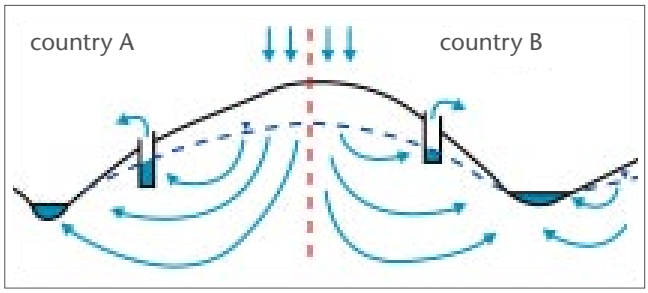
The assessment of the status of transboundary groundwaters sets out the scale and scope of the transboundary groundwaters in two sub-regions: Caucasus and Central Asia (see Section I) and South-Eastern Europe (see Section II). It describes the importance of transboundary groundwaters in supporting human uses; examines the pressure factors on these groundwater bodies; and provides information on status, trends and impacts in relation to both water quantity and quality. The Assessment also provides information about the management measures being taken, planned or needed to prevent, control or reduce transboundary impacts in groundwaters.

The methodology for the assessment of groundwaters broadly follows the guidance provided by UNECE in using the DPSIR framework (see Chapter 2 in Section I of Part 2) to describe: the pressures acting on groundwaters resulting from human activities; the status in terms of both quantity and quality of groundwaters and the impacts resulting from any deterioration in status; and the responses in terms of management measures that have already been introduced and applied, need to be applied, or are currently planned.

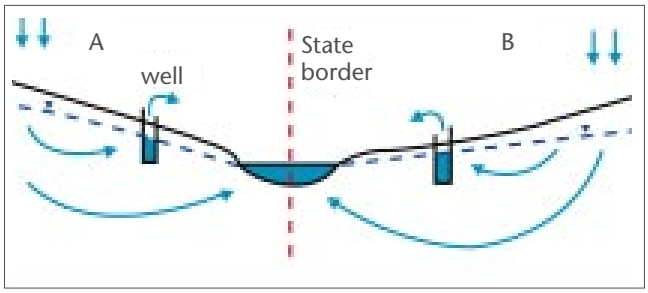
In the following sections, transboundary groundwaters have been classified according to general conceptual models (types) shown in the figure below.

PART 3
TRANSBOUNDARY GROUNDWATERS

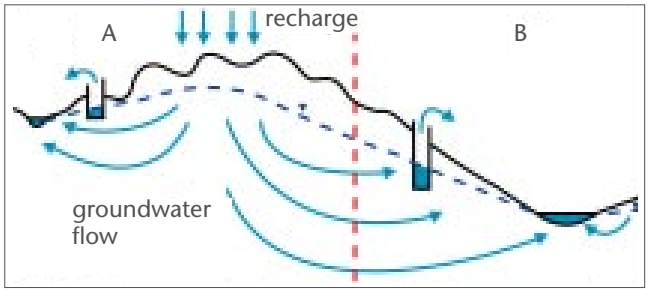
Introduction



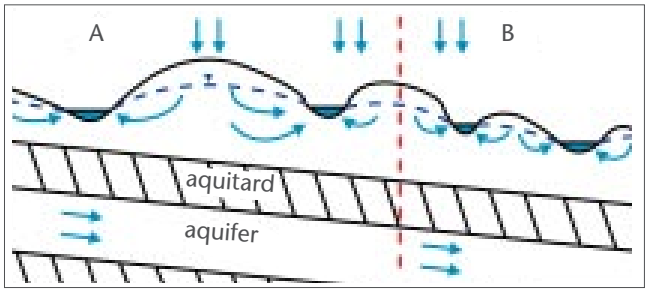
(1) State border follows surface water catchment and groundwater divide, little transboundary groundwater flow.



(3) State border follows major river or lake, alluvial aquifer connected to river, little transboundary flow.



(2) Surface water and groundwater divides separate from state border, recharge in one country, discharge in adjacent.

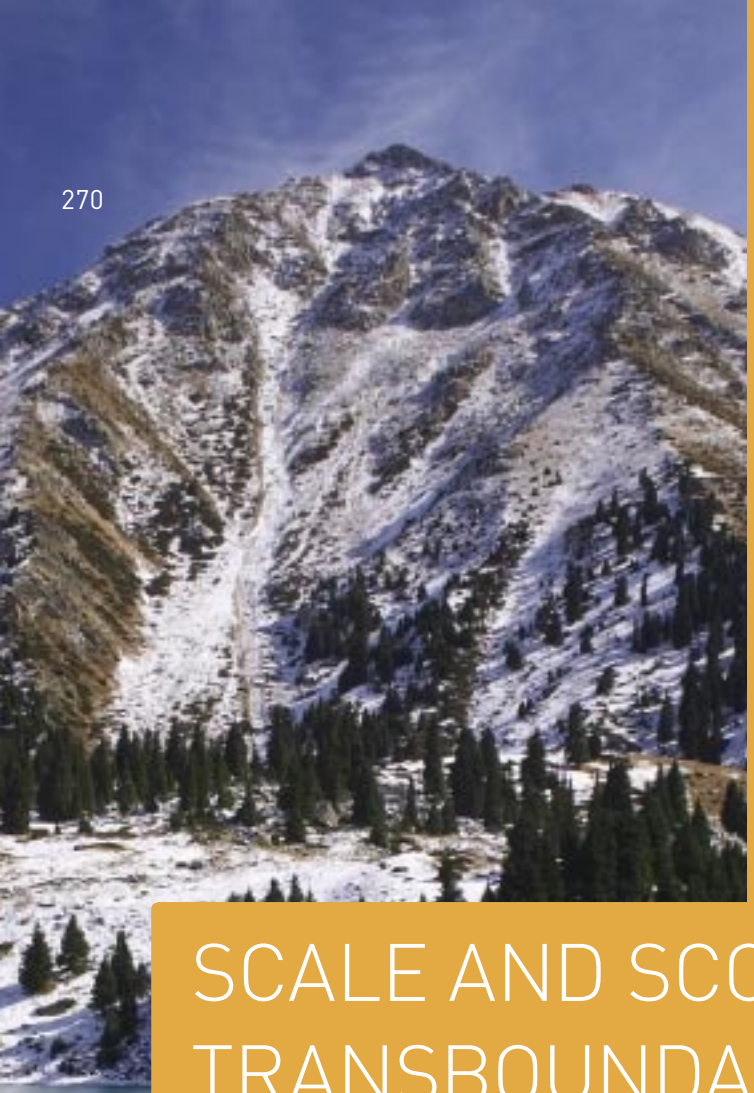


(4) Large deep aquifer, recharged far from border, not connected to local surface water and groundwater.

PART 3
TRANSBOUNDARY GROUNDWATERS

SECTION I

Transboundary Groundwaters in Caucasus and Central Asia



SCALE AND SCOPE OF TRANSBOUNDARY GROUNDWATERS IN CAUCASUS AND CENTRAL ASIA

For transboundary basins in Caucasus and Central Asia during the Soviet Union era, basin plans were developed by regional institutions and included inter-republic and multi-sectoral aspects, as well as allocation of water for various uses. Since independence more than a decade ago, Armenia, Azerbaijan and Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan (the countries of the CACENA region) have been striving to develop fair and rational bases for sharing and using their water resources. These countries have faced extreme economic inefficiencies and ecological damage in their efforts to transition to market economies. In the whole region, one can recognize improving water quality and increasing water quantity to meet basic human needs in these environmentally damaged and economically depressed areas as an urgent and priority task. Agricultural expansion and population growth over the past three decades have placed a great strain on the water resources of the region.

This regional assessment covers transboundary groundwater aquifers from the eight CACENA countries. The assessment is based on current knowledge. Such knowledge is still incomplete and will need to be confirmed and completed by further studies.

All together, 18 aquifers with significant resources were reported as transboundary, bordering or shared by two or more countries. However, only 16 of them were reported by two countries sharing them. The assessment has shown that transboundary groundwaters play a significant role in the CACENA region.

Different types, functions and uses can characterize aquifers. In general, all types of groundwaters can be found in the CACENA countries. However, there are young sediments in river basins as it was found from the available information.

General information on the types, connection with surface water resources and geology of the aquifers is summarized in the following table.

Identified transboundary aquifers						
No[1]	**Aquifer Name**	**Countries**	**Type/link with surface water**	**Lithology/age**	**Thickness mean-max (m)**	**Extent (km^2)**
1	Osh Aravoij	UZ/KG	n.a./shallow/deep /medium	Sandy gravel		
2	Almoe-Vorzin	UZ/KG	n.a./medium			
3	Moiansuv	UZ/KG	n.a./shallow-deep /strong-medium	Boulders pebble, loams, sandy, loams	150 -300	1,760
4	Sokh	UZ/KG	n.a./probably shallow /strong			
5	Alazan-Agrichay	AZ/GE	3/shallow/medium	Gravel-pebble, sand, boulder	150 -320	3,050
6	Samur	AZ/RU	3/shallow/strong	Gravel-pebble, sand, boulder	50 -100	2,900
7	Middle and Lower Araks	AZ/IR	3/shallow/strong	Gravel-pebble, sand, boulder	60 -150	1,480
8	Pretashkent	KZ/UZ	4/deep/weak	Sand, clay	200 -320	20,000
9	Chu Basin	KG/KZ	4/deep/weak	Sand, clay, loams	200 -350	
10	Pambak-Debet	GE/AM	3/shallow strong	Sand, clay, loams		
11	Agstev-Tabuch	AM/AZ	1/2/shallow/moderate			500
12	Birata-Urgench	TM/UZ	3/shallow/strong	Sand, loams	10 -50	60,000
13	Karotog	TJ/UZ	2/shallow/moderate			328
14	Dalverzin	UZ/TJ	2/shallow/moderate			
15	Zaforoboi	TJ/UZ	2/shallow/moderate			
16	Zeravshan	TJ/UZ	2/shallow/moderate			88
17	Selepta-Batkin – Nai- Icfor	KG/TJ	2/shallow/moderate			891
18	Chatkal-Kurman	KZ/UZ	4/ deep/weak	Sand, clay		20,000

[1] Aquifers numbered on map below.

Quaternary or neocene sediments form all identified transboundary aquifers. Predominant lithological types are gravel, sand, clay, and loams. Areal extent of the water bodies (in one country) varies greatly and reaches up to 60,000 km^2 (Turkmenistan). Mean thickness of aquifers ranges between 8 and 200 m and maximum thickness ranges between 20 and 350 m depending mainly on stratigraphy and age. Identified aquifers represent large water reservoirs with significant groundwater resources, which can play an important role in the region.

According to the simplified conceptual sketches provided it may be concluded that identified aquifers can be divided into two groups. The first group represents deeper groundwater aquifers with weak or medium link with local surface water systems recharged far from the border (type 4). Only in one case is the State border, which is situated on watershed divided line, identical with the recharge zone. The second group represents shallow groundwater flowing from the neighbouring countries towards the transboundary rivers (type 3). State border follows major rivers and aquifers are connected with the surface waters. From the information available it may be indicated that the degree of connection of groundwater flow to surface waters is an important consideration for their integrated management, and the assessment confirms these strong linkages for many of the transboundary groundwaters.

In the map below, the locations of the groundwaters covered by this assessment are shown. From this map, it can be seen that several of the countries of the region have their national borders traversed by transboundary groundwaters.

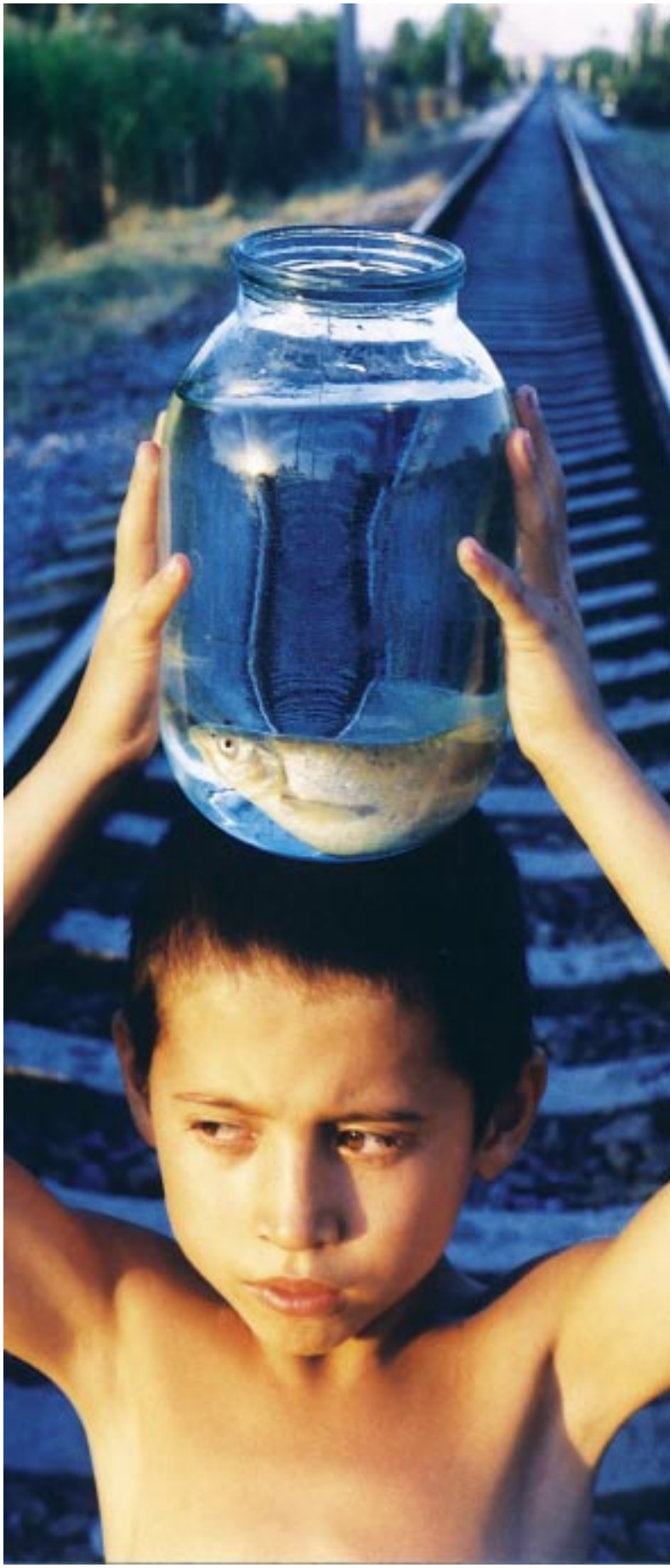
Distribution of transboundary groundwaters in Caucasus and Central Asia

GROUNDWATER USES AND FUNCTIONS

It was recognized during the assessment that groundwater resources are important in total water usage, and direct water abstraction for water supply is the main use of groundwater in all countries. In Georgia, 100% of total water consumption is used from groundwater abstraction. Azerbaijan and Armenia reported that portion of groundwater on total water consumption is 50% from its transboundary aquifers (aquifers No. 5, 6 and 7) and the same data were reported by Turkmenistan (aquifer No. 12). Such use is not surprising, due to the alluvial settings of aquifers, in comparison with the surface water resources.

In all cases the most frequent type of groundwater utilization is drinking water. The assessment has shown that all identified aquifers are utilized for drinking water purposes. But this type of groundwater use compared to the total groundwater abstraction varies to a large extent, from 10% (Azerbaijan, Turkmenistan) to 100% (Kazakhstan). In nine transboundary aquifers (aquifers No. 1, 3, 4, 5, 7, 9, 12, 14 and 17) the percentage of drinking water use on total groundwater abstraction is less than 50%; in seven cases (aquifers No. 6, 8, 10, 11, 13, 16 and 18) it achieves more than 75%. However, there are differences of the groundwater use even between the neighbouring countries (for instance, while in Kazakhstan the groundwater from Pre-Tashkent aquifer was reported to be used predominantly for drinking water purposes, in Uzbekistan it was reported to be used just as a source of mineral water).

Other possible uses indicated the significance of groundwater for agriculture support, reported in five aquifers (aquifers No. 1, 2, 3, 9 and 10) and for maintaining base flow and springs marked in four aquifers (aquifers No. 1, 2, 3 and 11). Other widely reported regional uses include small amounts for industry and spas. The strong linkages to rivers and lakes were confirmed, due to the alluvial aquifers and the consequent need to protect the ecosystems of these associated surface waters was emphasized in the case of Kyrgyzstan (Chu basin).



PRESSURE FACTORS

It is logical to expect that human activities in the CACENA region might have an impact on both transboundary groundwater quantity and quality. Alluvial settings of the aquifers are likely to be jeopardized by the pollution loads from the agricultural and industrial activities, since the groundwater resources are used for these purposes as indicated by the riparian countries. Furthermore, inefficient irrigation systems and mismanagement of the irrigation water diversions have resulted in elevated water and soil salinity levels and overall environmental degradation. However, recent data from the water bodies' monitoring is very scarce or even no monitoring activities are performed by countries. Therefore, assessment of the pressure factors on the transboundary aquifers is very limited.

AGRICULTURE

Among other types of groundwater utilization, abstraction for irrigation has comparable significance to that for drinking water. Central Asian countries are significantly dependent on irrigated agriculture, and both water quantity and quality have emerged as issues in the republics' development. The assessment shows that twelve out of 18 aquifers are utilized for irrigation. The percentage of total abstraction for irrigation is comparable with drinking water and varies in similar intervals. This finding is not a surprise due to the fact that agriculture is the largest water consumer in the region and a major employer of the region's workforce. In the CACENA region, the poor condition of irrigation infrastructure and bad agricultural practices jeopardize water and land resources. This could be the

case for the aquifers with very high percentage of abstraction for agriculture recorded by Azerbaijan (aquifers No. 5, 80-85%, and 7, 55-60%) and Uzbekistan (aquifer No. 3, 50-75%). However, the economic difficulties in the CACENA region have suppressed both the usage of water for irrigation and the application of fertilizers and pesticides. With the expected economic growth and the need to increase crop production, agricultural pressure factors are expected to become more important.

INDUSTRY, MINING, THERMAL SPA

Industrial pressure factors on transboundary aquifers in the CACENA region seem to be rather limited. For industry, water is modestly utilised only from eight aquifers, with a rate of less than 25% of total groundwater abstraction (aquifers No. 2, 3, 5, 6, 9, 10, 12 and 17). For mining, only four cases were recorded with less than 25% of total abstraction (aquifers No. 1, 9, 10 and 11) and for thermal spa two cases less than 25% were indicated (aquifers No. 9 and 12). Heavy metals and organic substances were reported by countries. However, precise and recent data from the monitoring programmes are not available. Country reports were mainly based on the expert judgement of the existing industrial activities in the aquifer recharge areas.

LIVESTOCK

Livestock watering is reported as a minor (less than 25%), but widely employed water use in the majority of the region. However, in the responses, nothing was reported on the type of the animal production (extensive or intensive) in the aquifer areas. Evidence of these pressures may come from pollution by pathogens and nitrogen, but there are no data reported to quantify this pressure factor on the transboundary aquifers in the CACENA region.

Percentage of total groundwater abstraction for different uses in the identified transboundary aquifers

Type of use	Percentage of total groundwater abstraction (aquifer no. refers to summary table above)			
	< 25%	25-50%	50-75%	> 75%
Drinking water	3, 5, 9, 12, 14	1, 4, 7, 17	2, 15	6, 8, 11, 10, 13, 16, 18
Irrigation	1, 6, 9, 10, 12	2, 17	3, 7, 15	5, 14
Industry	2, 3, 5, 6, 9, 10, 12, 17			
Mining	1, 9, 10, 11			
Thermal spa	9, 12			
Livestock	1, 2, 3, 9, 10, 12			

STATUS, TRENDS AND IMPACTS

From the inputs by countries in the CACENA region on the transboundary aquifers, one can recognize differences in the significance that countries dedicate to the groundwater resources. For instance, mountain countries such as Kyrgyzstan and Tajikistan have expressed less interest on the groundwaters, due to fact that both surface and groundwater resources are available. In general, most human activities provide some pressures on groundwater systems, and have the potential to affect both water quantity and quality. However, as it was found, the lack of effective, sustainable and comprehensive groundwater monitoring programmes identified in most countries of the CACENA region creates obstacles to the current and prospective evaluation of the groundwater quality and quantity in the aquifers used.

GROUNDWATER QUANTITY

As stated above, groundwater abstraction for water supply and irrigation in the region was identified as the main use of groundwater. The questions on water quantity impacts were oriented to two areas:

- Identify impacts on groundwater level;
- Identify both type and scale of problems associated with groundwater abstraction from the aquifer.

Concerning the trends on the groundwater level, no information was provided by countries. In spite of the fact that most of the participating countries have already

established groundwater quantity monitoring network, it might be an indicator that groundwater level is not an issue in the region.

From the inputs received, it can be deduced that mostly local impacts on quantity status of groundwater were observed. However, some countries also recorded widespread impacts (reduction of borehole yields, spring flow, polluted water drawn into aquifers) characterized as moderate (Turkmenistan, Uzbekistan) and severe (Kazakhstan, Uzbekistan, Turkmenistan). The main types of quantity impact caused by over-exploitation of groundwater resources occur as reduction of borehole yields, base flow and spring flow (aquifers No. 3, 8, 12, 13, 14, 15, 16, 17 and 18), polluted water being drawn into an aquifer (1, 2, 3, 9 and 12) degradation of ecosystems (3 and 9), and salt water upcoming (9 and 12). Information on groundwater quantity problems is summarized in the table below.

Groundwater quantity problems				
Problem	Increasing scale of problem →			
	1. Local and moderate	2. Local but severe	3. Widespread but moderate	4. Widespread and severe
Increased pumping lifts or costs		12	12	
Reduction of borehole yields	3, 13, 17, 18		12	8
Reduced base flow and spring flow	14, 15, 16			3, 12
Degradation of ecosystems	3, 9,			
Sea water intrusion				
Salt water upcoming	9	12		
Polluted water drawn into aquifer	1, 3, 9,		2, 12	
Land subsidence				
Decline of piezometric level				8

GROUNDWATER QUALITY

In general, countries have reported problems with groundwater quality. The assessment of the groundwater quality impact has shown occurrences of seven groups of pollutants: salinization, nitrogen substances, pesticides, heavy metals, pathogens, organic compounds, and hydrocarbons. There are four aquifers (aquifers No. 5, 6, 7 and 8) without any indication of groundwater quality impacts. In seven aquifers (1, 2, 3, 4, 12, 13 and 17), at least one kind of pollution was recorded as caused by human activities. In 3 cases, the natural origin of salinization was indicated (9, 10 and 12).

As the most frequent source of pollution, agriculture was recognized influencing five aquifers by nitrogen substances, pesticides and hydrocarbons (aquifers No. 1, 2, 12, 13 and 17). The level of agricultural pollution was recorded from “moderate” to “serious”. This is in direct connection with the current situation in the agriculture practices of the CACENA region, where where old-fashioned technologies and methods for farming are applied.

Industry is the main pollution source causing groundwater contamination by heavy metals, industrial organic compounds and hydrocarbons. Heavy metals originate also from ore mining (aquifers No. 1, 2 and 12). The level of impact on water quality by these pollutants varies between “slight” to “serious”.

There were identified other contaminants influencing four aquifers (aquifers No. 1, 2, 3 and 14): radioactive elements coming from disposal of waste products of extracting enterprises and sulphates and hardness. Groundwater quality problems in CACENA region are summarized in the following table.

Groundwater quality problems			
Problem	Nature of problem		Typical range of concentration
	Natural origins	From which human activities	
Salinization	9, 10 and 12	Irrigation: 4 and 17	1.00 – 3.00 g/l
Nitrogen species		Agriculture: 2, 12, 13 and 17	Values are not available
Pesticides		Agriculture: 1, 2 and 12	Values are not available
Heavy metals		Industry: 1 Ore mining: 2 and 12	Values are not available
Pathogens		Sewer leakage: 12	Values are not available
Industrial organic compounds		Industry: 12	Values are not available
Hydrocarbons		Agriculture: 1 and 2 Industry: 3 and 12	0.2 – 0.0015 mg/l
Radioactive elements		Disposal of waste products of extracting enterprises: 1 and 2	Values are not available
Sulphates and hardness		3 and 14	Values are not available

Concerning the situation on transboundary effects, the countries have reported different impact on groundwater quantity and quality. From the preliminary evaluation it may be concluded, that there are very few evidences of the decline of groundwater level caused by human activities in neighbouring countries. Only in two cases transboundary quantity impacts were observed (aquifers No. 1 and 8), while others were recorded without any evidence of water quantity transboundary effects. There was not any correlation found between types of aquifers and water-quantity impacts.

From the point of view of quality, the situation seems to be more serious. Most countries have indicated significant impact on groundwater quality caused by human activities in the neighbouring countries. There was no evidence of the geographical distribution in the aquifers. It may be remarked, that this evaluation can be understood as a very rough and preliminary estimation, because transboundary impact assessment can be influenced by many factors (mainly data availability) and probably does not reflect the real situation in the region.

MANAGEMENT RESPONSES

The assessment of the current situation in the region is not very optimistic, since most of the basic measures related to the sustainable water management have not been implemented so far or are being used insufficiently and have to be approved or introduced. In spite of the fact that most of the necessary measures are not in place, it was indicated that currently only a few measures are being planned for implementation (e.g. increasing efficiency of groundwater use and integrated river basin management, good agricultural practices, data exchange between countries). If this picture reflects the real situation, future perspectives for the groundwater sector seem to be questionable.

In some countries, certain management measures have already implemented and proved to be effective. In almost all cases groundwater quality and quantity monitoring has been introduced, even in some cases effectively (e.g. aquifers No. 2, 4, and 9). However it was widely recognized that measures were inadequate and needed to be improved (e.g. in Armenia, Azerbaijan, Georgia, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan). As a consequence of the inadequate monitoring activities, there is a lack of proper water assessment and planning activities of the transboundary aquifers in the majority of the responding countries. A similar situation was identified in the delineation of protection zones and vulnerability mapping. These were occasionally reported as being used and used effectively (aquifers No. 3, 8, 9 and 18), but otherwise needed to be improved.

In the management of groundwater resources, in the majority of the aquifers, management abstraction by licensing is being used, but considered to be insufficient where this were being applied, and that the abstraction needed to be better monitored.

For groundwater quality the most widely reported tasks that need to be applied were the treatment of urban and industrial wastewaters. Only two countries (Kyrgyzstan and Turkmenistan) reported these measures to be currently effective. In many instances, implementation or improvement of good agricultural practices is also needed, since within the region no country has implemented this measure effectively.

For the introduction or improvement of transboundary cooperation management measures based on integrated river basin management need to be implemented (see the table below). In this connection, the establishment of transboundary legal frameworks and institutions (e.g. agreements and joint bodies) was recorded as the main task for improvement. Only Turkmenistan reported existence of transboundary institutions. Also data exchange is currently widely considered to be insufficient, and there is a need for it to be introduced.

Groundwater management measures				
Management Measures	**Already used and effective**	**Used, but need to be improved**	**Need to be applied**	**Currently planned**
Transboundary legal framework and institutions (joint bodies, agreements, treaties, etc.)	12	1, 2, 4	5, 6, 7, 8, 11	
Groundwater abstraction management by regulation (licensing, taxation)		5, 6, 7, 8, 12	1, 2, 18	
Groundwater abstraction management by incentives or disincentives (subsidies, credits, energy prices, energy supply, etc.)		4, 5, 6, 7, 8, 9	2, 12	
Increasing efficiency of groundwater use		4, 5, 6, 7, 8, 9	1, 2	12
Monitoring of groundwater quantity	4, 9,	1, 2, 3, 5, 6, 7 8, 12, 15, 18	11, 13, 14, 16, 17	
Monitoring of groundwater quality	2, 4, 9,	1, 3, 5, 6, 7, 8, 18	11, 12, 13, 14, 16, 17	
Public awareness campaigns		5, 6, 7, 12	1, 4, 8, 9,	
Protection zones for public supplies	3, 8, 18	4, 5, 6, 7, 9,	12	
Vulnerability mapping for land use planning	8, 9, 18	5, 6, 7	1, 2, 3, 4, 12	
Good agricultural practices		5, 6, 7, 12	1, 3, 4, 9,	2
Groundwater integrated into river basin management		3, 4	1, 5, 6, 7, 9	12
Wastewater reuse or artificial recharge		9, 12	3, 4, 5, 6, 7	
Treatment of urban wastewater	9, 12	11,	3, 4, 5, 6, 7	
Exchange of data between countries		2	3, 5, 6, 7, 9, 12	
Treatment of industrial effluents	9,	12	1, 2, 3, 5, 6, 7	
Rendering of waste products and recultivation of grounds			1	
Neutralization of radioactive elements and rehabilitation of territory				2

Water management in CACENA countries is a complex and critical issue. The application of the Integrated Water Resources Management (IWRM) principles by the CACENA countries will require groundwater to be integrated into River Basin Management Planning. Sustainable transboundary cooperation will most likely be achieved by creating a basis for assessing the national and regional benefits from technical investments, but these must be complemented by supportive national policy and institutional reforms, as well as capacity- building to strengthen regional institutions.

CONCLUSIONS

Based on the available information delivered by the CACENA countries on the transboundary groundwater aquifers, the following conclusions can be made:

- The groundwater resources are very dominant in the CACENA countries;
- Groundwater resources are used in the CACENA region mainly for drinking water supply. Therefore, it is necessary to protect and improve both groundwater quality and quantity in the CACENA region as precondition for the sustainability of the environment and human beings' security;
- Along with agriculture, the direct water abstraction for water supply is the main use of groundwaters in CACENA countries;
- The majority of the basic measures to improve the groundwater management have not been implemented so far;
- Only scarce data are available from the transboundary groundwater monitoring programmes;
- There is a lack of water management planning approach in the transboundary bodies;
- Implementation or improvement of good agricultural practices is also needed;
- There is a need to establish transboundary institutions for proper cooperation and data exchange;
- Water management is a critical and important issue in the CACENA countries, which are focusing on the national demands rather the transboundary ones;
- There is a need for supportive policy and institutional reforms and capacity-building for the regional or transboundary institutions;
- It is highly recommended that pilot projects be prepared for the monitoring and assessment of the transboundary groundwater aquifers in the CACENA region, and that the case studies are carried out with a central focus on upgrading and building the capacity of the existing infrastructure in the monitoring and assessment of the transboundary groundwater aquifers. There is also a great need to better coordinate donors' activities.

FACTS AND FIGURES ON TRANSBOUNDARY GROUNDWATERS IN CAUCASUS AND CENTRAL ASIA

Aquifer No. 1: Osh Aravoij	Shared by: Uzbekistan and Kyrgyzstan	
Type 5, Medium links to surface water systems, groundwater flows from Uzbekistan to Kyrgyzstan		
	Uzbekistan	Kyrgyzstan
Area (km^2)		
Water uses and functions (percentage of total abstraction)	Drinking water supply (25-50%), irrigation, mining, livestock (<25%)	Drinking water supply (25-50%), irrigation
Pressure factors	Agriculture, industry, waste disposal	Agriculture
Problems related to groundwater quantity	Polluted water drawn into aquifer	Lack of relevant data to be quantified
Problems related to groundwater quality	Serious problems with pesticides, moderate problems with heavy metals, slight problems with hydrocarbons and radioactive elements	Lack of relevant data to be quantified
Transboundary impacts	Decline of groundwater level, groundwater pollution	Lack of relevant data to be quantified
Groundwater management measures	Need to be improved: transboundary institutions, monitoring of groundwater quantity and quality, need to be applied: abstraction management, efficiency of use, mapping, good agricultural practices, integrated river basin manage ment, treatment of industrial effluents, data exchange	Need to improved: transboundary institutions, monitoring of groundwater quantity and quality
Status and what is most needed	Improvement of the monitoring of groundwater quantity and quality	Improvement of the monitoring of groundwater quantity and quality
Future trends and prospects	Expected pressure on the water resources due to economic growth and climate change	Expected pressure on the water resources due to economic growth and climate change

Aquifer No. 2: Almoe-Vorzin		Shared by: Uzbekistan and Kyrgyzstan
Type 5, Medium links to surface water systems Groundwater flows from Uzbekistan to Kyrgyzstan		
	Uzbekistan	Kyrgyzstan
Area (km^2)		
Water uses and functions (percentage of total abstraction)	Drinking water (50-75%), irrigation (25-50%), industry, livestock (<25%)	Drinking water supply (25-50%), irrigation
Pressure factors	Agriculture, ore mining, waste disposal	Agriculture
Problems related to groundwater quantity	Polluted water drawn into aquifer	Lack of relevant data to be quantified
Problems related to groundwater quality	Nitrogen species, pesticides, heavy metals, hydrocarbons	Lack of relevant data to be quantified
Transboundary impacts	Groundwater pollution	Lack of relevant data to be quantified
Groundwater management measures	Effective: quality monitoring Need to be improved: quantity monitoring, transboundary institutions, data exchange Need to be applied: abstraction management, mapping, treatment of industrial effluents	Need to improved: transboundary institutions, monitoring of groundwater quantity and quality
Status and what is most needed	Good agricultural practices, neutralization of radioactive elements	Enhancement of monitoring programme
Future trends and prospects		Improvement of the monitoring of groundwater quantity and quality

Aquifer No. 3: Moiansuv		Shared by: Uzbekistan and Kyrgyzstan
Type 5, Strong, medium links to surface water system, average thickness 50 m		
	Uzbekistan	Kyrgyzstan
Area (km^2)	1,760	Not identified yet
Water uses and functions (percentage of total abstraction)	Irrigation (50-75%), drinking water, industry, livestock (<25%)	Drinking water supply, irrigation
Pressure factors	Industry	Agriculture
Problems related to groundwater quantity	Reduction of borehole yields, degradation of ecosystem, polluted water	Lack of relevant data to be quantified
Problems related to groundwater quality	Hydrocarbons, sulphates	Lack of relevant data to be quantified
Transboundary impacts	Groundwater pollution	Lack of relevant data to be quantified
Groundwater management measures	Effective: protection zones Need to be improved: transboundary institutions, quality and quantity monitoring, integrated river basin management Need to be applied: mapping, good agricultural practices, treatment of urban and industrial wastewater	Need to improved: transboundary institutions, monitoring of groundwater quantity and quality
Status and what is most needed		Enhancement of monitoring programme
Future trends and prospects	Improvement of the monitoring programme of both quality and quantity	Improvement of the monitoring of groundwater quantity and quality

Aquifer no. 4: Sokh		Shared by: Uzbekistan and Kyrgyzstan
Type 5, Strong links to surface water systems		
	Uzbekistan	Kyrgyzstan
Area (km^2)		
Water uses and functions		Drinking water supply, irrigation
Pressure factors	Irrigation	Agriculture
Problems related to groundwater quantity		Lack of relevant data to be quantified
Problems related to groundwater quality	Salinization (1-3 g/l)	Lack of relevant data to be quantified
Transboundary impacts	Groundwater pollution	Lack of relevant data to be quantified
Groundwater management measures	Effective: quantity and quality monitoring Need to be improved: transboundary institutions, abstraction management, protection zones, integrated river basin management. Need to be applied: mapping, good agricultural practices, urban wastewater treatment and reuse	Need to improved: transboundary institutions, monitoring of groundwater quantity and quality
Status and what is most needed		Enhancement of monitoring programme
Future trends and prospects		Improvement of the monitoring of groundwater quantity and quality

Aquifer No. 5: Alazan-Agrichay		Shared by: Azerbaijan and Georgia
Type 3, Medium links to surface waters Groundwater flows from Greater Caucasus to Alazani river		
	Azerbaijan	Georgia
Area (km^2)	3,050	Not identified yet
Water uses and functions (percentage of total abstraction)	Irrigation (80 – 85%) Drinking water supply (10 – 15%) Industry (3-5%)	Drinking water supply
Pressure factors	No substantial problems	No substantial problems
Problems related to groundwater quantity	No substantial problems	No substantial problems
Problems related to groundwater quality	No substantial problems	No substantial problems
Transboundary impacts	Lack of relevant data	Lack of relevant data
Groundwater management measures	Need to be improved: integrated management, abstraction management, efficiency of use, monitoring, agricultural practices, protection zones, mapping Need to be applied: treatment of urban and industrial wastewater, transboundary institutions, data exchange	Need to be improved: control of the use of groundwater resources. Need to be applied: treatment of urban and industrial wastewater, monitoring programmes both quantity and quality, data exchange
Status and what is most needed	Joint monitoring programme	Joint monitoring programme
Future trends and prospects	Increased water demands	Increased water demands by economic growth (irrigation, drinking water and industry)

Aquifer No. 6: Samur	Shared by: Azerbaijan and the Russian Federation (Samur river)	
Type 3, Gravel – pebble, sand, boulder		
	Azerbaijan	Russian Federation
Area (km^2)	2,900	
Water uses and functions (percentage of total abstraction)	Drinking water (90-92%), irrigation (5-8%), industry (2-3%)	
Pressure factors	None	
Problems related to groundwater quantity	None	
Problems related to groundwater quality	None substantial problem	
Transboundary impacts	Groundwater pollution	
Groundwater management measures	Need to be improved: abstraction management, quantity and quality monitoring, protection zones, good agricultural practices, mapping Need to be applied: transboundary institutions, data exchange, integrated river basin management, treatment of urban and industrial wastewater	
Status and what is most needed	Joint monitoring programme	
Future trends and prospects	Increased use of water due to economic growth	

Aquifer No. 7: Middle and Lower Araks	Shared by: Azerbaijan and Islamic Republic of Iran (Araks river)	
Type 3, Gravel – pebble, sand, boulder		
	Azerbaijan	Islamic Republic of Iran
Area (km^2)	1,480	
Water uses and functions (percentage of total abstraction)	Irrigation (55-60%), drinking water (40-45%)	
Pressure factors	None	
Problems related to groundwater quantity	None	
Problems related to groundwater quality	None	
Transboundary impacts	None	
Groundwater management measures	Need to be improved: abstraction management, quantity and quality monitoring, protection zones, good agricultural practices, mapping Need to be applied: transboundary institutions, data exchange, integrated river basin management, treatment of urban and industrial wastewater	
Status and what is most needed	Joint monitoring programme	
Future trends and future prospects	Increased use of water due to economic growth	

Aquifer No. 8: Pretashkent		Shared by: Uzbekistan and Kazakhstan
Type 4, Large deep groundwater (artesian type)		
	Uzbekistan	Kazakhstan
Area (km^2)		
Water uses and functions	Mineral water and partly as drinking water source	Drinking water supply
Pressure factors	Not recognized	Water abstraction on both sides of the aquifer
Problems related to groundwater quantity	Not recognized	Reduction of borehole yields
Problems related to groundwater quality	There are no problems with pollution	There are no problems with pollution
Transboundary impacts	Not recognized	Decline of the groundwater levels were observed
Groundwater management measures	Licensing of the groundwater abstraction and monitoring programme in place It is urgently needed to establish the transboundary institutions and data exchange	Licensing of the groundwater abstraction and monitoring programme in place It is urgently needed to establish the transboundary institutions and data exchange
Status and what is most needed	Enhancement of monitoring programme	To enhance monitoring programme and assessment methods as mathematical modelling for making water balance
Future trends and prospects	Increased economic activities and climate change can have a pressure on the groundwater resources	Increased economic activities and climate change can have a pressure on the groundwater resources

Aquifer No. 9: Chu Basin		Shared by: Kyrgyzstan and Kazakhstan
Type 4, Quaternary sand, gravel, weak links to surface water systems, groundwater flow from Kyrgyzstan to Kazakhstan		
	Kyrgyzstan	Kazakhstan
Area (km^2)		
Water uses and functions (percentage of total abstraction)	Drinking water, irrigation, industry, mining, livestock, thermal spa (<25%)	Drinking water 50%, irrigation 50%
Pressure factors	Water abstraction	Water abstraction
Problems related to groundwater quantity	Degradation of ecosystems, salt water upcoming	None
Problems related to groundwater quality	Salinization	None
Transboundary impacts	None	Not quantified yet
Groundwater management measures	Effective: quantity, quality monitoring, mapping, urban and industry wastewater treatment. Need to be improved: transboundary institutions, abstraction management, protection zones. Need to be applied: good agricultural practices, integrated river basin management, data exchange	Effective: quantity, quality monitoring Need to be improved: transboundary institutions, abstraction management Need to be applied: good agricultural practices, integrated river basin management, data exchange
Status and what is most needed	Enhancement of the monitoring programme	Enhancement of the monitoring programme
Future trends and prospects	Lack of data and information to make proper predictions	Lack of data and information to make proper predictions

Aquifer No. 10: Pambak-Debet		Shared by: Georgia and Armenia
Type 3		
	Georgia	Armenia
Area (km^2)		
Water uses and functions (percentage of total abstraction)	Drinking water supply 100%	Drinking water up to 90%, irrigation and mining industry
Pressure factors	Lack of data	Mining industry and agriculture
Problems related to groundwater quantity	Lack of data	Lack of data
Problems related to groundwater quality	Lack of data	Lack of data on the pollution from the agricultural and industrial activities
Transboundary impacts	Lack of data to evaluate these effects	Lack of data
Groundwater management measures	Effective: controlled water abstraction Need to be improved: urban and industrial wastewater treatment, Need to be applied: transboundary institutions to be set up, monitoring programme to be enhanced	It is important to make controlled water abstraction. Need to be improved: urban and industrial wastewater treatment, Need to be applied: transboundary institutions to be set up, monitoring programme to be enhanced and data exchange
Status and what is most needed	Joint monitoring programme	Joint monitoring programme
Future trends and prospects	Increased use of water as consequence of the economic growth	

Aquifer No. 11: Agstev-Tabuch	Shared by: Armenia and Azerbaijan	
Type 1, 2, Moderate connections with surface water systems.		
	Armenia	Azerbaijan
Area (km^2)	500	500
Water uses and functions (percentage of total abstraction)	Drinking water up to 75%, irrigation up to 25% and mining industry	Irrigation 80%, drinking water 15%, industry 5%
Pressure factors	Mining industry and waste disposal	Mining industry
Problems related to groundwater quantity	Lack of data	Lack of data
Problems related to groundwater quality	Lack of data on the pollution from the agricultural and industrial activities	Heavy metals
Transboundary impacts	Lack of data	Moderate pollution by heavy metals
Groundwater management measures	It is important to make controlled water abstraction. Need to be improved: urban and industrial wastewater treatment, Need to be applied: transboundary institutions to be set up, monitoring programme to be enhanced and data exchange	It is important to make controlled water abstraction Need to be improved: urban and industrial wastewater treatment, Need to be applied: transboundary institutions to be set up, monitoring programme to be enhanced and data exchange
Status and what is most needed	Great need to organize joint monitoring programme on both sides and to set up the regular data exchange	Great need to organize joint monitoring programme on both sides and to set up the regular data exchange
Future trends and prospects		Increased use of water by economic growth

Aquifer No. 12: Birata-Urgench	Shared by: Uzbekistan and Turkmenistan	
Type 3, Quaternary sand, loam, groundwater flow from Uzbekistan to Turkmenistan		
	Uzbekistan	Turkmenistan
Area (km^2)		
Water uses and functions	Drinking water supply	Drinking water supply
Pressure factors	Water abstraction	Water abstraction
Problems related to groundwater quantity	Widespread/moderate reduction of borehole yields, widespread/serious reduction of base flow, spring flow	Widespread/moderate reduction of borehole yields, widespread/serious reduction of base flow, spring flow
Problems related to groundwater quality	Salinization (natural origins and irrigation) as results of waste water and drainage waters	Salinization (natural origins and irrigation) as results of waste water and drainage waters
Transboundary impacts	Need to be investigated	Need to be investigated
Groundwater management measures	Joint quantity and quality monitoring, data exchange	Joint quantity and quality monitoring, data exchange
Status and what is most needed	Improvement of the groundwater monitoring programme	Improvement of the groundwater monitoring programme
Future trends and prospects	Lack of information for making trends prediction	Lack of information for making trends prediction

Aquifer No. 13: Karotog	Shared by: Tajikistan and Uzbekistan	
Type 2, Moderate connections with surface water bodies		
	Tajikistan	Uzbekistan
Area (km^2)	328	Necessary to be corrected
Water uses and functions	Drinking water supply	Drinking water supply
Pressure factors	Water abstraction	Water abstraction
Problems related to groundwater quantity	Change of water resources on the edge of sustainability	Change of water resources based on the water abstraction on the Tajikistan territory
Problems related to groundwater quality	Negligible local contamination by nitrate (agriculture)	Negligible local contamination by nitrate (agriculture)
Transboundary impacts	Necessary to be investigated	Necessary to be investigated
Groundwater management measures	Joint monitoring of the groundwater	Joint monitoring of the groundwater
Status and what is most needed	Enhancement of the monitoring network of groundwater	Enhancement of the monitoring network of groundwater
Future trends and prospects	Not sufficient information to make predictions	Not sufficient information to make predictions

Aquifer No. 14: Dalverzin	Shared by: Uzbekistan and Tajikistan	
Type 2, Moderate connections with surface water bodies		
	Uzbekistan	Tajikistan
Area (km^2)		
Water uses and functions	Irrigation	Drinking water supply and irrigation
Pressure factors	Water abstraction	Water abstraction
Problems related to groundwater quantity	Water resources are recharged in the course of year	Water resources are recharged in the course of year
Problems related to groundwater quality	Moderate increase in mineralization and hardness	Moderate increase in mineralization and hardness
Transboundary impacts	Necessary to be investigated	Necessary to be investigated
Groundwater management measures	Monitoring of the groundwater status	Monitoring of the groundwater status
Status and what is most needed	Enhancement of the representative monitoring network of transboundary waters	Enhancement of the representative monitoring network of transboundary waters
Notes		
Future trends and prospects	Lack of information for making predictions and trends	Lack of information for making predictions and trends

Aquifer No. 15: Zaforoboi	Shared by: Tajikistan and Uzbekistan	
Type 2, Moderate connections with surface water bodies		
	Tajikistan	Uzbekistan
Area (km^2)		
Water uses and functions	Drinking water and irrigation	Drinking water and irrigation
Pressure factors	Water abstraction	Water abstraction
Problems related to groundwater quantity	Natural resources are recharged in the autumn and winter period	Natural resources are recharged in the autumn and winter period
Problems related to groundwater quality	No contamination	Moderate pollution
Transboundary impacts	Necessary to be investigated	Necessary to be investigated
Groundwater management measures	Existing monitoring network of groundwater programme, necessary to be improved	Monitoring network of groundwater programme, necessary to be improved
Status and what is most needed	Enhancement of the representative monitoring network of transboundary waters	Enhancement of the representative monitoring network of transboundary waters
Notes		
Future trends and prospects	Lack of information for making predictions and trends	Lack of information for making predictions and trends

Aquifer No. 16: Zeravshan	Shared by: Tajikistan and Uzbekistan	
Type 2, Moderate connections with surface water bodies		
	Tajikistan	Uzbekistan
Area (km²)	88	To be corrected
Water uses and functions	Drinking water supply	Drinking water and technological water
Pressure factors	Moderate water abstraction	Moderate water abstraction
Problems related to groundwater quantity	Change of water resources on the edge of natural sustainability	Change of water resources on the edge of natural sustainability
Problems related to groundwater quality	Significant effect of the industrial activities on the territory of Tajikistan	Lack of data for evaluation
Transboundary impacts	Necessary to be investigated	Necessary to be investigated
Groundwater management measures	Need to organize complex monitoring programme	Existing monitoring programme of the groundwater
Status and what is most needed	Enhancement of the complex monitoring network of transboundary waters	Development of the complex monitoring network of transboundary waters
Future trends and prospects	Lack of information for making predictions and trends	Lack of information for making predictions and trends

Aquifer No. 17: Salepta- Batkin- Nai-Icfor (Syr Darya)	Shared by: Kyrgyzstan and Tajikistan	
Type 2, Moderate connections with surface water bodies		
	Kyrgyzstan	Tajikistan
Area (km²)		891
Water uses and functions	Irrigation and drinking water	Irrigation, drinking water and technological water
Pressure factors		Water abstraction
Problems related to groundwater quantity	Over exploitation registered	Water abstraction on the territory of Kyrgystan
Problems related to groundwater quality	Contamination by nitrates and salinization	Increased mineralization, hardness and sulphates
Transboundary impacts	Necessary to be investigated	Necessary to be investigated
Groundwater management measures	Special monitoring is not performed	Monitoring is done partly
Status and what is most needed	Enhancement of the complex monitoring network of transboundary waters	Enhancement of the complex monitoring network of transboundary waters
Future trends and prospects	Lack of information for making predictions and trends	Lack of information for making predictions and trends

Aquifer No. 18: Chhatkal-Kurman		Shared by: Kazakhstan and Uzbekistan
Type 4, Weak link to surface waters, groundwater flow from Kazakhstan to Uzbekistan		
	Kazakhstan	Uzbekistan
Area (km^2)	20,000	
Water uses and functions (percentage of total abstraction)	Drinking water (100%)	Drinking water (100%)
Pressure factors	Water abstraction	Water abstraction
Problems related to groundwater quantity	Reduction of borehole yields, decline of groundwater level	Reduction of borehole yields, decline of groundwater level
Problems related to groundwater quality	None	None
Transboundary impacts	Decline of groundwater level	Decline of groundwater level
Groundwater management measures	Effective: protection zones, mapping Need to be improved: quantity and quality monitoring, abstraction management Need to be applied: transboundary institutions	Enhancement of the monitoring programme
Status and what is most needed	Joint monitoring programme	Joint monitoring programme
Future trends and prospects		Lack of information to make predictions