51	-	53,9

If minimize water losses, strengthen water allocation system and provide seasonal water regulation and use additional ground waters locally in low flow seasons current water allocation system can be improved to the level to cover water demands now and in the future even taking into account increase of human water needs and reduction of surface and ground waters by impact of climatic changes. In cases of need for more irrigation water in the future there will be need to provide deeper flow regulation(by constructing of water reservoirs) and use of additional ground water resources.

Different options for water allocation annually and in summer(august) are considered in next chapter for different sections of rivers.

7. DEVELOPMENT OF WATER ALLOCATION PLAN FOR ZAYAMCHAY AND GOSHGARCHY RIVERS ACCORDING TO IWRM PRINCIPLES

7.1. Water allocation scheme based on current water abstraction and use structure

According to Cap-Net program, GWP IWRM tool EU Directives and other international documents water allocation plan should be based on ecosystem approach taking into account requirements of IWRM principles. In development of the water allocation plan first of all there is need to take into consideration environmental and social aspects of water use and then analyze different use by involvement of stakeholders from entire basin to be sure that water allocation to users is carried in equitable and efficiency way(www.cap-net.org).

In order to develop water allocation plan there is need to assess water economy balance for surface and ground waters.

According to Cap-Net IWRM tool following elements might be included into river water allocation plan:

- Natural flow in the considered area
- Available water resources
- Information about upstream flow abstraction
- Water for human needs
- Ecosystem flow requirements
- Water yields
- Information on water use and users in the section
- Climate change impacts
- Downstream water discharge

As mentioned in previous chapters main water scarcity is observed in downstream of river s where is taking place water abstraction for different purposes. In upstream of rivers water abstraction isn't high and doesn't have significant impact on water status. Therefore it is reasonable to pay more attention at water allocation plans for areas of Zayamchay river below Yanigli village and for Goshgarchay river below Sarkar village, where there is problem of significant flow reduction in these area as result of water abstraction and requirements of environmental flow isn't met.

Flow for ecosystem can be taken from Table 10. Available water resources will show the water resources available in the section without any abstraction. Water for human consumption can be calculated based on multiplying daily rate of water allocated for consumption (180 per person) to the number of population in each section(see tables 39-40)

Table 39. Human water demands in Goshgarchay river basin

Tytle	Source – Zagali water reservoir	Zagali water reservoir – Lower Dashkasan	Lower Dashkesan-New Gizilca	New Gizilca – Sarkar	Sarkar-Mouth	total
Number of population thousands persons	15.1 -	14,0	8.2	6.1 -	19.6 -	63.0
Water for hyman needs	0.03	0.03	0.02	0.01	0.04	0.13

Table 40. Human water demands in Zayamchay river basin

Tytle	Sub basins				Full basin
	Source – Agbashlar	Agbashlar-Yanıkhlı	Yanıkhlı-Tatar	Tatar mouth	
Number of population thousands persons	18.1	14.0	10.2	45.2	87.5
Water for hyman needs	0.04	0.03	0.02	0.08	0.17

To calculate water balance for 2016 was taken into account climate change impact n water resources occurred during last 25 years and also full drinking water demand of population according to rates of Azersy (180l/person/day). Based on the information on ecosystem and human water demands according to modern water allocation plan requirements first has been calculated water yields as difference between flow available in the river and above two. After was assessed water balance as difference between water yield and water amounts abstracted for different use (Tables 41-42).

Table 41. Annual water economy balance of Goshqarchay basin , m^3/s

Element of balance	Sub basins					Full basin
	Source – Zagali water reservoir	Zagali water reservoir – Lower Dashkasan	Lower Dashkesan-New Gizilca	New Gizilca – Sarkar	Sarkar-Mouth	
Imcome						
Almost natural flow /	0.60 -	0.70	1.35	1.56 -	1.63 -	1.63
Available in section river flow	0.60	0.67	1,24	1,20	0.97	
Water for hyman needs	0.030	0.031	0.020	0.010	0.041	0.133
Ecosystem flow demands	0.20	0.22	0.32	0.37	0.44	0.44
Water yields	0.37	0.42	0.90	0.82	0.49	1.03
Water use						
Agriculture	-	-	0.23	0.29	0.26	0.78
Industry	-	0.05				0.05
Uncontrolled water abstraction and water infiltration at the river bed in downstream	-				0.24	0.24
Balance	**+0.37**	**+ 0.37**	**+ 0.67**	**+0.53**	**-0.01**	**-0.01.**

Table 42. Annual water economy balance of Zayamchay basin , m^3/s

Element of balance	Sub basins				Full basin
	Source – Agbashlar	Agbashlar-Yanıkhlı	Yanıkhlı-Tatar	Tatar mouth	
Imcome					
Almost natural flow	5.18	5.66	5.80	5,83	5.83
Availabale in section river flow	5.18	5,62	3.79	1.45	
Outflow					
Water for hyman needs	0.04	0.03	0.02	0.08	0.17
Flow for ecosystem	1.11	1.27	1.33	1.33	1.33
Water yield	4.03	4,34	2,43	0.04	4.33
Water intake:					
Agriculture	-	1.02	0.72	0.08	1.82
Water transfer to areals of Shamkir and Tovuz regions (outside of the basin) and uncontrolled water use		0.92	1,63	0.20	2,75
Balance	+4.03	+2.40	**0.08**	**-0.24**	**-0.24**

As one can see from above tables these water allocation systems first of all take into account ecosystem flow demands and human water needs and then based on them available water yields provision of water supply to different sectors. It also is clearly seen form these tables that annual (in summer as well) deficit of water balance increases (compared to previous water balances calculated above in previous chapters)when instead of real water use for drinking purposes is used proposed by Azersy within National Water Supply Project water demand rate for population and also when instead of ecological flow is used ecosystem water requirements.

In order to solve the water scarcity problem in river downstream one can consider ways of reduction of abstracted flow losses and also use of good irrigation technology and methods. The other options such as use of more ground waters in water supply and irrigation and also use of treated waste water for technical purposes should also be considered.

As mentioned in Chapter 4 as result of climatic changes in 2016 flow is reduced about 5% compared to 1990 and is expected to be reduced by 10% in 2035 compared to 1990. In water allocation plans for both rivers as result of population increase by 10% by 2035 values of abstracted drinking water should also be increased by 10% consequently .

As mentioned in previous chapters in total 55 mln cub.m water should be enough for irrigated areas of Zayamchay river basin (9.7 th.ha) and 35 Mln cub.m for Goshgarchay river basin irrigative lands (5.0 th.ha). As over 30%.of currently abstracted waters go to losses therefore one can presume that not all lands are used in agriculture today and therefore if no water losses then r above shown water volumes can be enough to increase currently irrigated areas till the level of above shown size of total irrigated areas .

Therefore by improving of state of irrigation system and application of modern irrigation technology amounts of water abstraction from river can be reduced at the amount equal to current water losses(which can be left in river to improve its ecosystem) and some more irrigation waters to provide above volumes of irrigation water demand for nearby areas can be taken from rechargeable ground water sources.

Then in water allocation plan for 2035 area of irrigation can be accepted to be 9.7 th. ha for Zayamchay and 5.0 th. ha for Goshgarchay presuming that because of taking of water allocation improvement measures areas of currently used lands will be increased to that size.

In tables(43-44) are given water allocation plans for 2015 and 2035 taking into account all above issues

Table 43. Water allocation plan for Goshqarchay basin , m^3/s for 2015 and 2035 years

Element of balance		**Sub basins**					**Full basin**
		Source – Zagali water reservoir	**Zagali water reservoir – Lower Dashkasan**	**Lower Dashkesan-New Gizilca**	**New Gizilca – Sarkar**	**Sarkar-Mouth**	
Imcome							
Almost natural flow		0.60 -	0.70	1.35	1.560 -	1.63 -	1.63
Flow impacted by climatic changes	2016	0.570	0.665	1,277	1.486	1.549	1.549
	2035	0.540	0.630	1,215	1,404	1.476	1.476
Available in section river flow	2016	0.570	0.635	1,166	1,125	0.888	
	2035	0.540	0.597	1,098	1,035	0.806	
Flow required for ecosystem and human needs							
Water for hyman needs	2016	0.030	0.031	0.020	0.010	0.041	0.132
	2035	0.033	0.034	0.022	0.011	0.045	0.145
Ecosystem flow demands		0.20	0.22	0.32	0.37	0.44	0.44
Water yields	2016	0.34	0.384	0.826	0.745	0.407	0.977
	2035	0.307	0.343	0.756	0.654	0.321	0.891
Water use by sectors							
Agriculture		-	-	0.230	0.290	0.260	0.780
Industry		-	0.050				0.05
Uncontrolled water abstraction and water infiltration at the river bed in downstream		-				0.240	0.240
Balance	2016	+0.340	+0.334	+0.596	+0.455	-0.093	-0.093
	2035	+0.307	+0.293	+0.526	+0.364	-0.179	-0.179

Table 44 Water allocation plan for Zayamchay river basin , m^3/s for 2015 and 2035 years

Element of balance		Sub basins				Full basin
		Source – Agbashlar	Agbashlar-Yanıkhlı	Yanıkhlı-Tatar	Tatar mouth	
Imcome						
Almost natural flow		5.18	5.66	5.80	5,83	5.83
Flow impacted by climatic changes	2016	4.921	5.377	5.510	5.538	5.538
	2035	4.662	5.094	5.220	5.247	5.247
Flow available in the section	2016	4.921	5.337	3.500	1.158	
	2035	4.662	5.050	3.203	0.858	
Outflow						
Water for hyman needs	2016	0.040	0.030	0.020	0.080	0.170
	2035	0.044	0.033	0.022	0.088	0.187
Flow for ecosystem		1.11	1.27	1.33	1.33	1.33
Water yield	2016	3.771	4.037	2.150	-0.252	4.038
	2035	3.508	3.747	1.851	-0.550	3.730
Water intake:						
Agriculture		--	1.02	0.72	0.08	1.82
Water transfer to areals of Shamkir and Tovuz regions (outside of the basin) and uncontrolled water use		-	0.92	1.63	0.20	2,75
Balance	2016	3.771	2.097	-0.20	-0.532	-0.532
	2035	3.508	1.807	-0.50	-0.84	-0.84

As it is seen from above tables in both rivers currently(by 2016) exists water scarcity problem and in the future there will be not enough water to cover all demands without implementing relevant PoM

In August this situation is more bad. Water scarcity is high in down stream of both rivers. This can be seen from tables 45-46.

Table 45. Water allocation plan for Goshqarchay basin in August, m^3/s for 2015 and 2035 years

Element of balance	Sub basins					Full basin
	Source – Zagali water reservoir	Zagali water reservoir – Lower Dashkasan	Lower Dashkesan-New Gizilca	New Gizilca – Sarkar	Sarkar-Mouth	
Imcome						
Natural flow	0.30	0.51	1.41	1.51	1,51	1.51

		-		-	=		
Flow impacted by climatic changes	2016	0.285	0.484	1.339	1.434	1.434	1.434
	2035	0.270	0.459	1.269	1.359	1.359	1.359
Available in section river flow	2016	0.285	0.454	1.228	1.073	0.773	
	2035	0.270	0.426	1.152	0.990	0.689	
Flow required for ecosystem and human needs							
Water for hyman needs	2016	0.030	0.031	0.020	0.010	0.041	0.132
	2035	0.033	0.034	0.022	0.011	0.045	0.145
Ecosystem flow demands		0.19	0.21	0.30	0.34	0.40	0.40
Water yields	2016	0.065	0.213	0.908	0.723	0.332	0.902
	2035	0.047	0.182	0.830	0.639	0.244	0.814
Water use by sectors							
Industry		-	0.25(0.20 returned)		-	-	0.05
Agriculture		-	-	0.23	0.29	0.46	0.98
Uncontrolled water abstraction and water infiltration at the river bed in downstream		-				0.34	0.34
Balance	2016	0.065	0.163	0.678	0.433	-0.468	-0.468
	2035	0.047	0.132	0.600	0.349	-0.556	-0.556

Table 46. Water allocation plan for Zayamchay river basin , m^3/s for 2015 and 2035 years in August

Element of balance		**Sub basins**				**Full basin**
		Source – Agbashlar	**Agbashlar- Yanıkhlı**	**Yanıkhlı-Tatar**	**Tatar mouth**	
Imcome						
Almost natural flow		3.97	4.50	4,76	4.76	4.76
Flow impacted by climatic changes	2016	3.771	4.275	4.522	4.522	4.522
	2035	3.573	4.050	4.284	4.284	4.284
Flow available in the section	2016	3.771	4.235	2.212	-0.178	
	2035	3.573	4.006	1.967	-0.425	
Outflow						

Water for hyman needs	2016	0.04	0.03	0.02	0.08	0.170
	2035	0.044	0.033	0.022	0.088	0.187
Flow for ecosystem		0.790	0.790	0.790	0.790	0.790
Water yield	2016	2.941	3.415	1.402	-1.048	3.562
	2035	2,739	3.183	1.155	-1.303	3.307
Water intake:						
Agriculture		-	1.02	0.72	0.08	1.82
Water transfer to areals of Shamkir and Tovuz regions (outside of the basin) and uncontrolled water use			1.22	1.65	0.20	3,07
Balance	2016	2.941	1.175	-0.968	-1.328	-1.328
	2035	2,739	0.943	-1.215	-1.583	-1.583

As one can see from these tables there is need to take particular actions to save water in summer. In addition to above measures presumed for annual water balance there should also be needed to regulate flow within the year as well and etc.

7.2. Improvement of water allocation through implementing of possible measures.

In order to improve water allocation there is need to find more efficiency way of water management in Goshgarchay and Zayamchay river basins. There is need to analyze different sources, available resources, improve state of used water supply infrastructure, consider basin level water management taking into account all users and stakeholders from upstream to downstream. Based on analyze of existing water sources used for water supply and status of infrastructure on water supply one can say that to improve water allocation Programm of Measures should cover below areas:

- reducing of water losses during transportation(by rehabilitating of irrigation infrastructure) and
- reducing of water losses during irrigating of crops(using modern irrigation methods),
- construction of centralized water supply system to increase efficiency of drinking water supply
- treatment and reuse of waste waters
- increase volume and efficiency of use of ground waters where there is high need for that and where recharging capacity allows it
- construction of small reservoirs to keep environmental requirements and provide all year- round water supply
- improvement of permit and licensing system

In area of domestic and drinking water supply it should be noted that increase of drinking water per person from 60-80l/day to 180L/day may lead to increasing of drinking water abstraction values from 1.8-2.0 mln cub.m to 4.0-5.0 mln cub.m. Therefore there will be need to see if instead of further increasing of water abstraction from rivers can be used local ground waters in centralized water supply systems in villages. There also is need to check if waste waters impact to the ground and surface water and consider possibility of their treatment and use for different purposes. In total during construction (rehabilitation) of WSSS in residential areas of basins as part of total water demands can be considered possibility of use of additional ground water resources in volume of 2.5 mln. m^3 in Zayamchay river basin and 2 mln. m^3 in Goshgarchay river basin, which may in turn allow to reduce of abstratcion of surface water for the same amount.

In relation to water use for irrigation purposes it should be noted that water resources in both basins are widely used in irrigation. Unfortunately water losses are also high. Of abstrated from Zayamchay river

55-59 mln. m^3 water 12-13 mln. m^3 is being lost during transportation in irrigation canals and in addition in the field water losses makes around 20%. In Goshgarchay river basin of 20-22 mln. m^3 abstrated water 10.5-11.5 mln. m^3 is beeing lost . In this regards by use of modern irrigation technology water losses can be reduced for about 10 mln. m^3 in Zayamchay river basin and 5 mln. m^3 in Goshgarchy river basin and this value can be left in rivers by the same level reducing the surface water abstraction.

Of 107 mln. m^3 ground water resources of Goshgarchay river basin currently 48.0 mln. m^3 and of 123 mln. m^3 ground water resource of Zayamchay river basin 51.4 mln. m^3 is currently used for irrigation. This values can be increased for about 15,0 mln. m^3 in Zayamchay river basin and for 10 mln. m^3 in Goshgarchay river basin and water abstraction from rivers then can be reduced by this value as well.

As from Zayamchay water is transfered to areals of Tovuz regions (outside of the basin) and some flow is abstracted for uncontrolled water use therefore as an alternative option for the future most part of this amount(12.5 mln. m^3) can be provided by ground water sources of Zayamchay river basin(which makes just 13% of the total rechargable water resources of the basin) and small part (2.5 mln. m^3) provided by ground waters of those areas outside of Zayamchay river basin where waters of the reiver by ground canals is transferred for irrigation purposes.

In total as result of realization of above actions in Zayamchay river basin use of surface water can be reduced by 27.5 mln. m^3 and in Goshgarchay river basin by 17.5 mln. m^3.

In order to improve water allocation in summer and other low flow periods there can help construction of new water reservoir on Zayamchay river planned by Amelioration JSC and construction of new small water reservoirs on tributaries of rivers can also be considered,

Finally all above described measures to updated water allocation plans can look like as in tables 47-48

Table 47. PoM to improve water allocation in Zayamchay river basin , m^3/s for 2015 and 2035 years

Element of balance	**Sub basins**				**Full basin**
	Source – Agbashlar	**Agbashlar- Yanıkhlı**	**Yanıkhlı-Tatar**	**Tatar mouth**	
Construction of WSSS and useing GW for drinking purposes	0.018	0.013	0.009	0.039	0.079
Increasing of GW use in irrigation		0.100	0.150	0.145	0.395
Reduction of water losses in irrigation		0.16	0.14	0,015	0.315

Table 48. PoM to improve water allocation in Goshgarhay river basin , m^3/s for 2015 and 2035 years

Element of balance	**Sub basins**					**Full basin**
	Source – Zagali water reservoir	**Zagali water reservoir – Lower Dashkasan**	**Lower Dashkesan-New Gizilca**	**New Gizilca – Sarkar**	**Sarkar-Mouth**	
Imcome						
Reduction of impact on river as result of implementation of PoM						

Increasing of GW use in irrigation		-	0.055	0.130	0.130	0.315
Reduction of water losses in irrigation	-		0,052	0.052	0.053	0.157
Construction of WSSS and useing GW for drinking purposes	0.014	0.015	0.009	0.005	0.020	0.063

There is need to conduct study for economic feasibility for above actions and the develop Programm of Measures according to them.

Finally after all above measures updated water allocation plans can look like as in tables 49-50 (to haveone single unit all water resources are transferred into m^3/s).

Tabale 49. Water allocation plan for Zayamchay river basin , m^3/s for 2016 and 2035 years

Element of balance		**Sub basins**				**Full basin**
		Source – Agbashlar	**Agbashlar-Yanıkhlı**	**Yanıkhlı-Tatar**	**Tatar mouth**	
Surface Waters(SW)						
Almost natural flow		5.18	5.66	5.80	5,83	5.83
Flow impacted by climatic changes	2016	4.921	5.377	5.510	5.538	5.538
	2035	4.662	5.094	5.220	5.247	5.247
Flow available in the section	2016	4.921	5.355	4.021	1.968	
	2035	4.662	5.068	3.724	1.668	
Water for hyman needs	2016	0.022	0.017	0.011	0.041	0.091
	2035	0.026	0.02	0.013	0.049	0.108
Flow for ecosystem		1.11	1.27	1.33	1.33	1.33
Water yield	2016	3.789	4.068	2.680	0.597	4.117
	2035	3.526	3.778	2.381	0.289	3.809
Agriculture water use		--	1.02	0.72	0.08	1.82
Water transfer to areals of Shamkir and Tovuz regions (outside of the basin) and uncontrolled water use		--	0.43	1.35	0.18	1.96
Surface water Balance	2016	3.789	2.618	0.610	0.337	0.337
	2035	3.526	2.328	0.311	0.029	0.029
Ground Waters(GW)						
2015: GW yields: 3.940, GW use for Irrigation: 1.619; GW transfer to Tovuz region and local use for drinking and communal purposes:0.334 , Available resources: 1.987 mln.cub,m						

PoM on increasing of GW use:						
Construction of WSSS and useing GW for drinking purposes		0.018	0.013	0.009	0.039	0.079
Increasing of GW use in irrigation			0.100	0.150	0.145	0.395
GW Balance (5% reduction in 2035 in result of climate change)	2016	GW yields: 3.940, GW use for Irrigation: 2.014 (including 0.395 m^3/s GW use increase in irrigation); GW transfer to Tovuz region and local use for drinking and communal purposes:0.413 , Available resources: 1.513				
	2035	GW yields: 3.740, GW use for Irrigation: 2.014(including 0.395 m^3/s GW use increase in irrigation); GW transfer to Tovuz region and local use for drinking and communal purposes:0.413 , Available resources: 1.313				
Total						
Water Resources	2016	SW:5.538; GW: 3.940; Total: 9, 478				
	2035	SW:5.247; GW: 3.740; Total: 8, 987				
Water Balance	2016	SW:0.382; GW: 1.513; Total: 1, 895				
	2035	SW:0.024; GW: 1.313; Total: 1, 337				

Table 50. Water allocation plan for Goshqarchay basin , m^3/s for 2015 and 2035 years

Element of balance		**Sub basins**					**Full basin**
		Source – Zagali water reservoir	**Zagali water reservoir – Lower Dashkasan**	**Lower Dashkesan-New Gizilca**	**New Gizilca – Sarkar**	**Sarkar-Mouth**	
Imcome							
Almost natural flow		0.60 -	0.70	1.35	1.560 -	1.630 -	1.630
Flow impacted by climatic changes	2016	0.570	0.665	1,277	1.486	1.549	1.549
	2035	0.540	0.630	1.215	1.404	1.467	1.467
Available in section river flow	2016	0.570	0.649	1.195	1.215	1,035	
	2035	0.540	0.611	1.127	1.125	0.944	
Flow required for ecosystem and human needs							
Water for hyman needs	2016	0.016	0.016	0.011	0.005	0.021	0.069
	2035	0.019	0.019	0.013	0.006	0.025	0.082
Ecosystem flow demands		0.200	0.220	0.320	0.370	0.440	0.440
Water yields	2016	0.354	0.413	0.864	0.840	0.574	1.04
	2035	0.321	0.372	0.794	0.749	0.479	0.945

Water use by sectors							
Agriculture		-	-	0.178	0.238	0.207	0.623
Industry		-	0.050				0.050
Uncontrolled water abstraction and water infiltration at the river bed in downstream		-				0.240	0.240
Surface water blance	2016	0.354	0.363	0.686	0.602	0.127	0.127
	2035	0.321	0.322	0.616	0.511	0.032	0.032
Ground Waters(GW)							
2015: GW yields: 3.400, GW use for Irrigation: 1.506; Use of GW for drinking and communal purposes:0.016 , Available resources: 1.878							
PoM on increasing of GW use:							
Construction of WSSS and useing GW for drinking purposes		0.014	0.015	0.009	0.005	0.020	0.063
Increasing of GW use in irrigation			-	0.055	0.130	0.130	0.315
GW Balance (5% reduction in 2035 in result of climate change)	2016	GW yields: 3.400, GW use for Irrigation: 1.821; Use of GW for drinking and communal purposes:0.079 , Available resources: 1.500					
	2035	GW yields: 3.230, GW use for Irrigation: 1.821 Use of GW for drinking and communal purposes:0.079 , Available resources: 1.330					
Total							
Water Resources	2016	SW:1.549; GW: 3.400; Total: 4, 949					
	2035	SW:1.467; GW: 3.230; Total: 4, 697					
Water Balance	2016	SW:0.127; GW: 1.500; Total: 1, 627					
	2035	SW:0.032; GW: 1.330; Total: 1, 362					

As is seen from table in spite of fact that in 2016 there will be some positive balance in river(in addition to ecological flow also some extra water will be left) there is need to plan ground water use according to water regime of the river and seasonal and water demand requirements to avoid demand management problems in low flow period. This issue can be easily solved if there will be constructed new reservoirs to regulate flows. But in their absence the accurate water use schemes , which are based on precise flow forecasts and demand plans for different sections of the river can allow to provide efficiency water allocation if above measures are conducted and water use is based on procedures considered in water allocation systems..

Same work can be done to reduce river water use in August as well. In result of taking of above PoM may change water use balance in basins in August as it is shown in tables 51-52.

Table 51. Water allocation plan for Goshqarchay basin , m^3/s for 2015 and 2035 years in August

Element of balance		**Sub basins**					**Full basin**
		Source – Zagali water reservoir	**Zagali water reservoir – Lower Dashkasan**	**Lower Dashkesan-New Gizilca**	**New Gizilca – Sarkar**	**Sarkar-Mouth**	
Imcome							
Almost natural flow		0.30	0.51	1.41	1.51	1,51	1.51
Flow impacted by climatic changes	2016	0.285	0.484	1.339	1.434	1.434	1.434
	2035	0.270	0.459	1.269	1.359	1.359	1.359
Available in section river flow	2016	0.285	0.468	1.257	1.218	1.105	
	2035	0.270	0.440	1.181	1.135	1.021	
Flow required for ecosystem and human needs							
Water for hyman needs	2016	0.016	0.016	0.011	0.005	0.021	0.069
	2035	0.019	0.019	0.013	0.006	0.025	0.082
Ecosystem flow demands		0.19	0.21	0.30	0.34	0.40	0.40
Water yields	2016	0.079	0.242	0.946	0.873	0.684	0.965
	2035	0.061	0.211	0.868	0.789	0.596	0.877
Water use by sectors							
Agriculture		-	-	0.123	0.108	0.277	0.508
Industry		-	0.050				0.05
Uncontrolled water abstraction and water infiltration at the river bed in downstream		-				0.34	0.34
Balance	2016	0.079	0.192	0.823	0.765	0.067	0.067
	2035	0.061	0.161	0.745	0.681	-0.021	-0.021

Tbale 52. Water allocation plan for Zayamchay river basin , m^3/s for 2015 and 2035 years in August

Element of balance		**Sub basins**				**Full basin**
		Source – Agbashlar	**Agbashlar-Yanıkhlı**	**Yanıkhlı-Tatar**	**Tatar mouth**	
Imcome						
Almost natural flow		3.97	4.50	4,76	4.76	4.76
Flow impacted by climatic changes	2016	3.771	4.275	4.522	4.522	4.522
	2035	3.573	4.050	4.284	4.284	4.284
Flow available in the section	2016	3.771	4.253	2.603	0.912	
	2035	3.573	4.025	2.358	0.665	
Outflow						
Water for hyman needs	2016	0.022	0.017	0.011	0.041	0.091
	2035	0.026	0.02	0.013	0.049	0.108
Flow for ecosystem		0.790	0.790	0.790	0.790	0.790
Water yield	2016	2.959	3.446	1.802	0.081	3.641
	2035	2.757	3.214	1.555	-0.174	3.386
Water use by sectors						
Agriculture		-	1.02	0.72	0.08	1.82
Water transfer to Tovuz and Shamkir and uncontrolled flow abstraction			0.86	0.96	0.145	1,965
Balance	2016	2.959	1.566	0.122	-0.144	-0.144
	2035	2.757	1.334	-0.125	-0.399	-0.399

As one can see from above table implementation of PoM for Goshgarchay river should be enough to address water scarcity problem in future and no special actions will be needed to be taken in summer. In 2035 there will be in river less than ecosystem water demand for 5% only.

But in Zayamchay river basin in summer there will be a some water deficiency, but as in total annual water use balance would meet water demands and environmental requirements in the basin. There will be need to have water allocation plans in place and conduct use of ground waters to cover water demand as flow of river won't be sufficient to cover it. Also it should be noted that construction of Zayamchay water reservoir and regulation of flow can help to solved this problem more easier..

8. PROGRAM OF MEASURES AND THEIR ECONOMIC ASSESSMENT

Introduction

To improve water allocation system in Zayamchay and Goshgarchay rivers basins it is necessary to conduct measures implementation of which may allow to provide needed amount of water for ecosystem, social needs and for all priority users.

Therefore identified in pervious chapter main directions to develop efficiency water allocation plan during 2015-2035 are:

- reducing of water losses during transportation(by rehabilitating of irrigation infrastructure) and
- reducing of water losses during irrigating of crops(using modern irrigation methods),
- construction of centralized water supply system to increase efficiency of drinking water supply
- treatment and reuse of waste waters
- increase volume and efficiency of use of ground waters where there is high need for that and where recharging capacity allows it
- construction of small reservoirs to keep environmental requirements and provide all year- round water supply
- improvement of permit and licensing system

In order to realize identified water demand management work there is need to identify and implement measures in different sections of rivers , including those on reduction of water losses by rehabilitation of existing and construction of new irrigation and drinking water supply infrastructure, water necessary use of ground waters for water supply, strengthening of water use permit system and tariffs reforms.

Main possible measures are identified in following sections of this chapter.

8.1. Priority measures to be implemented in Zayamchay and Goshgarchay rivers basins and their cost.

In order to identify and priorities measures to meet environmental objectives following existing and planned actions have been taken into consideration:

- State of water resources and needed action to meet environmental objectives
- Ongoing state programs in water sector and related other areas like improvement of water supply and sanitation system, improvement of irrigation water use efficiency, reduction of water pollution through improved solid waste management, programs for protected areas etc
- Implementation of IWRM approach and different water related EU Directives through development of relevant legal and institutional basis(EU WFD 2000)

As under different state programs work on improvement of water supply and sanitation system in main cities of the region and also improvement of irrigation water use efficiency, rehabilitation of irrigation infrastructure to reduce water losses has already started and also under National Solid Waste Management program there will be conducted improvement of solid waste management in the region in coming years according to international standards therefore in this document cost effectiveness assessment for those activities hasn't been carried as funding for this projects is already decided by government, instead of that was estimated cost of measures identified to provide efficiency water allocation in the basins..

From this perspective in the sphere of water supply and sanitation can be developed proposal on improvement/ creation of water supply and sanitation system for residential areas with population over 2000 and over 5000 inhabitants.

There is also need to conduct study on ways for improvement of water use control system, development of relevant tariff for different water uses, identification of pollution control and water conservation methods.

Below list of pilot projects on some technical projects have been identified in Goshgarchay and Zayamchay rivers basins.

Table 53. Program of Measures to improve water allocation in Zayamchay and Goshgarchay river basins

N	Water issue	Main objectives	PoM
Zayamchay river			
1	The Zayamchay River section from the Tatarli settlement to the confluence with the Shamkir Reservoir is significantly affected by water abstraction and the waste water discharge.	Provide ecosystem water and human demands by implementing of measures on water quality and quantity improvement according to national standards and EU legislation	**2016-2018** - Construction of centralized water supply system by use of ground waters and construction of system of waste water collection, treatment and use for Tatar village(4790persons), Zayam village(7645) and other villages in the section by use of ground waters and develop proposals where necessary and possible to collect , treat and use the waste waters from these areas **2018-2025** Construction of WSSS for above villages and treatment and reuse of waste waters **2016-2025** -Improve water use permit and abstraction control system according to requirements of National and EU legislation - study how planning to be constructed Zayamchay water reservoir will affect flow regime of river and improve water allocation in downstream **2020-2035** Rehabilitate water infrastructure to reduce water losses and application of modern irrigation technology and methods
2	The Zayamchay river section from Yaniqli to Tatarli settlement. Both water abstraction for the irrigation purposes and waste water	Provide ecosystem water and human demands by implementing of measures on water quality and quantity improvement according to national standards and EU legislation	**2016-2018** - - Construction of centralized water supply system by use of ground waters and construction of system of waste water collection, treatment and use for Yaniqli village (4894) and Kohnaqala village(7020) and other villages in the section and develop proposals where necessary and possible to collect , treat

	from the several settlements can have an impact on the river water.		and use the waste waters from these areas **2018-2025** Construction of WSSS for above villages and treatment and reuse of waste waters **2016-2020** -Improve water abstraction control system according to requirements of National and EU legislation - study how planning to be constructed Zayamchay water reservoir will affect flow regime of river and improve water allocation in downstream **2020-2035** Rehabilitate water infrastructure to reduce water losses and application of modern irrigation technology and methods
3	The Zayamchay river section from Agbashlar to Yaniqli assessment of role of Zayamchay water reservoir planned by Amelioration JSC in improvement of water allocation in downstream and meeting of requirements of ecosystem and human water needs	Improvement of water allocation in downstream and provision of necessary quantity of water in river to meet requirements of ecosystem and human water needs	**2016-2020:** - study how planning to be constructed Zayamchay water reservoir will affect flow regime of river and improve water allocation in downstream **2016-2018** Prepare proposal on taking into account developed water allocation plan during exploitation of water reservoir **2020-2035** Rehabilitate water infrastructure to reduce water losses and application of modern irrigation technology and methods
4	In the basin of the Zayamchay river at different sections study of ground water yields and possibility of their use for	improvement of water allocation in downstream and i provision of necessary quantity of water in river to meet requirements of ecosystem and human water needs	**2016-2020** - Study how use of rechargeable good quality ground waters will help to reduce water abstraction from Zayamchay river and its tributary rivers and improve water allocation in downstream and

	local water supply and irrigation to reduce water abstraction from Zayamchay river and its tributary rivers and improve water allocation in downstream and meeting of requirements of ecosystem and human water needs		meeting of requirements of ecosystem and human water needs **2020-2035** Develop and implement sceneries on local scale ground water use for irrigation and drinking purposes
Goshgarchay river			
5	The Qoshqarchay River from the Hachaqaya settlement to to the confluence with the Kura River is significantly affected by the anthropogenic activities of water abstraction for irrigation and the waste water discharge	Improve quality of water according to national standards and EU legislation and provision of necessary quantity of water in river to meet requirements of ecosystem and human water needs	**2016-2018** - Construction of centralized water supply system by use of ground waters and construction of system of waste water collection, treatment and use for Hachaqaya and other villages in the section **2018-2025** Construction of WSSS for above villages and treatment and reuse of waste waters **2016-2020** - -Improve water permit and abstraction control system according to requirements of National and EU legislation **2020-2035** Rehabilitate water infrastructure to reduce water losses and application of modern irrigation technology and methods
6	The Qoshkachay river section from the Bayan to Metallurgic factory. In this part of the river water is abstracted for industrial purposes and also waste water from the	Improve quality of water according to national standards and EU legislation and provision of necessary	**2016-2020** - Study how can treatment of industrial waste waters be provided before discharging into river **2016-2020** --Improve water permit and abstraction control system according to requirements of National and EU legislation **2020-2035**

	factory is discharge directly to the river.*	quantity of water in river to meet requirements of ecosystem and human water needs	Rehabilitate water infrastructure to reduce water losses and application of modern irrigation technology and methods
7	In the Goshgarchay river section from mouth to Zagali water reservoir(lake) and tributaries of Goshgarchay river assessment of possibility of increasing of capacity of Zagali reservoir and also possible small reservoirs construction on Goshgarchay tributary rivers for improvement of water allocation in downstream and meeting of requirements of ecosystem and human water needs	improvement of water allocation in downstream and i provision of necessary quantity of water in river to meet requirements of ecosystem and human water needs	**2016-2019** - study how increasing of capacity of Zagali reservoir and also small reservoirs construction on Goshgarchay tributary rivers will affect flow regime of river and improve water allocation in downstream **2020-2035** Rehabilitate water infrastructure to reduce water losses and application of modern irrigation technology and methods
8	In the basin of Goshgarchay river at different sections study of ground water yields and possibility of their use for local water supply and irrigation to reduce water abstraction from Goshgarchay river and its tributary rivers and improve water allocation in downstream and meeting of requirements of ecosystem and	improvement of water allocation in downstream and i provision of necessary quantity of water in river to meet requirements of ecosystem and human water needs	**2016-2020** - study how use of rechargeable good quality ground waters will help to reduce water abstraction from Goshgarchay river and its tributary rivers and improve water allocation in downstream and meeting of requirements of ecosystem and human water needs **2021-2035** Implementation of measures on use of ground waters for local irrigation wan water supply needs

	human water needs		

8.2 Economic assessment of measures

As mentioned in chapter 6 in area of domestic and drinking water supply increase of drinking water per person from 60-80l/day to 180L/day may lead to increasing of drinking water abstraction values from 1.8-2.0 mln cub.m to 4.0-5.0 mln cub.m. Therefore there will be need to see if instead of further increasing of water abstraction from rivers can be used local ground waters in centralized water supply systems in villages. Waste waters also can be treated by construction of waste water treatment plan and used for technical purposes. Total cost of construction of centralized water supply system in average can be 150 USD per person and waste water collection and treatment system 180 USD per person according to different water supply and sanitation programs implemented in Azerbaijan(NWSSP 2007).

All this work may help to save about 2.0-3.0 mln cub.m of river water cost of transportation and treatment(before drinking) of which is higher than extraction and use of ground waters locally.

For the residential areas in the basins average cost of rehabilitation of WSSS are given in Table below.

Table 54. Approximate cost of construction of centralized WSSS in residential areas of Zayamchay and Goshgarchay rivers basins

№	River basins	Population	Part of admistrative region	Cost of WSSS Mln, USD
1	Zayamchay	87500	Gadabay(25000)	7,5
			Tovuz(22500)	7,5
			Shamkir(40000)	12
2	Goshgarchay	63000	Samukh (9500)	2,8
			Shamkir (28000	8,5
			Goygol (5500)	1,7
			Dashkasan (20000)	6,0
4	In 2 basins	150500	Total	46,0

As one can see from above table total cost of construction of WSSS in 2 basins will be about 46,0 Mln USD.

Similar will be cost of extraction of additional amount of ground water for irrigation locally (15,0 mln. m^3 in Zayamchay river basin and for 10 mln. m^3 in Goshgarchay river basin) but this will lead to saving of some water in river to meet demand and also avoiding of water transportation.

In order to improve water allocation in summer and other low flow periods there can help construction of new water reservoir on Zayamchay river planned by Amelioration JSC and construction of new small water reservoirs on tributaries of rivers can also be considered. For reservoirs with capacity of few

millions cost should be about 5 USD per cub. m of stored water, for relatively larger reservoirs 4 USD and for big reservoirs 3 USD.

To assess cost of measure for construction of reservoir can be used the average costing system used during planning of reservoirs. For example Technical characteristics and cost of construction of planned water reservoirs is given in Annex.1 According to the annex total cost of Zayamchay reservoir should be about 325 Mln USD and also there are some small reservoirs designed to be constructed with totalcost of around 10 Mln USD.

Regarding the precise cost of planned measures it should be assessed during implementation of feasibility study for them. To conduct the feasibility studies may last from 6 month to one year will be required around 50 thousands USD for each of them.

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Annex 1. Ongoing reservoir construction projects

Below are shown water reservoirs which are under construction and planned to be constructed

TECHNICAL AND ECONOMIC PARAMETERS

Zayamchay Water Reservoir	
Total water capacity	115 mln.m³;
Irrigated areas:	
A) The areas under strengthening of water supply	9900 ha;
B) Planned areas for irrigation	4600 ha;
Approximate cost	300-350 Mln AZN(325 Mln USD;

A. Rain water reservoirs planning to be constructed (in Shamkir rayon) by Amelioration JSC

N	Title of water reservoirs	Total capacity, mln m^3 m/ approximate cost(Mln AZN)	Total capacity, mln m^3	Water surface territory, ha	Height of dam
1	Cayari	3,5/8	3,5	26	9
2	Goygol	6,6/15	6,6	44	12,5
3	Morul-Alpoud	0,01/0.02	0,01	2,5	4
4	Dallar-Cayir	0,11/030	0,11	21,5	5
5	Dallar-Cırdakhan	0,12/030	0,12	6	9