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Working Group on Monitoring and Assessment

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Item 4 of the provisional agenda

## ASSESSMENT OF THE STATUS OF TRANSBOUNDARY WATERS IN THE UNECE REGION[1]

## PRELIMINARY ASSESSMENT OF TRANSBOUNDARY GROUNDWATERS IN CAUCASUS AND CENTRAL ASIA[2]

Submitted by the Chairperson of the Working Group on Monitoring and Assessment[*]

[1] At their fourth meeting (Bonn, Germany, 20–22 November 2006), the Parties to the Convention mandated its Working Group on Monitoring and Assessment with the assessment of transboundary rivers, lakes and groundwaters in the UNECE region. For details, please refer to documents ECE/MP.WAT/WG.2/2007/1 and ECE/MP.WAT/WG.2/2007/3.

[2] This document was prepared by Mr. Peter.Roncak (Slovak Hydrometeorological Institute) upon the request made by the Working Group on Monitoring and Assessment at its seventh meeting

[*] The present document was submitted late due to resources constraints in the secretariat and late submission by some countries.

**Background**

1. This assessment was prepared following the respective decisions taken by the fourth meeting of the Parties to the Water Convention and by the Working Group on Monitoring and Assessment (WGMA) at its fifth and sixth meetings. The overall approach to the task was established by the Groundwater Core Group of the WGMA at its meeting in Paris in April 2006 and accepted by the WGMA at its seventh meeting in Geneva in May 2006.

2. This report presents a preliminary assessment of the status of transboundary groundwaters in Caucasus and Central Asia region (CACENA). The report sets out the scale and scope of the transboundary groundwaters in the region and their importance 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 report also provides information about the management measures being taken, planned or needed to prevent, control or reduce transboundary impacts in groundwaters in the CACENA region.

3. The assessment is based largely on responses to a specifically designed data collection questionnaire (Annex 1[3]) prepared by the Groundwater Core Group and distributed in July 2006 to the national focal points. Questionnaires have provided very valuable information, however not sufficient to cover whole range of the groundwater issues in the region. Therefore, the information thus obtained has been supplemented by existing information from the previous UNECE inventory of transboundary groundwaters[4], from other sources such as the GEF/UNDP projects, OSCE and UNESCO programmes and projects and other research and development projects financed by the different donors.

4. The assessment methodology broadly follows the guidance provided by UNECE[5] in using the DPSIR framework to describe the pressures acting on the groundwaters, the status in terms of both quantity and quality of the groundwaters and the impacts resulting from any deterioration in status.

5. The assessment for the CACENA region has been coordinated and managed for UNECE by the Slovak Hydrometeorological Institute. Further support has been provided by the International Groundwater Assessment Centre (IGRAC), and OSCE Office in the region. A workshop to review the draft of the assessment was held in Almaty in May 31 – June 1, 2007, with the support of UNESCO and OSCE, where future activities and necessary measures were discussed by participating countries representatives as well.

## I. TRANSBOUNDARY GROUNDWATERS

6. For transboundary basins in the Central Asia during the Soviet Union era basin plans were developed by regional design institutions and included inter-republic and multi-sectoral

[3] The Annex on overview of groundwater characteristics will be prepared in due course for the final publication of the assessment of the status of transboundary waters in the UNECE region

[4] Almássy E and Buzás Z. 1999. Inventory of transboundary groundwaters. UNECE Task Force on Monitoring and Assessment. Lelystad.

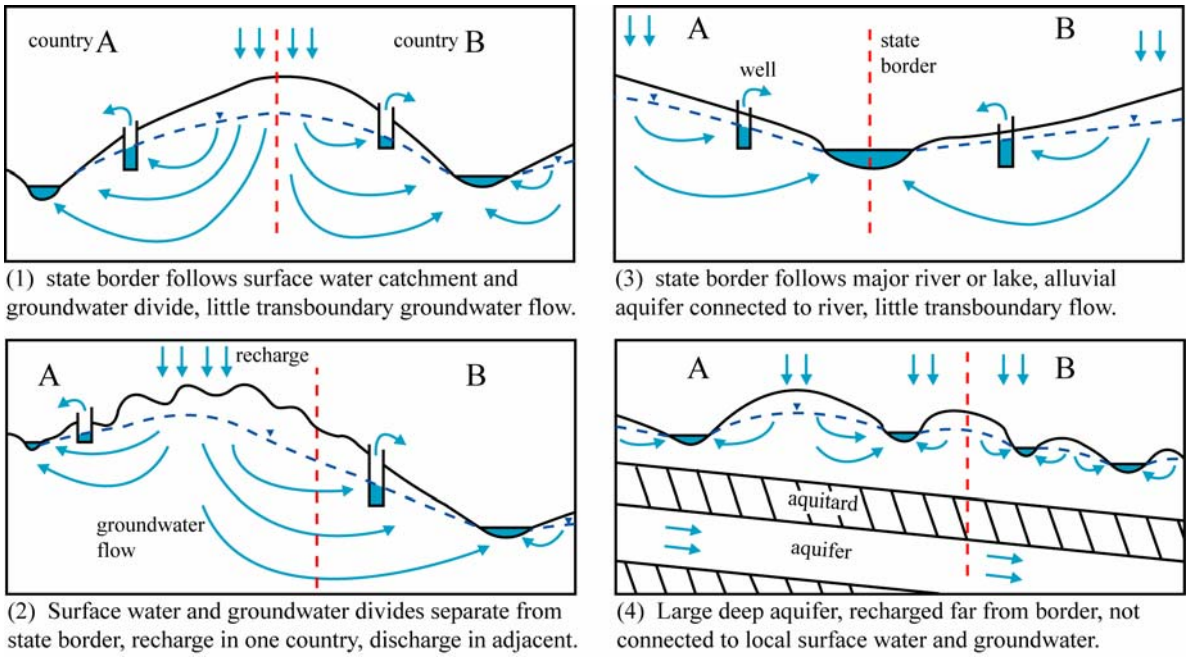
[5] Guidelines on Monitoring and Assessment of Transboundary Groundwaters, 2000. UNECE Task Force on Monitoring and Assessment. Lelystad.

aspects, as well as allocation of water for various uses. Since independence more than a decade ago, the Caucasus and Central Asian countries (Armenia, Azerbaijan, Georgia as well as Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan) have been striving to develop fair and rational bases for sharing and using their water resources. These former Soviet 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 need. Central Asia´s agricultural expansion and population growth over the past three decades have placed a great strain on the water resources of the region.

## A. Scale and scope of transboundary groundwaters

7. This regional assessment covers transboundary groundwater aquifers from 8 countries: Uzbekistan (UZ), Azerbaijan (AZ), Kazakhstan (KZ), Kyrgyzstan (KG), Georgia (GE), Tajikistan (TA), Armenia (AM) and Turkmenistan (TM). All together 20 aquifers with significant groundwater resources were reported as transboundary groundwater bodies bordering and sharing by two countries. However, only 13 of the them were reported by both countries. The preliminary assessment has shown that transboundary groundwaters play a significant role in the CACENA region.

8. Different types, functions and uses can characterize groundwater aquifers. In general, all types of groundwaters can be found in the responding countries**.** However, they are young sediments in river basins as it was reported in the questionnaires.




(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.

**Figure 1. Conceptual models of typical transboundary aquifers**

9. General information from the first part of questionnaires giving overview on the types and geology of the aquifers is summarised in the following table.

**Table 1 – Identified transboundary aquifers**

| Countries (Code) | Aquifer **Name** | Type/link with surface water | Lithology/age | Thickness mean-max (m) | Extent **($km^2$)** |
|---|---|---|---|---|---|
| Uzbekistan/ Kyrgyzstan UZ/KG (UZ1) | Osh Aravoij | 5/shallow/deep gw /medium | Sandy gravel | | |
| Uzbekistan/ Kyrgyzstan UZ/KG (UZ2) | Almoe-Vorzin | 5/medium | | | |
| Uzbekistan/ Kyrgyzstan UZ/KG (UZ3) | Moiansuv | 5/shallow-deep gw /strong-medium | Boulders pebble, loams, sandy, loams | 150 - 300 | 1760 |
| Uzbekistan/ Kyrgyzstan UZ/KG (UZ4) | Sokh | 5/probably shallow gw/strong | | | |
| Azerbaijan/ Georgia AZ/GE (AZ1) | Alazan-Agrichayskij | 3/shallow gw /medium | Gravel-pebble, sand, boulder | 150 - 320 | 3050 |
| Azerbaijan/ Russia AZ/RF (AZ2) | Samurskij | 3/shallow gw/strong | Gravel-pebble, sand, boulder | 50 - 100 | 2900 |
| Azerbaijan/ Iran AZ/IR (AZ3) | Middle and Lower Arazskij | 3/shallow/strong | Gravel-pebble, sand, boulder | 60 - 150 | 1480 |
| Kazakhstan/ Uzbekistan KZ/UZ (KZ1) | Chhatkalo Kurmanskij | 4/deep gw/weak | Sand, clay | 200 – 320 | 20 000 |
| Kyrgyzstan/ Kazakhstan KG/KZ (KG1) | Chu Basin | 4/deep gw/weak | Sand, clay, loams | 200 - 350 | |
| Kyrgyzstan/ Uzbekistan KG/UZ (KG2) | Sokh | 4/deep gw/weak | Sand, clay, loams | 200 - 350 | |
| Georgia/ Azerbaijan | Alazan-Agrichayskij | 1/2/3/shallow gw/strong | Cobble bed | 8 - 20 | more than 1 |

| | | | | | |
|---|---|---|---|---|---|
| GE/AZ, GE/Turkey, GE/AM | | | | | |
| Turkmenistan /Uzbekistan TM/UZ, | Birata-Urgench | 3/shallow gw /strong | Sand, loams | 10 - 50 | 60 000 |
| Turkmenistan / Iran TM/IR | Ashkaad | 3/shallow gw /strong | Sand, loams | | |
| Turkmenistan / Afghanistan (TM1) | No name | 3/shallow gw /strong | Sand, loams | | |

10. Figures in the table 1 show that the 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 between 1 $km^2$ (Georgia) to 60 000 $km^2$ (Turkmenistan). Mean thickness of acquifers ranges between 8 - 200 m and maximum thickness ranges between 20 - 350 m depending mainly on stratigraphy and age. It is indicated, that identified aquifers represent large water reservoirs with significant groundwater resources, which can play important role in the region.

11. According to the simplified conceptual sketches provided it may be concluded that identified aquifers can be divided into two groups. First group represents deeper groundwater aquifers with weak or medium link with local surface water systems recharged far from the border (type 4, and 5). Only in one case state border, which is situated on watershed divided line, is identical with recharge zone. 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.

12. In the Figures 2a and 2b the locations of the groundwaters covered by this assessment are shown, indicating for which of them information has been received by questionnaires received from both countries sharing the aquifers. From this map, it can be seen that several of the countries of the region have their national borders traversed by transboundary groundwaters.

*Figure 2a. Distribution of transboundary groundwaters in the Caucasus region (delivered by UNESCO) to be completed*

*Figure 2b. Distribution of transboundary groundwaters in the Central Asia region(delivered by UNESCO) to be completed*

## B. Groundwater use

13. The questionnaire responses show that groundwater resources are important in total water usage and direct water abstraction for water supply is the main use of groundwater in all

responding 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 (AZ1, AZ2, AZ3) and the same data reported Turkmenistan (TM1 50 %). Such use is not surprising, due to the alluvial settings of aquifers, in comparison with the surface water resources.

14. In all cases the most frequent type of groundwater utilisation is drinking water. The preliminary assessment has shown that all identified aquifers are utilised for drinking water purposes. But percentage of this type of groundwater use of total groundwater abstraction varies in large extent from 10 % (Azerbaijan, Turkmenistan) to 100 % (Kazakhstan). In 7 transboundary aquifers (UZ3, AZ1, KG1, KG2, TM1 UZ1, AZ3) the percentage of drinking water use on total groundwater abstraction is less than 50 %, only in 3 cases (AZ2, KZ1, GE) 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-Tashkentkij aquifer is reported to be used predominantly for drinking water purposes, in Uzbekistan it was reported to be used just as a source of mineral water).

15. From other possible use was indicated significance of groundwater for agriculture support reported in 5 aquifers (Uzbekistan UZ1, UZ2, UZ3, Kyrgyzstan KG1, KG2) and for maintaining base flow and springs marked in 4 aquifers (Uzbekistan UZ1, UZ2, UZ3) and Georgia. 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 emphasised in the case of Kyrgyzstan (Chu Basin).

## II. PRESSURE FACTORS

16. 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 form the agricultural and industrial activities, since the groundwater resources are used for these purposes as indicated by the countries in questionnaires. 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 are very scared or even no monitoring activities are performed by countries. Therefore, assessment of the pressure factors on the transboundary aquifers is very limited.

### A. Agriculture

17. From other types of groundwater utilization, abstraction for irrigation has comparable significance as drinking water. Central Asia countries are significantly dependent on the irrigated agriculture, and both water quantity and quality has emerged as an issue in the republic´s development. The assessment shows that 9 from 12 aquifers are utilised 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 fact that agriculture is the larger 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. It could be a case for the aquifers with very high percentage of abstraction for agriculture recorded by Azerbaijan (AZ1 80-85%, AZ3 55-60 %) and Uzbekistan (UZ3 50-75 %). However, the economic difficulties in the CACENA region have suppressed both the usage of water for irrigation and the application of fertilisers and pesticides. With the expected economic growth and the need to increase crop production, agricultural pressure factors are expected to become more important.

## B. Industry, mining, thermal spa

18. Industrial pressure factors for transboundary aquifers in the CACENA region seem to be rather limited. For industry, water is modestly utilised only from 5 aquifers with the rate less than 25 % of total groundwater abstraction (UZ2, UZ3, AZ1, AZ2, KG2, KG1, TM1). For mining were recorded only 3 cases with less than 25 % of total abstraction (Uzbekistan UZ1, Kyrgyzstan KG1, KG2) and for thermal spa 2 cases less than 25 % were indicated (Kyrgyzstan KG1, Turkmenistan TM1). Heavy metals and organic substances are reported by countries in the questionnaires. 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 basins.

## C. Livestock

19. Livestock watering is reported as a minor (less than 25%), but widely used water in majority of the region. However, in the responses it was not reported anything on the type of the animal production (extensive or intensive) in the aquifer areas. Evidence 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.

**Table 2 – Percentage of total groundwater abstraction for different uses**

| Type of use | Percentage | If you do not know the exact percentage, than mark one of the following options | | | |
|---|---|---|---|---|---|
| | | < 25 % | 25 – 50 % | 50 – 75 % | > 75 % |
| Drinking water | | UZ3, AZ1, KG1, KG2, TM1 | UZ1, AZ3, | UZ2 | AZ2, KZ1, GE, |
| Irrigation | | UZ1, AZ2, KG1, KG2, TM1 | UZ2 | UZ3, AZ3 | AZ1 |
| Industry | | UZ2, UZ3, AZ1, AZ2, KG2, KG1, TM1 | | | |
| Mining | | UZ1, KG1, KG2 | | | |
| Thermal spa | | KG1, TM1 | | | |
| Livestock | | UZ1, UZ2, UZ3, KG1, KG2, TM1 | | | |

## III. PRELIMINARY EVALUATION OF STATUS, TRENDS AND IMPACTS

20. From the country reports of 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 as Kyrgyzstan and Tajikistan have expressed less interests on the groundwaters, due to fact that both surface and groundwater resources are available, in contrast to neighbouring countries, where human activities can make impact on the transboundary aquifers. Globally, most of the human activities provide some pressures on groundwater systems, which have the potential to affect both water quantity and quality. However, as it was reported in the questionnaires, lack of effective, sustainable and comprehensive groundwater monitoring programmes identified in most countries of the CACENA region, create the obstacles in current state and prospective evaluation of the groundwater quality and quantity in the used aquifers.

### A. Problems related to groundwater quantity

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

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

22. Concerning the trends on the groundwater level, no information was provided from responding countries. In spite of the 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.

23. From the answers on the second question it can be dedicated that mostly local impacts on quantity status of groundwater were observed. However, some countries recorded also widespread impacts (reduction of borehole yields, spring flow, polluted water drawn into aquifer) characterised 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 (UZ3, TM1, KZ1) degradation of ecosystems (UZ3, KG1, KG2) salt water upcoming (KG1, KG2, TM1) and polluted water drawn into aquifer (UZ1, UZ3, KG1, KG2 UZ2, TM1). Information on groundwater quantity problems is summarised in Table 1.

**Table 3 – 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 | | TM1 | TM1 | |
| Reduction of borehole yields | UZ3 | | TM1 | KZ1 |
| Reduced base flow and spring flow | | | | UZ3, TM1 |
| Degradation of ecosystems | UZ3, KG1, KG2, | | | |
| Sea water intrusion | | | | |
| Salt water upcoming | KG1, KG2, | TM1 | | |
| Polluted water drawn into aquifer | UZ1, UZ3, KG1, KG2 | | UZ2, TM1 | |
| Land subsidence | | | | |
| Other (please specify) | | | | |
| Decline of piezometric level | | | | KZ1 |
| 3 x no problems (AZ1, AZ2, AZ3) | | | | |

## B. Problems related groundwater quality

24. 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 4 aquifers (Azerbaijan – AZ1, AZ2, AZ3, Kazakhstan KZ1) without any indication of groundwater quality impacts. In the 5 aquifers (UZ1, UZ2, UZ3, UZ4, TM1) there were recorded at least one kind of pollution caused by human activities. In 3 cases natural origin of salinization was indicated (Kyrgyzstan KG-1, KG2, Turkmenistan TM1).

25. As the most frequent source of pollution, agriculture was recognized influencing 3 aquifers by nitrogen substances, pesticides and hydrocarbons (UZ1, UZ2, TM1). The level of agricultural pollution was recorded from moderate (class 2) to serious (class 4). This is in direct connection with the current situation in the agriculture practices of the CACENA region, where old fashion technologies and methods for farming are applied.

26. Industry is the main pollution source causing groundwater contamination by heavy metals, industrial organic compounds and hydrocarbons. Heavy metals originate also from ore mining UZ1, UZ2, TM1). The level of impact on water quality by these pollutants varies between slight (class 1) to serious (class 4).

27. There were identified other contaminants influencing 2 aquifers (UZ2, UZ3): radioactive elements coming from disposal of waste products of extracting enterprises and sulphates. Groundwater quality problems in CACENA region are summarized in Table 4.

**Table 4 – Groundwater quality problems**

| *Problem* | *Nature of problem* | | **Typical range of concentration** | **Scale, using classes 1-4 from table above** |
|---|---|---|---|---|
| | **Natural origins** | **From which human activities[1]** | | |
| Salinization | KG1, KG2, TM1 | Irrigation UZ4, TM1 | 1,00 – 3,00 g/l | 2<br>3 |
| Nitrogen species | | agriculture UZ2, TM1 | Values are not available | 2<br>3 |
| Pesticides | | agriculture UZ1, UZ2, TM1 | Values are not available | 4, 3<br>2 |
| Heavy metals | | industry UZ1<br>ore mining UZ2, TM1 | Values are not available | 3<br>4<br>2 |
| Pathogens | | Sewer leakage TM1 | Values are not available | 1 |
| Industrial organic compounds | | Industry TM1 | Values are not available | 2 |
| Hydrocarbons | | Agriculture UZ1, UZ2<br>Industry UZ3, TM1 | 0,2 – 0,0015 mg/l | 2, 2<br>1<br>1 |
| Other *(please specify)* | | | | |
| Radioactive elements<br><br><br><br><br>Sulphates | | Disposal of waste products of extracting enterprises UZ1, UZ2<br><br><br>UZ3 | Values are not available | 1,1<br><br><br><br><br>1 |
| 4 x no problems (AZ1, AZ2, AZ3, KZ1) | | | | |

28. Concerning the situation on transboundary effects, the countries have reported different impact on groundwater of 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 2 cases transboundary quantity impacts were observed (UZ1 type 5, KZ1 type 4), while 9 aquifers were recorded without any evidence of water quantity effects. There was not any correlation found between types of aquifers and water quantity impacts.

29. From quality point of view the situation seem to be more serious. Most countries have indicated significant impact on groundwater quality caused by human activities in the neighbouring countries. There was not evidence of the geographical distribution in the aquifers. It may be remarked, that this evaluation can be understood as very rough and preliminary

estimation, because transboundary impact assessment can be influenced by many factors (mainly data availability) and probably does not reflect real situation in the region.

## IV. PRELIMINARY EVALUATION OF MANAGEMENT RESPONSES

30. The final part of the questionnaire was used to seek information concerning responses in the context of management measures already being applied or should be implemented in the future. The preliminary assessment have shown, that current situation in the region reflects not very optimistic views, since most of the basic measures listed in the questionnaires have not been implemented so far or are being used insufficiently and have to be approved or introduced. Despite of the fact that most of the necessary measures are not in place, there have been indicated that currently only few measures are being planned for implementation (increasing efficiency of groundwater use - TM1, integrated river basin management – TM1, good agricultural practices – UZ2, data exchange between countries – UZ1). If this picture reflects real situation, future perspectives of groundwater sector seem to be questionable.

31. Few responses considered some management measures to be already implemented and effective. There were indicated that in almost all cases groundwater quality and quantity monitoring is introduced, even in some cases effective (UZ2, UZ4, KG1, KG2), but it was wildly recognised as inadequate and need to be improved (Georgia, Armenia, Kyrgyzstan, Uzbekistan Tajikistan). 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. Similar situation was identified in delineation of protection zones, and vulnerability mapping. There were occasionally reported as being used and effective (UZ3, KZ1), but also need to be improved.

32. In the management of groundwater resources most responses recorded groundwater management abstraction by licensing is being used, but considered to be insufficient where they were being applied and need to be implemented better.

33. For groundwater quality the most widely reported tasks need to be applied were the treatment of urban and industrial wastewaters. Only two countries (KG1, KG2, TM1) 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.

34. For the introduction or improvement of transboundary co-operation management measures based on integrated river basin management need to be implemented. In this connection establishment of the transboundary institutions (commissions, agreements and treaties) were 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 to be introduced.

**Table 5 - Groundwater management measures**

| *Management Measures* | **Already used and effective** | **Used, but need to be improved** | **Need to be applied** | **Currently planned** |
|---|---|---|---|---|
| Transboundary institutions (commissions, agreements, treaties, etc.) | TM1 | UZ1, UZ2, UZ4 | AZ1, AZ2, AZ3, KZ1 | |
| Groundwater abstraction management by regulation (licensing, taxation) | | AZ1, AZ2, AZ3, KZ1, TM1 | UZ1, UZ2 | |
| Groundwater abstraction management by incentives or disincentives (subsidies, credits, energy prices, energy supply, etc.) | | UZ4, AZ1, AZ2, AZ3, KG1, KG2 | UZ2, TM1 | |
| Increasing efficiency of groundwater use | | UZ4, AZ1, AZ2, AZ3, KG1, KG2 | UZ1, UZ2 | TM1 |
| Monitoring of groundwater quantity | UZ4, KG1, KG2 | UZ1, UZ2, UZ3, AZ1, AZ2, AZ3, KZ1, TM1 | | |
| Monitoring of groundwater quality | UZ2, UZ4, KG1, KG2 | UZ1, UZ3, AZ1, AZ2, AZ3, KZ1 | TM1 | |
| Public awareness campaigns | | AZ1, AZ2, AZ3, TM1 | UZ1, UZ4, KZ1, KG1, KG2 | |
| Protection zones for public supplies | UZ3, KZ1 | UZ4, AZ1, AZ2, AZ3, KG1, KG2 | TM1 | |
| Vulnerability mapping for land use planning | KZ1, KG1, KG2 | AZ1, AZ2, AZ3 | UZ1, UZ2, UZ3, UZ4, TM1 | |
| Good agricultural practices | | AZ1, AZ2, AZ3, TM1 | UZ1, UZ3, UZ4 , KG1, KG2 | UZ2 |
| Groundwater integrated into river basin management | | UZ3, UZ4 | UZ1, AZ1, AZ2, AZ3, KG1, KG2 | TM1 |
| Wastewater reuse or artificial recharge | | KG1, KG2, TM1 | UZ3, UZ4, AZ1, AZ2, AZ3 | |
| Treatment of urban wastewater | KG1, KG2, TM1 | | UZ3, UZ4, AZ1, AZ2, AZ3 | |
| Exchange of data between countries | | UZ2 | UZ3, AZ1, AZ2, AZ3, KG1, KG2, TM1 | UZ1 |
| Treatment of industrial effluents | KG1, KG2 | TM1 | UZ1, UZ2, UZ3, AZ1, AZ2, AZ3 | |
| Other *(please specify)* | | | | |
| Rendering of waste products and recultivation of grounds<br>Neutralization of radioactive elements and rehabilitation of territory | | | UZ1 | UZ2 |
| | | | | |

35. Water management in CACENA countries is a complex and critical issue. Applying IWRM principles by the CACENA countries will require groundwater to be integrated into River Basin Management Planning. Sustainable transboundary co-operation 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, and capacity building for regional institutions.

## V. CONCLUSIONS AND RECOMMENDATIONS

36. Based on the available information delivered by the CACENA countries on the transboundary groundwater aquifers, it can be concluded as follows:

(a) The groundwater resources are very dominant in the CACENA countries,

(b) As an urgent and priority, the improvement of the water quality and increasing of groundwater quantity to meet the basic human needs were recognized in the region,

(c) The direct water abstraction for water supply is the main use of groundwater in CACENA countries along with agriculture, and it is expected to be even more pronounced due to economic development and climate change impact,

(d) Majority of the basic measures to improve the groundwater management have not been implemented so far,

(e) Scarce data are available from the groundwater monitoring programmes in the transboundary regions,

(f) There is a lack of water management planning approach in the transboundary regions of the CACENA countries,

(g) Implementation or improvement of the good agricultural practices is also needed,

(h) There is a need to establish transboundary institutions for proper cooperation and data exchange,

(i) Water management is a critical and important issue in the CACENA countries focusing on the national demands rather the transboundary ones,

(j) There is a need for the supportive policy and institutional reforms and capacity building for the regional or transboundary institutions.

37. It is highly recommended to prepare the pilot projects for monitoring and assessment of the transboundary groundwater aquifers in the CACENA region and to carry out the case studies with main focus on the capacity building and upgrading existing infrastructure in monitoring and assessment of the transboundary groundwater aquifers. There is a great need to set up the objectives and coordination for the donors that would serve for the more effective results to be achieved.

38. The representatives of the CACENA countries taking part on the Almaty workshop have come by the consensus to the main message to be delivered to the Ministers in Belgrade: *“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 the human beings security".*

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