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Item 7 of the provisional agenda

**Assessment of the status of transboundary waters in the UNECE<sup>1</sup> region**
**Assessment of transboundary rivers, lakes and groundwaters  
 in the Caucasus discharging into the Caspian Sea**

 Note prepared by the secretariat<sup>2</sup>

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<sup>1</sup> United Nations Economic Commission for Europe.

<sup>2</sup> The present document has been finalized after the official documentation deadline due to late receipt of comments and resource constraints.

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## I. Introduction

1. The present document contains the assessments of the different transboundary rivers, lakes and groundwaters in the Caucasus which are located within the Caspian Sea drainage basin. The river basins assessed in this document are sub-basins of the Kura. The document has been prepared by the secretariat on the basis of information provided by the countries in the Caucasus region: Armenia, Azerbaijan, Georgia, the Islamic Republic of Iran, the Russian Federation and Turkey. It should be noted that maps of the basins and maps showing locations of the transboundary aquifers are not referred to here but will be developed for the final assessment, consulting the riparian countries when necessary. For descriptions of the transboundary aquifer types and related illustrations, please refer to Annex V of document ECE/MP.WAT/2009/8.

2. There are some gaps in the data presented in this document and some mismatches in the figures reported can also be observed (highlighted in italics in the text). The Parties and non-Parties concerned are invited to review the information and provide the secretariat with amendments and additions by 31 August 2010. In particular, completing the assessments of basins on which some riparian countries' input is missing is encouraged.

## II. Kura River Basin<sup>3</sup>

3. The basin of the river Kura is shared by Armenia, Azerbaijan, Georgia, the Islamic Republic of Iran and Turkey.<sup>4</sup> The 1,515 km river has its source in Turkey on the North slope of the Allahuekber Mountains Range at the height of about 3,068 m a.s.l. and discharges to the Caspian Sea.

4. The basin has a pronounced mountainous and highland character in Turkey with an elevation between 1,300–3,068 m a.s.l. and an average elevation of about 2,184 m a.s.l.

5. Major transboundary tributaries include the following rivers: the Araks/Aras, Iori, Alazani, Debet, Agstev, Potskhovi/Posof and Ktsia-Khrami. Transboundary aquifers within the Kura Basin include the Alazan/Agrichay, Debet and Agstev-Akstafa/Tavush-Tovuz.<sup>5</sup>

6. Transboundary conservation areas located in Kura-Araks River Basin are the following:<sup>6</sup> (1) Lagodeghi-Zakatala-West Daghestan (transboundary Georgia-Azerbaijan-Russian Federation; total area 498,706 ha); (2) Iori-Mingechavir (transboundary Georgia-Azerbaijan; 631,181 ha); (3) Alazani-Ganykh (transboundary Georgia-Azerbaijan; 51,230 ha); (4) Kura-Jandari (transboundary Georgia-Azerbaijan; 30,068 ha); (5) Maku and western Iranian border (transboundary Iran-Turkey; 486,479 ha); (6) Agri Dagi and Armash (transboundary Turkey, Armenia, Azerbaijan, Iran; 271,669 ha); (7) Javakheti (transboundary Georgia, Armenia, Turkey; 322,994 ha); (8) Igdir Plain and Armavir (transboundary Turkey, Armenia; 403,170 ha).

<sup>3</sup> Based on information from Armenia, Azerbaijan, Georgia, the Islamic Republic of Iran, Turkey and the First Assessment of Transboundary Rivers, Lakes and Groundwaters (ECE/MP.WAT/25).

<sup>4</sup> The Russian Federation is usually not considered as a basin country, as its territory in the basin is far below 1 per cent of the total basin area.

<sup>5</sup> These transboundary aquifers are described in the assessment of the Alazani, Debet and Agstev sub-basins, respectively.

<sup>6</sup> Source: Kura-Aras River Basin Transboundary Diagnostic Analysis. Project Reducing Trans-boundary Degradation of the Kura-Aras River Basin (Kura-Aras PDF B). January 2007.

Table 1  
Area and population in the Kura basin

| Country                  | Area in the country (km <sup>2</sup> ) | Country's share % | Population | Population density (persons/km <sup>2</sup> ) |
|--------------------------|--|-------------------|------------|---|
| Armenia                  | 29 743                                 | 15.8              |            |   |
| Azerbaijan               | 57 831                                 | 30.7              | 6 900 000  | 145   |
| Georgia                  | 29 741                                 | 15.8              | 2 659 000  | 89  |
| Islamic Republic of Iran | 43 209                                 | 23.0              |            |   |
| Turkey                   | 27 548 <sup>a</sup>                    | 14.6              | 112 242    | 24 <sup>b</sup>                               |
| <b>Total</b>             | <b>188 072</b>                         |                   |            |   |

<sup>a</sup> The area in total within the whole Kura-Araks Basin which is Turkey's territory; the area within the Kura Basin only is 4,662 km<sup>2</sup>. The population figures refer to the Kura Basin area only.

<sup>b</sup> Turkish Statistical Institute, 2008.

Sources: UNECE Environmental Performance Review (EPR) programme; Ministry of Nature Protection of Armenia; Ministry of Ecology and Natural Resources of Azerbaijan; Ministry of Environment Protection and Natural Resources of Georgia; Iranian Ministry of Energy/Deputy of Water and Wastewater Affairs; and Turkey's General Directorate of State Hydraulic Works.

Table 2  
Renewable water resources in the Kura Basin per country

| Country                  | Renewable surface water resources (km <sup>3</sup> /year) | Renewable groundwater resources (km <sup>3</sup> /year) | Total renewable water resources (km <sup>3</sup> /year) | Renewable water resources per capita (m <sup>3</sup> /capita/year) | Period of observations used for estimating water resources |
|--------------------------|---|---|---|--|--|
| Armenia                  |   |   |   |  |  |
| Azerbaijan               | 8.0   | 5.2   | 13.2  | 1 913  | Long term  |
| Georgia                  | 6.438   | 1.923   | 8.362   | 3 144  | 1935–1990  |
| Islamic Republic of Iran |   |   |   |  |  |
| Turkey                   | 1.093   | 0.040   | 1.133   | 10 067   | 1969–1997  |

Table 3  
Discharge characteristics of the Kura at gauging station Akkiraz in Turkey (latitude: 43° 7', longitude 41° 15'; Elevation: 1,380 m a.s.l.)

| Discharge characteristics | Discharge (m <sup>3</sup> /s) | Period of time or date |
|---------------------------|-------------------------------|------------------------|
| Q <sub>av</sub>           | 32.8                          | 1979–1998              |
| Q <sub>max</sub>          | 338                           | 11/08/1986             |
| Q <sub>min</sub>          | 5.6                           | 02/01/1983             |

Table 4

**Discharge characteristics of the Kura at gauging station Khertvisi in Georgia (downstream of the border with Turkey; latitude: 41° 29'; longitude 43° 17').**

| <i>Discharge characteristics</i> | <i>Discharge (m<sup>3</sup>/s)</i> | <i>Period of time or date</i> |
|----------------------------------|------------------------------------|-------------------------------|
| Q <sub>av</sub>                  | 32.4                               | 1930–1990                     |
| Q <sub>max</sub>                 | 55.6                               | 1930–1990                     |
| Q <sub>min</sub>                 | 17.6                               | 1930–1990                     |

Table 5

**Discharge characteristics of the Kura at Tbilisi city gauging station in Georgia (latitude: 41° 44'; longitude 44° 47')**

| <i>Discharge characteristics</i> | <i>Discharge (m<sup>3</sup>/s)</i> | <i>Period of time or date</i> |
|----------------------------------|------------------------------------|-------------------------------|
| Q <sub>av</sub>                  | 204.0                              | 1936–1990                     |
| Q <sub>max</sub>                 | 325.0                              | 1936–1990                     |
| Q <sub>min</sub>                 | 133.0                              | 1936–1990                     |

Table 6

**Mean monthly discharges of the Kura at Tbilisi city gauging station in Georgia (latitude: 41° 44'; longitude 44° 47') based on observations from 1930 to 1990**

| <i>Mean monthly discharges</i>  |                                  |                                  |
|---------------------------------|----------------------------------|----------------------------------|
| October: 114 m <sup>3</sup> /s  | November: 111 m <sup>3</sup> /s  | December: 95.8 m <sup>3</sup> /s |
| January: 83.2 m <sup>3</sup> /s | February: 91.3 m <sup>3</sup> /s | March: 165 m <sup>3</sup> /s     |
| April: 456 m <sup>3</sup> /s    | May: 567 m <sup>3</sup> /s       | June: 353 m <sup>3</sup> /s      |
| July: 182 m <sup>3</sup> /s     | August: 110 m <sup>3</sup> /s    | September: 102 m <sup>3</sup> /s |

Table 7

**Discharge characteristics of the Kura at gauging station Kyragkesaman in Azerbaijan (on the border with Georgia; latitude: 41° 00'; longitude: 46° 10')**

| <i>Discharge characteristics</i> | <i>Discharge (m<sup>3</sup>/s)</i> | <i>Period of time or date</i> |
|----------------------------------|------------------------------------|-------------------------------|
| Q <sub>av</sub>                  | 276.0                              | 1953–1958, 1986–2008          |
| Q <sub>max</sub>                 | 446.0                              | 1953–1958, 1986–2008          |
| Q <sub>min</sub>                 | 44.5                               | 1953–1958, 1986–2008          |

Table 8

**Mean monthly discharges of the Kura at gauging station Kyragkesaman in Azerbaijan based on observations from 1953 to 2008**

| <i>Mean monthly discharges</i> |                                 |                                  |
|--------------------------------|---------------------------------|----------------------------------|
| October: 162 m <sup>3</sup> /s | November: 182 m <sup>3</sup> /s | December: 171 m <sup>3</sup> /s  |
| January: 161 m <sup>3</sup> /s | February: 167 m <sup>3</sup> /s | March: 248 m <sup>3</sup> /s     |
| April: 586 m <sup>3</sup> /s   | May: 685 m <sup>3</sup> /s      | June: 460 m <sup>3</sup> /s      |
| July: 224 m <sup>3</sup> /s    | August: 127 m <sup>3</sup> /s   | September: 134 m <sup>3</sup> /s |
| Mean discharge                 | 276 m <sup>3</sup> /s           |                                  |

Table 9

**Discharge characteristics of the Kura at gauging station Salyan in Azerbaijan (latitude: 48° 59'; longitude: 39° 36')**

| <i>Discharge characteristics</i> | <i>Discharge (m<sup>3</sup>/s)</i> | <i>Period of time or date</i> |
|----------------------------------|------------------------------------|-------------------------------|
| Q <sub>av</sub>                  | 448.0                              | 1953–2008                     |
| Q <sub>max</sub>                 | 657.0                              | 1953–2008                     |
| Q <sub>min</sub>                 | 74.0                               | 1953–2008                     |

Table 10

**Mean monthly discharges of the Kura at gauging station Salyan in Azerbaijan (latitude: 41° 00'; longitude 46° 10') based on observations from 1953 to 2008**

| <i>Mean monthly discharges</i> |                                 |                                  |
|--------------------------------|---------------------------------|----------------------------------|
| October: 330 m <sup>3</sup> /s | November: 381 m <sup>3</sup> /s | December: 473 m <sup>3</sup> /s  |
| January: 514 m <sup>3</sup> /s | February: 501 m <sup>3</sup> /s | March: 507 m <sup>3</sup> /s     |
| April: 579 m <sup>3</sup> /s   | May: 662 m <sup>3</sup> /s      | June: 539 m <sup>3</sup> /s      |
| July: 322 m <sup>3</sup> /s    | August: 271 m <sup>3</sup> /s   | September: 299 m <sup>3</sup> /s |
| Mean discharge                 | 448 m <sup>3</sup> /s           |                                  |

7. Spring floods cause damage in some parts of the basin. A number of reservoirs and dams on the Kura serve also for flood regulation. The Mingechevir Reservoir has improved the situation regarding flood control in the lowlands of the river.

Table 11

**Most important water reservoirs in the Kura River Basin**

| <i>River/tributary</i> | <i>Reservoir, country</i> | <i>Year of construction</i> | <i>Full volume (mln m<sup>3</sup>)</i> | <i>Payload volume (mln m<sup>3</sup>)</i> | <i>Installed capacity (MW)</i> |
|------------------------|---------------------------|-----------------------------|--|---|--------------------------------|
| Kura                   | Mingachevir (AZ)          |                             | 15 730                                 | 8 210                                     |                                |
| Kura                   | Shamkir (AZ)              |                             | 2 677                                  | N/A                                       |                                |
| Aras                   | Aras (AZ)                 |                             | 1 350                                  | 1 150                                     |                                |
| Aragvi                 | Jhinali (GE)              |                             | 520                                    | 370                                       |                                |
| Iori                   | Sioni (GE)                |                             | 325                                    | 315                                       |                                |
| Khrami                 | Khrami (GE)               |                             | 313                                    | 293                                       |                                |
|                        | Samgori (Tbilisi) (GE)    |                             | 308                                    | 155                                       |                                |
| Agstafa                | Agstafa (AZ)              |                             | 120                                    | 111                                       |                                |
| Kura                   | Yenikend (AZ)             |                             | 158                                    | 136                                       |                                |
| Algeti                 | Algeti (GE)               |                             | 65                                     | 60  |                                |

| <i>River/tributary</i> | <i>Reservoir, country</i> | <i>Year of construction</i> | <i>Full volume (mln m<sup>3</sup>)</i> | <i>Payload volume (mln m<sup>3</sup>)</i> | <i>Installed capacity (MW)</i> |
|------------------------|---------------------------|-----------------------------|--|---|--------------------------------|
| Kura                   | Barbarinsk (AZ)           |                             | 62                                     | 10  |                                |
|                        | Jandari (GE)              |                             | 54.28                                  | 25.03                                     |                                |
| Patara Liahvi          | Zonkari (GE)              |                             | 40.3                                   | 39  |                                |
|                        | Iakublo (GE)              |                             | 11                                     | 10.8                                      |                                |

*Sources:* Azerbaijan, Georgia and United Nations Development Programme/Sida project Reducing Trans-boundary Degradation of the Kura-Aras river basin, 2005.

Table 12

**Kura aquifer (No. 60<sup>7</sup>). Type 2, volcanic rocks of Tertiary and Quaternary age: Tuff breccia, mergel, quartz porphury, albitophyre. Moderate links with surface water**

|  | <i>Georgia</i>  | <i>Azerbaijan</i> |
|--|---|-------------------|
| Area (km <sup>2</sup> )                            | 70  |                   |
| Renewable groundwater resource (m <sup>3</sup> /d) |   |                   |
| Thickness in m (mean, max)                         | 100, 250  |                   |
| Number of inhabitants                              |   |                   |
| Population density                                 |   |                   |
| Groundwater uses and functions                     | Used for drinking water                                 |                   |
| Other information                                  | A common monitoring programme is indicated to be needed |                   |

## Pressures

8. The economy of the Turkish part of the Kura Basin relies on agriculture and animal production and, in Azerbaijan, extensive areas are under irrigated agriculture (some 745,000 ha in Azerbaijan, including 300,000 ha in the Azerbaijani part of the Araks/Aras sub-basin). In the part of the basin that is Turkey's territory, nearly one fifth of irrigable land is irrigated, but the area is increasing through land development projects. Upon completion of Turkey's Kura Master Plan, more than 38,000 ha of land will be irrigated. Where the groundwater table is high and there are problems with drainage, irrigation contributes to soil salinization. Water withdrawal from the Kura for irrigation occurs mainly downstream from Mingchevir.

9. In the Georgian part of the basin, agriculture is one of the main factors affecting groundwater as large amounts of water are abstracted for irrigation and via pollution from fertilizers. Animal stocks have also gradually increased in parallel with irrigation. There are also manure and fertilizer pollution problems related to agricultural activities in the basin. There is some limited manufacturing activity in Turkey based on agriculture and animal husbandry.

<sup>7</sup> This is a new aquifer number because the aquifer did not appear in the First Assessment of Transboundary Rivers, Lakes and Groundwaters.

10. Logging has reduced forested areas and deforestation and overgrazing makes areas vulnerable to erosion, resulting in reduced stability of the ground and loose sediment making the river water turbid. Climatic, topographic and geological conditions also contribute to erosion. Land and soil degradation are a concern, e.g., in the upper part of the basin (Turkey). In addition to fertile soil wash-out, land degradation in the basin involves also salinization, especially in more arid parts of the basin. These are both reported to be a concern in Georgia and Azerbaijan. Some stone and aggregate quarries in Turkey have a degrading effect on the landscape, but at local scale. Aggregate quarries add to erosion risk in the riverbed. Planned dam constructions are expected to influence the flow and hydromorphology.

11. Some 11 million people live in the catchment area of the Kura River<sup>8</sup> Wastewater discharges pose a risk of surface and groundwater pollution, because of a lack of wastewater treatment plants in urban settlements. In Georgia, municipal wastewater treatment plants are mostly not in functioning condition. In rural settlements, there is commonly no sewerage network. In the Turkish part, the influence of wastewater from municipalities and households is considered local, but severe.

12. There are similar risks from controlled and uncontrolled dumpsites, which are assessed by Turkey as local but severe in influence. In the Azerbaijani and Georgian parts of the basin, pollution from illegal dump sites is one of the main factors influencing the condition of waters. There are controlled dumpsites in municipalities in the Turkish part, but some, like Ardahan, may cause pollution of nearby agricultural land.

13. Polluting activities present in the basin include also mining (in Armenia, Georgia and the Islamic Republic of Iran), metallurgical and chemical industries. The major pollutants are heavy metals (copper (Cu), zinc (Zn), cadmium (Cd)) from mining and the leather industry, and ammonia and nitrates from the fertilizer industry. The waste rock dumps of Madneuli mine in the village of Kazreti, Georgia, are reported have an impact through rainfall flushing metals and other contaminants from the heaps to the river Mashavera.

14. Ceyhan-Tbilisi-Baku oil pipeline traversing the territory of Georgia in the basin is felt to pose a pollution risk.

Table 13  
**Land use/land cover in the Kura Basin**

| Country    | Water bodies (%) | Forest (%) | Cropland (%) | Grassland (%) | Urban/ industrial areas (%) | Surfaces with little | Wetlands/ Peatlands (%) | Other forms of land use (%) |
|------------|------------------|------------|--------------|---------------|-----------------------------|----------------------|-------------------------|-----------------------------|
|            |                  |            |              |               |                             | or no vegetation (%) |                         |                             |
| Armenia    |                  |            |              |               |                             |                      |                         |                             |
| Azerbaijan | N/A              | 12.3       | 12.9         | 4.7           | 5.9                         | N/A                  | N/A                     | N/A                         |
| Georgia    | N/A              | 42.5       | 18.5         | 42.2          | N/A                         | N/A                  | N/A                     | N/A                         |

<sup>8</sup> Environmental Performance Review Azerbaijan, UNECE, 2004.

| Country                  | Water bodies (%) | Forest (%) | Cropland (%)      | Grassland (%) | Urban/ industrial areas (%) | Surfaces with little or no vegetation (%) | Wetlands/ Peatlands (%) | Other forms of land use (%) |
|--------------------------|------------------|------------|-------------------|---------------|-----------------------------|---|-------------------------|-----------------------------|
| Islamic Republic of Iran |                  |            |                   |               |                             |   |                         |                             |
| Turkey <sup>a</sup>      | 2.8              | 6.6        | 17.4 <sup>b</sup> | 59            | N/A                         | N/A                                       | 0.3                     | 13.9                        |

<sup>a</sup> The percentage for Turkey represents watershed of Kura River (4,662 km<sup>2</sup>).

<sup>b</sup> About 20 per cent of the cropland is irrigated.

Table 14  
Water use in different sectors (per cent)

| Country                  | Total withdrawal ×10 <sup>6</sup> m <sup>3</sup> /year | Agricultural % | Domestic % | Industry %     | Energy %     | Other % |
|--------------------------|--|----------------|------------|----------------|--------------|---------|
| Armenia                  |  |                |            |                |              |         |
| Azerbaijan               | 11 785   | 63.4           | N/A        | 20.8           | <sup>b</sup> | N/A     |
| Georgia                  | 12 158   | 1              | 3          | 2              | 94           | N/A     |
| Islamic Republic of Iran |  |                |            |                |              |         |
| Turkey                   | 65   | 88             | 12         | 0 <sup>a</sup> | 0            | N/A     |

<sup>a</sup> Considered negligible in Turkey as there are no substantial industrial facilities in the Turkish part of the basin and as the existing small factories generally use water from municipalities or from groundwater wells.

<sup>b</sup> Non-consumptive water use for energy purposes in Azerbaijan is 13.1 km<sup>3</sup>/year.

15. The Kura River is the source of drinking water for almost 80 per cent of the population of Azerbaijan.

16. The main water users in the Georgian part of the Kura River Basin are: agriculture, industry, municipalities and the energy sector (hydro- and thermal energy generation). In agriculture the water source for irrigation in Eastern Georgia is surface water. The efficiency of the irrigation network is quite low, with water losses estimated at 40–50 per cent. The main industry sectors using water are: chemical industry, building material industry, non-ferrous metallurgy and food processing industry. Groundwater makes up 80 per cent of the drinking water distributed through centralized networks.

17. In the Turkish part, water for domestic use is commonly taken from springs and wells. Groundwater is also used locally for irrigation by farmers. Groundwater abstraction is not considered to be of concern. Surface water is withdrawn for irrigation locally also in Turkey, but its influence is considered insignificant.

## Status

18. According to Turkish Inland Water Quality Standards, water quality in the Turkish part of the Kura River is in Class I and Class II, that is, unpolluted and/or less polluted water bodies, respectively.

19. According to measurements by Armenia from 2006 to 2009 along the Araks/Aras River, heavy metals such as aluminum (Al), iron (Fe), manganese (Mn), chrome (Cr) and

vanadium (V) occur in water in moderate amounts. Some of these are part of the typical geochemical background of the Araks/Aras. Cr occurs at amounts exceeding the maximum allowable concentration (MAC) almost every year. Nitrate level did not exceed MAC during the same observation period.

20. According to the Ministry of Environment of Georgia, in the Kura River in 2008 (Tbilisi, Vakhushti Bagrationi bridge) the biochemical oxygen demand for five days (BOD<sub>5</sub>) fluctuated between 1.79 (April) and 7.36 mg/l (September), and the concentrations of ammonium ion (NH<sub>4</sub><sup>+</sup>) from 0.3 (January) to 1.4 mg/l (October). In 2009, the maximum concentration of ammonium ion was nine times higher than the corresponding MAC, ranging from 0.209 (November) to 3.616 (October). Other measured components within the respective MAC. To date, ecological and chemical status of the river is satisfactory in Georgia's view.

21. According to the Ministry of Ecology and Natural Resources of Azerbaijan, in 2009, the concentrations of BOD<sub>5</sub> ranged 2.45–5.02 mg/l, the concentration of NH<sub>4</sub><sup>+</sup>-ion from 0.38 to 1.0 mg/l, the concentration of copper and zinc ranged from 0.69 to 1.01 mg/l in the Kura River at monitoring station Kura Shikhli-2. Phenols concentrations ranged from 0.003 to 0.007 mg/l. Other measured components were below the respective MAC. To date, in Azerbaijan's view, ecological and chemical status of the river is not satisfactory.

## Trends

22. Turkey reports that no study has been carried out for historical climate change on Kura River Basin based on observation. However, according to national prediction and long-term scenarios, both precipitation and river run-off are expected to decrease by 10 to 20 per cent, the former by 2030 and the latter by 2070–2100. Seasonal variability in precipitation and flood/drought risk are predicted to increase. Based on expert knowledge, groundwater level is predicted to decrease and groundwater quality to be affected negatively. Both consumptive and non-consumptive water uses are foreseen to increase.

23. To assess the future impact of predicted climate changes on the hydrological regime of the Alazani and Iori Rivers, crossing the territory of the East Georgia, a hydrological model — the Water Evaluation and Planning System (WEAP) — was applied. The water resources of these rivers are intensively used for the irrigation of crops and pastures. Forecast of changes in climatic parameters (temperature, precipitation) has been performed applying two regional models.<sup>9</sup> Both rivers have been assessed starting from the upper part of their catchments, but limited by the Georgian territory. Climate change impacts on the upper parts of the Alazani and Iori Rivers and some segments on the territory of Georgia have been assessed for the time horizon 2070–2100. For that period, the annual mean temperature forecast is 8.9°C (current average 3.3°C) in the upper part of the Alazani and 11.9°C (current average 6.4°C) in the upper part of the Iori. The projected average for the annual sum of precipitation is 2,260 mm (current average 2,280 mm) for the Alazani and 1,351 mm (current average 1325 mm) for the Iori. The predicted decreases in flow are about 8.5 per cent in the Alazani and 11 per cent in the Iori.

24. In the Turkish part of the Kura Basin, water use is expected to increase substantially, to 0.331 km<sup>3</sup>/year (presently 0.065 km<sup>3</sup>/year) upon the completion of the projects in the Kura Master Plan. In particular, water use for hydropower is foreseen to increase. Georgia predicts increases in withdrawals in some tributaries, including the Alazani, Iori and Ktsia-Khrami Rivers, from a few per cent up to 10 per cent by 2015.

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<sup>9</sup> Regional climate models PRECIS and MAGICC/SCHENGEN.

### III. Iori sub-basin<sup>10</sup>

25. The basin of the 320-km Iori River is shared by Georgia and Azerbaijan. The river has its source in on the southern slope of the Main Caucasian Range at the height of 2,600 m and discharges into the Kura, as a left-hand side (northern) tributary. The upper part of the sub-basin is mountainous, located on the southern slope of the Kaveazskogo ridge, and the lower within Kakheti Kartlino plateau (lowland steppe).

26. In Georgia, the river system is made up of 509 smaller rivers with an overall length of 1,777 km. There are nine major tributaries to the Iori, ranging in length from 10 to 32 km: the Lapianhevi (10 km), the Ragolanttskali (12 km), the Hashrula (12 km), the Gombori (13 km), the Keno (16 km), the Adede (16 km), the Sagome (18 km), the Ole (29 km) and the Lakbe (32 km).

Table 15  
Area and population in the Iori sub-basin

| Country      | Area in the country (km <sup>2</sup> ) | Country's share % | Population | Population density (persons/km <sup>2</sup> ) |
|--------------|--|-------------------|------------|---|
| Georgia      | 4 650                                  | 88.4              | 240 800    | 52  |
| Azerbaijan   | 610                                    | 11.6              |            |   |
| <b>Total</b> | <b>5 260</b>                           |                   |            |   |

*Sources:* Ministry of Environment Protection and Natural Resources of Georgia for the area in Georgia; Ministry of Ecology and Natural Resources of Azerbaijan for the area in Azerbaijan.

#### Hydrology and hydrogeology

27. The hydrological regime of the river is characterized by spring floods (from snowmelt and heavy rainfall that usually occurs during March), summer/autumn high waters and steady low-water levels in winter.

28. In Georgia, there are three large irrigation reservoirs on the Iori River: the Sioni Reservoir, used for irrigation, hydropower generation and water supply; the Tbilisi Reservoir, used for irrigation and water supply; and the Dalimta Reservoir, used for irrigation.

Table 16  
Renewable water resources in the Iori sub-basin

| Country              | Renewable surface water resources (km <sup>3</sup> /year) | Renewable groundwater resources | Total renewable water resources (km <sup>3</sup> /year) | Renewable water resources per capita (m <sup>3</sup> /capita/year) | Period of observations used for estimating water resources |
|----------------------|---|---------------------------------|---|--|--|
| Georgia <sup>a</sup> | 0.366   | 0.155                           | 0.522   | 2 166  | 1992–2004  |
| Azerbaijan           |   |                                 |   |  |  |

<sup>a</sup> Surface water estimate based on data from 1963 to 1992, groundwater from 2004.

<sup>10</sup> Based on information from Azerbaijan and the First Assessment of Transboundary Rivers, Lakes and Groundwaters.

Table 17

**Mean monthly discharges of the Iori at Lelovani gauging station, Georgia (277 km from the river's mouth, elevation: 1,640 m a.s.l.)**

| <i>Discharge characteristics</i> | <i>Discharge (m<sup>3</sup>/s)</i> | <i>Period of time or date</i> |
|----------------------------------|------------------------------------|-------------------------------|
| Q <sub>av</sub>                  | 11.6                               | 1964–1992                     |
| Q <sub>max</sub>                 | 324                                | 27/06/1976                    |
| Q <sub>min</sub>                 | 1.00                               | 21/08/1970                    |

Table 18

**Discharge characteristics of the Iori at Lelovani gauging station, Georgia**

| <i>Mean monthly discharges</i>  |                                  |                                   |
|---------------------------------|----------------------------------|-----------------------------------|
| October: 7.96 m <sup>3</sup> /s | November: 6.83 m <sup>3</sup> /s | December: 5.96 m <sup>3</sup> /s  |
| January: 4.82 m <sup>3</sup> /s | February: 5.14 m <sup>3</sup> /s | March: 10.4 m <sup>3</sup> /s     |
| April: 21.3 m <sup>3</sup> /s   | May: 25.4 m <sup>3</sup> /s      | June: 20.0 m <sup>3</sup> /s      |
| July: 13.2 m <sup>3</sup> /s    | August: 9.23 m <sup>3</sup> /s   | September: 8.82 m <sup>3</sup> /s |

Table 19

**Mean monthly discharges of the Iori at gauging station Kasaman in Azerbaijan (44 km from the river's mouth) based on observations during the following periods: 1976–1984, 1988–1989, 1992–1994, 2001–2008**

| <i>Mean monthly discharges</i>  |                                  |                                   |
|---------------------------------|----------------------------------|-----------------------------------|
| October: 5.15 m <sup>3</sup> /s | November: 6.02 m <sup>3</sup> /s | December: 6.18 m <sup>3</sup> /s  |
| January: 6.02 m <sup>3</sup> /s | February: 5.89 m <sup>3</sup> /s | March: 6.37 m <sup>3</sup> /s     |
| April: 6.26 m <sup>3</sup> /s   | May: 6.21 m <sup>3</sup> /s      | June: 7.57 m <sup>3</sup> /s      |
| July: 6.42 m <sup>3</sup> /s    | August: 6.29 m <sup>3</sup> /s   | September: 5.80 m <sup>3</sup> /s |
| Mean discharge                  | 6.17 m <sup>3</sup> /s           |                                   |

Table 20

**Aquifer No. 61 (name?): Aquifer does not correspond with described types. Sandstones, conglomerates, marls, limestones, alluvial-proluvial pebbles and sands, Tertiary and Quaternary in age. Groundwater flow direction from Georgia to Azerbaijan. Medium links with surface water**

|                                 | <i>Georgia</i>  | <i>Azerbaijan</i> |
|---------------------------------|---|-------------------|
| Area (km <sup>2</sup> )         | 100   |                   |
| Border length (km)              |   |                   |
| Thickness in m (mean, max)      | 100, 300  |                   |
| Groundwater management measures |   |                   |
| Groundwater uses and functions  | Used for drinking                                       |                   |
| Other information               | A common monitoring programme is indicated to be needed |                   |

## Pressures and status

29. The sub-basin is characterized by meadow and forest vegetation. Above 2,000 m, on the ridges, there is a narrow strip of alpine vegetation and, below it, a broad band of subalpine meadows. The rest of the sub-basin is covered by forests, including the so-called Bactrian woods along the river. Areas close to the river valley are covered by steppe vegetation. In Eldarskoy steppe, small patches of relict pine forest remain, unique in the Caucasus.

Table 21  
Land use/land cover in the Kura Basin

| Country    | Water bodies (%) | Forest (%) | Cropland (%) | Grassland (%) | Urban/ industrial areas (%) | Surfaces with little or no vegetation (%) | Wetlands/ Peatlands (%) | Other forms of land use (%) |
|------------|------------------|------------|--------------|---------------|-----------------------------|---|-------------------------|-----------------------------|
| Georgia    | N/A              | 14.5       | 29.5         | 55.1/0.491    | N/A                         | N/A                                       | N/A                     | 0.34                        |
| Azerbaijan |                  |            |              |               |                             |   |                         |                             |

30. Diffuse pollution from agriculture (About 94,000 ha are used for irrigated agriculture) and municipal wastewater are the main anthropogenic pollution sources in Georgia. Georgia considers anthropogenic pollution as moderate and limited in extent. In Azerbaijan, 1,522 ha are used for irrigated agriculture.

31. One of the main factors influencing water quality negatively in the Georgian part is uncontrolled waste dumps on the river banks. Their influence is severe according to Georgia, but only local.

32. In the Georgian part, wastewater treatment facilities in municipalities are not operational and in rural settlements there is no wastewater collection system. Georgia ranks the influence of this pressure as severe and widespread.

33. Surface water withdrawal for different purposes is a pressure factor according to Georgia (withdrawals by sector given in the table below), with withdrawal for agricultural purposes having the most widespread and severe influence. In addition to water losses in degraded irrigation infrastructure, this is partly due to there being five territorial units of self-government in the Georgian part with limited coordination. Surface water withdrawals also have widespread influence, but at a more moderate level. Withdrawals for households and industry are limited. Drinking water to a part of Tbilisi is supplied from Tbilisi Reservoir (a part of the Sioni-Zhinvali Reservoir complex), receiving water from the Iori River. A few years ago there were concerns about the capacity to meet the increasing drinking water demands of Tbilisi, together with agricultural water demands. Currently, the city of Tbilisi is improving its water supply — for example by reducing water losses — in line with a presidential programme, according to which settlements in Georgia should be supplied with adequate amounts of water of appropriate quality by 2013.

34. Georgia considers groundwater resources within the sub-basin as not significant with regard to the total water demand, of which only 1.4 per cent is met from groundwater. However, Iori Valley is mainly supplied with groundwater from the flood-plain and river terraces above the flood-plain. Furthermore, drilled wells tap artesian groundwater for use by the population and industry.

Table 22  
**Water use in different sectors in the Iori sub-basin (percentage)**

| Country    | Total withdrawal<br>$\times 10^6$ m <sup>3</sup> /year | Agricultural<br>% | Domestic<br>% | Industry<br>% | Energy<br>% | Other<br>% |
|------------|--|-------------------|---------------|---------------|-------------|------------|
| Azerbaijan |  |                   |               |               |             |            |
| Georgia    | 291 <sup>a</sup>                                       | 2.95              | 1.31          | 0.31          | 94.75       | 0.68       |

<sup>a</sup> 2008 figures.

35. Azerbaijan reported that there was little human impact on the river. The Ministry of Environment of Georgia assesses the river's ecological and chemical status as "good".

### Trends

36. By 2015, Georgia predicts an increase of approximately 3 per cent in water withdrawal from the Iori, to approximately  $300 \times 10^6$  m<sup>3</sup>/year. A slight relative decrease is expected in agricultural water withdrawal, but small increases are expected in withdrawals for households and industry.

## IV. Alazani sub-basin<sup>11</sup>

37. The basin of the river Alazani<sup>12</sup> is shared by Georgia and Azerbaijan. The 391-km river (104 km in Georgia, 282 km along the common border between Georgia and Azerbaijan, and 5 km in Azerbaijan) has its source in the southern slopes of the Main Caucasus Mountain Range (elevation 2,600–2,800 m a.s.l) and is bound in the west by the Kahetsky Range and its southern extension, Gomborsky ridge. The Alazani flows for a substantial part of its length along the Georgia-Azerbaijan border and discharges into the Mingachevir Reservoir in Azerbaijan.

38. The most important tributaries (by length) are the following: the Kabala (48 km), the Chartlishevi (39 km), the Mazymchay (39 km), the Belokanchay (39 km), the Katehchay (59 km), the Talachay (40 km), the Kurmuhchay (55 km) and the Agrichay (134 km). In the basins of left bank tributaries of the Alazani, the base flow component to the river flow (from groundwater) is estimated to be 40–50 per cent. There is currently some concern about worsening conditions for generating baseflow. The Alazan-Agrichay transboundary aquifer is linked to the Alazani River.

39. Melting of seasonal snow and rainfall causes spring flooding, but flooding resulting from rainy days in the summer can also result insignificant increases in water levels, especially in the lower reaches of the river.

<sup>11</sup> Based on information from Azerbaijan and the First Assessment of Transboundary Rivers, Lakes and Groundwaters

<sup>12</sup> The river is known as Alazani in Georgia and as Ganyh in Azerbaijan.

Table 23  
**Area and population in the Alazani sub-basin**

| Country      | Area in the country (km <sup>2</sup> ) | Country's share<br>% | Population           | Population density<br>(persons/km <sup>2</sup> ) |
|--------------|--|----------------------|----------------------|--|
| Azerbaijan   | 4 755                                  | 41                   | 564 900 <sup>a</sup> | 119/63   |
| Georgia      | 6 962                                  | 59                   | 342 400              | 49   |
| <b>Total</b> | <b>11 717</b>                          |                      |                      |  |

<sup>a</sup> Figure for 2009.

40. Transboundary protected areas within the Alazani sub-basin include Lagodekhi-Zagatala-West Dagestan (between Georgia, Azerbaijan and the Russian Federation, the total area of 498,706 ha), and Alazani Ganikh (between Georgia and Azerbaijan; 51,230 ha).

Table 24  
**Renewable water resources in the parts of the Alazani sub-basin that are the territory of Azerbaijan and Georgia**

| Country    | Renewable surface<br>water resources<br>(km <sup>3</sup> /year) | Renewable<br>groundwater<br>resources (km <sup>3</sup> /year) | Total renewable<br>water resources<br>(km <sup>3</sup> /year) | Renewable water<br>resources per capita<br>(m <sup>3</sup> /capita/year) | Period of<br>observations used for<br>estimating water<br>resources |
|------------|---|---|---|--|---|
| Azerbaijan | 3.472   | 0.0007  | 3.473   | 6,150  | 1995–2008   |
| Georgia    | 1.360 <sup>a</sup>  | 1.24  | 2.60  | 7,600  | 1946–1992   |

<sup>a</sup> Surface water resources in the Georgian part of the Alazani basin are estimated at 1.360 km<sup>3</sup>/year at Shakriani gauging station and 3.001 km<sup>3</sup>/year at Zemo-Kedi gauging station.

Table 25  
**Mean monthly discharges of the Alazani at gauging station Shakriani in Georgia (latitude: 41°59' N, longitude: 45°34' E; elevation 1,260 m a.s.l.) based on observations from 1952 to 1990**

| <i>Mean monthly discharges</i>  |                                  |                                   |
|---------------------------------|----------------------------------|-----------------------------------|
| October: 37.6 m <sup>3</sup> /s | November: 30.6 m <sup>3</sup> /s | December: 22.2 m <sup>3</sup> /s  |
| January: 18.9 m <sup>3</sup> /s | February: 20.6 m <sup>3</sup> /s | March: 33.2 m <sup>3</sup> /s     |
| April: 68.6 m <sup>3</sup> /s   | May: 91.1 m <sup>3</sup> /s      | June: 78.4 m <sup>3</sup> /s      |
| July: 52.4 m <sup>3</sup> /s    | August: 35.2 m <sup>3</sup> /s   | September: 37.1 m <sup>3</sup> /s |
| Mean discharge                  | 43.1 m <sup>3</sup> /s           |                                   |

Table 26

**Mean monthly discharges of the Alazani at gauging station Zemo Keady in Georgia (latitude: 41°26' N, longitude: 46° 27' E; elevation 900 m a.s.l.) based on observations from 1952 to 1990**

| <i>Mean monthly discharges</i>  |                                  |                                   |
|---------------------------------|----------------------------------|-----------------------------------|
| October: 86.2 m <sup>3</sup> /s | November: 69.9 m <sup>3</sup> /s | December: 58.1 m <sup>3</sup> /s  |
| January: 50.0 m <sup>3</sup> /s | February: 52.6 m <sup>3</sup> /s | March: 82.4 m <sup>3</sup> /s     |
| April: 149 m <sup>3</sup> /s    | May: 173 m <sup>3</sup> /s       | June: 158 m <sup>3</sup> /s       |
| July: 110 m <sup>3</sup> /s     | August: 73.5 m <sup>3</sup> /s   | September: 79.4 m <sup>3</sup> /s |
| Mean discharge                  | 95.1 m <sup>3</sup> /s           |                                   |

Table 27

**Discharge characteristics of the Alazani at gauging station Agrichay in Azerbaijan (latitude: 41°16''; longitude: 46°43'')**

| <i>Discharge characteristics</i> | <i>Discharge (m<sup>3</sup>/s)</i> | <i>Period of time or date</i> |
|----------------------------------|------------------------------------|-------------------------------|
| Q <sub>av</sub>                  | 110                                | 1950–2008                     |
| Q <sub>max</sub>                 | 192                                | 1950–2008                     |
| Q <sub>min</sub>                 | 69.5                               | 1950–2008                     |

Table 28

**Mean monthly discharges of the Alazani at gauging station Ganichay in Azerbaijan (1.7 km downstream from the confluence of the Ayrichay) based on observations from 1950 to 2008**

| <i>Mean monthly discharges</i>  |                                  |                                   |
|---------------------------------|----------------------------------|-----------------------------------|
| October: 94.3 m <sup>3</sup> /s | November: 87.7 m <sup>3</sup> /s | December: 74.9 m <sup>3</sup> /s  |
| January: 67.8 m <sup>3</sup> /s | February: 72.3 m <sup>3</sup> /s | March: 99.4 m <sup>3</sup> /s     |
| April: 168 m <sup>3</sup> /s    | May: 201 m <sup>3</sup> /s       | June: 173 m <sup>3</sup> /s       |
| July: 111 m <sup>3</sup> /s     | August: 77.0 m <sup>3</sup> /s   | September: 87.4 m <sup>3</sup> /s |
| Mean discharge                  | 110 m <sup>3</sup> /s            |                                   |

Table 29

**Alazan-Agrichay aquifer (No. 62<sup>13</sup>): Type 3, Consists of an unconfined part (more vulnerable to, e.g., pollution) at the top part of an alluvial cone located at the foot of the mountains, underlain by confined aquifer where groundwater is artesian. Slate and clay shale, siltstone, sandstone, limestone, marl, sea and continental Molasse, sandstones, conglomerates, sands; Jurassic, Cretaceous, Tertiary and Quaternary in age. Groundwater flow direction from Greater Caucasus to the Alazani River, i.e., from Georgia to Azerbaijan. Medium links with surface water**

|                                 | <i>Georgia</i>  | <i>Azerbaijan</i>  |
|---------------------------------|---|--|
| Area (km <sup>2</sup> )         | 980   | 3 050  |
| Border length (km)              | 140   |  |
| Thickness in m (mean, max)      | 150, 320  |  |
| Groundwater management measures | Need to be improved: integrated management, abstraction management, efficiency of use, monitoring, agricultural practices, protection zones, mapping  | 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 |
| Groundwater uses and functions  | Used for drinking water (e.g. towns of Telavi and Gurjaani are supplied from groundwater in the alluvium); agriculture  | Irrigation (80–85%)<br>Drinking water supply (10–15%)<br>Industry (3–5%)   |
| Other information               | A common monitoring programme is indicated to be needed. A substantial problems related to groundwater quantity or quality. Water demand was expected to increase. There is no information about transboundary impacts. |  |

## Pressures

41. Azerbaijan expresses concern about transboundary pollution from municipal wastewater (e.g. biochemical oxygen demand — BOD, chemical oxygen demand — COD, nitrogen, phosphorus) and pollution from agriculture (e.g., nitrogen, phosphorus, pesticides). Municipal wastewaters are among the main anthropogenic pollution sources in Georgia.

42. Georgia ranks diffuse pollution from agriculture, viticulture and animal husbandry in the Alazani basin as severe and widespread. As irrigation infrastructure involves a high share of open unlined channels, the water efficiency is low. More than 40,000 ha is irrigated from the Upper Alazani irrigation system and the Lower Alazani system is expected to be renovated (20,000 ha), resulting in a decrease of water losses.

<sup>13</sup> In the First Assessment of Transboundary Rivers, Lakes and Groundwaters, the number of the aquifer was 5.

43. Flood-plain forests are still taken to cultivation to some extent. Erosion of river banks occurs, the influence of which Georgia assesses as severe, but local.

Table 30

**Land use/land cover in the Alazani sub-basin**

| Country    | Water bodies | Forest                                     | Cropland | Grassland | Urban/industrial areas | Surfaces with little or no vegetation | Wetlands/peatlands | Other forms of land use |
|------------|--------------|--|----------|-----------|------------------------|---------------------------------------|--------------------|-------------------------|
| Azerbaijan | N/A          | 15.6 (5 859 km <sup>2</sup> ) <sup>a</sup> |          |           |                        | N/A                                   | N/A                | N/A                     |
| Georgia    | N/A          | 26.9                                       | 26.8     | 45.8/0.17 | N/A                    | N/A                                   | N/A                | 0.2                     |

<sup>a</sup> The reported cropland figure it is bigger than Azerbaijan's share of the basin.

Table 31

**Water use in different sectors (percentage) from the Alazani**

| Country    | Total withdrawal<br>×10 <sup>6</sup> m <sup>3</sup> /year | Agricultural | Domestic | Industry | Energy | Other |
|------------|---|--------------|----------|----------|--------|-------|
| Azerbaijan |   |              |          |          |        |       |
| Georgia    | 632 378 <sup>a</sup>                                      | 0.4          | 0.9      | 0.2      | 91.7   | 6.7   |

<sup>a</sup> 2008 figures.

**Status**

44. The Ministry of Environment of Georgia assesses the river's ecological and chemical status as "good".

45. According to the Ministry of Ecology and Natural Resources of Azerbaijan, in the Alazani in 2009 (Ganyhchay gauging station 1.7 km below confluence with the Agrichay) BOD<sub>5</sub> concentrations fluctuated between 1.95 and 3.02 mg/l, the concentration of NH<sub>4</sub><sup>+</sup> ion from 0.18 to 0.65 mg/l and the concentration of copper and zinc ranged from 0.03 to 0.08 mg/l. The concentration of phenols was measured at 0.002–0.004 mg/l. Other measured components were within the respective MAC. At present, the river is moderately polluted.

**Trends**

46. By 2015, Georgia predicts an increase of approximately 10 per cent in water withdrawal from the Alazani, to approximately 700 × 10<sup>6</sup> m<sup>3</sup>/year. The biggest relative increases are expected in agriculture and industry, followed by household water.

**V. Ktsia-Kharami sub-basin<sup>14</sup>**

47. The sub-basin of the Ktsia-Kharami River is shared by Armenia, Azerbaijan and Georgia. The 201-km long Ktsia-Khrami River has its source in a spring on the southern

<sup>14</sup> Based on information from Armenia and Georgia, and the First Assessment of Transboundary Rivers, Lakes and Groundwaters.

slope of the Trialeti range at the height of 2,422 m and discharges into the Kura. The Debet is a major transboundary tributary.

48. The basin of the Ktsia-Khrami has a pronounced mountainous character of rugged terrain with an average elevation of about 1,535 m a.s.l. The Ktsia-Khrami River is characterized by one significant spring flood. In other periods of the year the water level is mostly low, occasionally disrupted by summer-fall high waters.

49. An alluvial transboundary aquifer Ktsia-Khrami is linked to the surface waters of the sub-basin.

Table 32

**Area and population in the Ktsia-Khrami sub-basin, including the Debet sub-basin**

| Country                  | Area in the country<br>(km <sup>2</sup> ) | Country's share % | Population | Population density<br>(persons/km <sup>2</sup> ) |
|--------------------------|---|-------------------|------------|--|
| Armenia                  | 3 790                                     | 45.4              | 7 340      | 2/89 <sup>a</sup>                                |
| Georgia                  | 310                                       |                   | 20 632     | 66   |
| Subtotal Debet sub-basin | 4 100                                     |                   |            |  |
| Georgia                  | 4 160                                     | 53.5              | 180 992    | 40   |
| Azerbaijan               | 80  | 1.1               |            |  |

### Hydrology and hydrogeology

50. In the part of the Ktsia-Khrami sub-basin that is Georgia's territory, surface water resources are estimated at 1.631 km<sup>3</sup>/year (based on data from 1928 to 1990) and groundwater resources at 0.0815 km<sup>3</sup>/year, making up a total of 1.713 km<sup>3</sup>/year. This equals 9,465 m<sup>3</sup>/year/capita.

Table 33

**Ktsia-Khrami aquifer (No. 63<sup>15</sup>): Type 3, alluvial aquifer connected to river, little transboundary impacts. Gravel-Tertiary and Quaternary age conglomerates, tuffaceous sandstones, calcareous basalts, dolerites, quartz sandstone, marl, sand etc. Strong links with surface water**

|                                 | Georgia   | Azerbaijan |
|---------------------------------|---|------------|
| Area (km <sup>2</sup> )         | 340   |            |
| Thickness: mean, max (in m)     | 120, 250  |            |
| Groundwater management measures | Used for drinking water                         |            |
| Groundwater uses and functions  |   |            |
| Additional information          | Joint monitoring programme is felt to be needed |            |

<sup>15</sup> The aquifer did not appear in the First Assessment of Transboundary Rivers, Lakes and Groundwaters.

Table 34

**Discharge characteristics of the Ktsia-Kharami at the gauging station “Red Bridge” (at the border of Georgia and Azerbaijan) latitude: 41° 20’ N; longitude: 45° 06’ E**

| <i>Discharge characteristics</i> | <i>Discharge (m<sup>3</sup>/s)</i> | <i>Period of time or date</i> |
|----------------------------------|------------------------------------|-------------------------------|
| Q <sub>av</sub>                  | 51.7                               | 1928–1990                     |
| Q <sub>max</sub>                 | 90.1                               | 1928–1990                     |
| Q <sub>min</sub>                 | 29.3                               | 1928–1990                     |

Table 35

**Mean monthly discharges of the Ktsia-Kharami at gauging station “Red Bridge” based on observations from 1982 to 1999**

| <i>Mean monthly discharges</i>  |                                  |                                   |
|---------------------------------|----------------------------------|-----------------------------------|
| October: 37.1 m <sup>3</sup> /s | November: 35.9 m <sup>3</sup> /s | December: 33.2 m <sup>3</sup> /s  |
| January: 33.4 m <sup>3</sup> /s | February: 34.5 m <sup>3</sup> /s | March: 47.6 m <sup>3</sup> /s     |
| April: 101 m <sup>3</sup> /s    | May: 111 m <sup>3</sup> /s       | June: 88.7 m <sup>3</sup> /s      |
| July: 42.9 m <sup>3</sup> /s    | August: 24.4 m <sup>3</sup> /s   | September: 30.9 m <sup>3</sup> /s |
| Mean discharge                  | 51.7 m <sup>3</sup> /s           |                                   |

Table 36

**Land use/land cover in the Ktsia-Kharami sub-basin**

| <i>Country</i>       | <i>Water bodies</i> | <i>Forest</i> | <i>Cropland</i> | <i>Grassland</i> | <i>Surfaces with little or no vegetation</i> |                           |                        |                                |
|----------------------|---------------------|---------------|-----------------|------------------|--|---------------------------|------------------------|--------------------------------|
|                      |                     |               |                 |                  | <i>Urban/industrial areas</i>                | <i>Wetlands/peatlands</i> | <i>Protected areas</i> | <i>Other forms of land use</i> |
| Georgia <sup>a</sup> |                     | 20.6          | 56.4            | 32.8             |  |                           |                        |                                |
| Azerbaijan           |                     |               |                 |                  |  |                           |                        |                                |

<sup>a</sup> The percentages are calculated based on the hectare amounts reported by Georgia. They add up to 109.8 per cent of the reported Georgian territory within the basin.

Table 37

**Water use in different sectors (percentage) Ktsia-Kharami Basin**

| <i>Country</i>       | <i>Total withdrawal ×10<sup>6</sup> m<sup>3</sup>/year</i> | <i>Agricultural</i> | <i>Domestic</i> | <i>Industry</i> | <i>Energy</i> | <i>Other</i> |
|----------------------|--|---------------------|-----------------|-----------------|---------------|--------------|
| Georgia <sup>a</sup> | 853.298  | 1                   | 3               | 2               | 94            | <1           |
| Azerbaijan           |  |                     |                 |                 |               |              |

<sup>a</sup> Figures from the Yearbook of Water Use in Georgia 2008.

51. Municipal wastewater treatment plants in a number of cities in Georgia are not operational and in rural areas there is no sewage collection/network. The impact is considered serious, but remaining local according to Georgia. Pollution from illegal waste dumps is one of the main sources of pollution in the Georgian part of the sub-basin, and its impact is described as widespread and severe.

52. Copper-mining industry is reported to have a negative impact on the river in Georgia: acid mine drainage — leaching of metals from waste rock dumps when exposed to

rainfall at JSC Madneuli in the village Kazreti — causes pollution of the Mashavera River (a tributary of Ktsia-Khrami).

53. The Ceyhan-Tbilisi-Baku oil pipeline traversing the basin is considered to pose a risk of accidental pollution in Georgia.

### **Status and management response**

54. Georgia reports that during the period from 2007 to 2009, the concentration of ammonium ions in the Ktsia-Khrami exceeded the MAC three times in January 2008 and nine times in July 2009. Other measured components were within the respective MAC during the same observation period.

55. Regarding agricultural water use, drip irrigation techniques have been introduced through several projects in Georgia.

56. The mining company JSC Madneuli has developed a plan of water conservation measures, which is being implemented consistently. Georgia reports some measures to have been realized to protect river banks.

57. By ranking of factors affecting water resources by importance in the basin by Georgia, pollution from municipal non-treated or inefficiently treated wastewaters, including occurrence of viruses and bacteria, stands out as a priority issue to address.

58. In the framework of the European Union (EU) Project: “Trans-Boundary River Management Phase II for the Kura River Basin — Armenia, Georgia, Azerbaijan”, joint monitoring is being carried out between Georgia, Azerbaijan and Armenia four times a year.

### **Trends**

59. Georgia predicts water use for agriculture, domestic needs and for industry to increase relative to water use for energy by 2015. The total water withdrawal in 2015 is predicted to be  $840 \times 10^6 \text{ m}^3/\text{year}$ , which is less than in 2008.

60. In accordance with the procedures formulated in 2009 in draft strategic directions of the Ministry of Environment and Natural Resources of Georgia, a river basin management plan will be developed for the Ktsia-Khrami River in 2012.

## **VI. Debet sub-basin<sup>16</sup>**

61. The basin of the river Debet<sup>17</sup> is shared by Armenia and Georgia. The 154-km Debet River rises at about 2,100 m a.s.l. and flows through a deep valley, joins with the Ktsia-Khrami and discharges into the Kura. The sub-basin has a pronounced mountain territory character with an average elevation of about 1,770 m a.s.l.

62. Major transboundary tributaries include Dzoraget (length 67 km, catchment area 1460 km<sup>2</sup>) and Pambak (length 84 km, catchment area 1370 km<sup>2</sup>).

63. A transboundary aquifer called Debet is linked to the surface waters in the basin.

<sup>16</sup> Based on information from Armenia and Georgia, and the First Assessment of Transboundary Rivers, Lakes and Groundwaters

<sup>17</sup> The river is known as Debed in Armenia and Debeda in Georgia.

Table 38  
**Area and population in the Debet sub-basin**

| <i>Country</i> | <i>Area in the country (km<sup>2</sup>)</i> | <i>Population</i>  | <i>Population density (persons/km<sup>2</sup>)</i> |
|----------------|---|--------------------|--|
| Armenia        | 3 790 (92.4%)                               | 7 340 <sup>a</sup> | 89   |
| Georgia        | 310 (7.6%)                                  | 20 632             | 66   |
| <b>Total</b>   | <b>4 100</b>                                |                    |  |

*Sources:* Ministry of Environment Protection and Natural Resources of Georgia and L.A. Chilingarjan et al. "Hydrography of rivers and lakes in Armenia", Institute of hydro-technology and water problems, Armenia.

<sup>a</sup> Statistical management, Armenia; <http://www.armstat.am/>.

## Trends

64. Flow of the Debet River is not regulated. There is one reservoir on the Dzoraget River in the Armenian part of the catchment area of the Debet River-Mecavan with a volume of 5.40 million m<sup>3</sup>. This facility for energy generation impacts moderately on natural flow.

65. Spring floods affect the lower part of the sub-basin, also causing damage.

66. Surface water resources the Debet sub-basin as flow generated in Armenia are estimated at 1.197 km<sup>3</sup>/year (based on data from 1955 and 1961 to 2008) and groundwater resources at 0.180 km<sup>3</sup>/year (average for the years from 1991 to 2008), making up a total of 1.377 km<sup>3</sup>/year. This equals 188,000 m<sup>3</sup>/year/capita.

Table 39  
**Discharge characteristics of the Debet at gauging station Ayrum in Armenia (at 8 km upstream from the border of Georgia and Armenia)**

| <i>Discharge characteristics</i> | <i>Discharge (m<sup>3</sup>/s)</i> | <i>Period of time or date</i> |
|----------------------------------|------------------------------------|-------------------------------|
| Q <sub>av</sub>                  | 37.1                               | 1955–1959, 1961–2008          |
| Q <sub>max</sub>                 | 759                                | 1955–1959, 1961–2008          |
| Q <sub>min</sub>                 | 5.80                               | 1955–1959, 1961–2008          |

Table 40  
**Mean monthly discharges of the Debet at gauging station Ayrum in Armenia based on the observation periods 1955–1959 and 1961–2008**

| <i>Mean monthly discharges</i>  |                                  |                                   |
|---------------------------------|----------------------------------|-----------------------------------|
| October: 22.6 m <sup>3</sup> /s | November: 20.9 m <sup>3</sup> /s | December: 15.9 m <sup>3</sup> /s  |
| January: 16.5 m <sup>3</sup> /s | February: 14.0 m <sup>3</sup> /s | March: 26.5 m <sup>3</sup> /s     |
| April: 80.4 m <sup>3</sup> /s   | May: 96.8 m <sup>3</sup> /s      | June: 62.5 m <sup>3</sup> /s      |
| July: 40.8 m <sup>3</sup> /s    | August: 28.4 m <sup>3</sup> /s   | September: 20.4 m <sup>3</sup> /s |
| Mean discharge                  | 37.1 m <sup>3</sup> /s           |                                   |

Table 41

**Debet aquifer (No. 64)<sup>18</sup>: Type 3 (Alluvial aquifer connected to the river, little transboundary impacts). Alluvial–proluvial formation of modern Quaternary age in the upper part of the basin. Volcanic–sedimentary rocks, limestones, tuffbreccia Consists of two main aquifers. Medium links with surface water**

|  | <i>Georgia</i>  | <i>Armenia</i>   |
|--|---|--|
| Area (km <sup>2</sup> )                    |   | 20   |
| Thickness – mean, max (in m)               |   | 20–30, 50 <sup>19</sup>  |
| Groundwater resource (m <sup>3</sup> /day) |   | 39 000   |
| Groundwater management measures            | Effective: controlled water abstraction<br>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 |
| Groundwater uses and functions             | Drinking water supply 100%  | Drinking water up to 90%, irrigation and mining industry<br>Mining industry (assessed as severe in influence but local), agriculture and drainage water from dumps (widespread but moderate).  |
| Pressure factors                           | Lack of data  |  |
| Additional information                     | 1) There is a lack of data about problems related to groundwater quantity and quality; 2) Joint monitoring programme is felt to be needed; 3) Georgia predicts increased water use as a consequence         | of economic growth.  |

<sup>18</sup> Based on information provided by Armenia and the first Assessment of Transboundary Rivers, Lakes and Groundwaters. In the first Assessment, the aquifer was called “Pambak–Debet” (aquifer no. 10)

<sup>19</sup> There are two main aquifers: one at a depth of 71–120 m and with a thickness of stratum 48 m and a second one at a depth of 98–150 m and with a thickness of stratum of 25 m.

## Pressures

Table 42

### Land use/land cover in the Debet sub-basin

| Country              | Water bodies | Forest             | Cropland                         | Grassland           | Surfaces                |                              |                     | Other forms of land use |
|----------------------|--------------|--------------------|----------------------------------|---------------------|-------------------------|------------------------------|---------------------|-------------------------|
|                      |              |                    |                                  |                     | Urban/ industrial areas | with little or no vegetation | Wetlands/ peatlands |                         |
| Armenia              | 0.01         | 17                 | 23 <sup>b</sup>                  |                     |                         |                              |                     |                         |
| Georgia <sup>a</sup> |              | 27 km <sup>2</sup> | 327 km <sup>2</sup> <sup>c</sup> | 336 km <sup>2</sup> |                         |                              |                     |                         |

<sup>a</sup> The reported surface areas exceed the total surface area reported as the territory of Georgia within the sub-basin.

<sup>b</sup> From the cropland area, 27 per cent is irrigated.

<sup>c</sup> From the cropland area, 40 km<sup>2</sup> or 13 per cent is irrigated.

Table 43

### Water use in different sectors (percentage) Debet sub-basin

| Country | Total withdrawal<br>×10 <sup>6</sup> m <sup>3</sup> /year | Agricultural | Domestic | Industry | Energy | Other |
|---------|---|--------------|----------|----------|--------|-------|
|         |   |              |          |          |        |       |
| Georgia | 8.9   | 99           |          | 1        |        |       |

67. In the Armenian part of the basin, surface water withdrawal for irrigation is 101.695 ×10<sup>6</sup> m<sup>3</sup>, which impacts on natural water flow locally.

68. In the Armenian part of the sub-basin, heavy metal (V, Mn, Cu, Fe) concentrations are naturally elevated, linked to the occurrence of ore deposits. Armenia ranks this influence as widespread and severe. Wastewater from the ore enrichment and processing industry are the main anthropogenic pollution sources. Improvements in ore processing facilities in recent years have decreased water pollution, but leakages from a tailings dam that stores wastes from the Achtalinsk ore processing factory are still a concern. There are also wastewater discharges from municipal sources (some 110 human settlements in the Armenian part). Armenia assesses the influence related to different wastewater as severe, but local in scope in the case of industry and more widespread from municipal sources.

69. Diffuse pollution from agriculture (51 per cent of the Armenian agriculture uses water from the sub-basin of the Debet) is among the main pollution sources.

70. Due to the recent economic crisis, about 15 per cent of all forest has been cut down, or some 14,000 ha. This deforestation impacts on the flow regime as well as water quality, but Armenia assesses the influence as local and moderate.

71. In Armenia, freight transport concentrates in the southern region and the Debet sub-basin in particular. There is wet and dry deposition of pollutants from the atmosphere, which get washed to surface waters increasing their content of suspended solids, COD, zinc, copper and lead. Shortcomings in solid waste handling can influence water quality negatively, but this is local and remains moderate.

## Status and transboundary impact

72. The chemical and ecological status of the water system is not satisfactory for the maintenance of aquatic life, but meets the requirements for municipal, agricultural, industrial and other uses.

73. The most significant factors concerning impacts on surface water are untreated municipal wastewater (increased content of BOD, COD, nitrogen, phosphorus), pollution from agriculture (e.g., nitrogen, phosphorus) and pollution from industrial wastewater (heavy metals). In Armenia, the intensity of the before-mentioned factors is observed to be already reduced at the border between Armenia and Georgia and therefore inferred not to have transboundary impacts. In the period 2006–2009 the average mineral content at the border between Armenia and Georgia was 270 mg/l according to monitoring by Armenia.

## Management response

74. So far, no particular measures have been taken in Armenia to address the pollution by municipal wastewaters.

75. In the framework of the EU Project: “Trans–Boundary River Management Phase II for the Kura River Basin — Armenia, Georgia, Azerbaijan”, joint monitoring is being carried out between Georgia, Azerbaijan and Armenia four times a year.

## Trends

76. In terms of climate change, Armenia predicts by 2030 that the air temperature will rise by 1.1°C and that precipitation will decline by 3.1 per cent. River discharge is predicted to decline by 3–5 per cent and groundwater level to drop by 8–10 per cent under the influence of climate change. Some moderate deterioration of groundwater quality is expected. It is considered that related indirect or secondary impacts (for example on land use and agriculture) will be appreciable in Armenia, but that water use will not be greatly influenced.

## VII. Agstev sub–basin<sup>20</sup>

77. The basin of the 121 km river Agstev is shared by Armenia and Azerbaijan. The river has its source at about 3,000 m above sea level and discharges into the Kura River.

78. The sub-basin has a pronounced mountainous character with an average elevation of about 1,615 m a.s.l.

79. Major transboundary tributaries include the 58-km long Getik River (basin area 586 km<sup>2</sup>) and the 58-km long Voskepar River (basin area 510 km<sup>2</sup>). Lake Parz and Ijevan Reservoir are located within the sub-basin.

<sup>20</sup> Based on information from Armenia and Azerbaijan, and the First Assessment of Transboundary Rivers, Lakes and Groundwaters

Table 44

**Discharge characteristics of the Agstev at gauging station Idshevan in Armenia (upstream of the border with Azerbaijan; 56 km upstream from the river's mouth)**

| <i>Discharge characteristics</i> | <i>Discharge (m<sup>3</sup>/s)</i> | <i>Period of time or date</i> |
|----------------------------------|------------------------------------|-------------------------------|
| Q <sub>av</sub>                  | 10.3                               | 1929–2008                     |
| Q <sub>max</sub>                 | 177                                | 1929–2008                     |
| Q <sub>min</sub>                 | 0.4                                | 1929–2008                     |

Table 45

**Mean monthly discharges of the Agstev at gauging station Idshevan in Armenia during the observation period 1929–2008**

| <i>Mean monthly discharges</i>  |                                  |                                   |
|---------------------------------|----------------------------------|-----------------------------------|
| October: 5.06 m <sup>3</sup> /s | November: 4.95 m <sup>3</sup> /s | December: 3.62 m <sup>3</sup> /s  |
| January: 3.41 m <sup>3</sup> /s | February: 3.20 m <sup>3</sup> /s | March: 7.65 m <sup>3</sup> /s     |
| April: 27.1 m <sup>3</sup> /s   | May: 29.9 m <sup>3</sup> /s      | June: 18.6 m <sup>3</sup> /s      |
| July: 9.45 m <sup>3</sup> /s    | August: 6.09 m <sup>3</sup> /s   | September: 4.55 m <sup>3</sup> /s |
| Mean discharge                  | 10.3 m <sup>3</sup> /s           |                                   |

Table 46

**Agslev–Akstafa/Tavush–Tovuz aquifer (No. 65)<sup>21</sup>: Does not correspond with described types. Volcanic and carbonate rocks of Middle Jurassic and Middle Eocene age. Consists of two main aquifers<sup>22</sup>. Groundwater flow from Armenia to Azerbaijan. Moderate connections with surface water**

|  | <i>Armenia</i>  | <i>Azerbaijan</i>                                  |
|--|---|--|
| Area (km <sup>2</sup> )                    | 500   | 500  |
| Thickness – mean, max (in m)               | N/A   | N/A  |
| Groundwater resource (m <sup>3</sup> /day) | 279 000   | N/A  |
| Groundwater management measures            | It is important to make controlled water abstraction<br>Need to be improved: urban and industrial wastewater treatment,<br>Need to be applied: transboundary institutions to be set up,<br>monitoring programme to be enhanced and data exchange  |  |
| Groundwater uses and functions             | Drinking water up to 75%,<br>irrigation up to 25%   | Irrigation 80%, drinking water<br>15%, industry 5% |
| Pressure factors                           | 1) industrial waste products (wine and woodworking factories of Ijevan, food processing of Dilijan), which leads to increased concentrations of organic matter (e.g. BOD, COD, nitrogen and phosphorus; impact severe but local); 2) waste disposal<br>Mining industry (heavy metal pollution, with moderate transboundary impacts) |  |

<sup>21</sup> In the first Assessment, the aquifer was called “Agstev–Tabuch” (aquifer no. 11)

<sup>22</sup> At Margaovitsky groundwater system, there are two artesian aquifers: one with a depth of 46–57 m and a thickness of 11 m and another one with a depth of 98–150 m and a thickness of 52 m.

Additional information

Azerbaijan predicted increased water use as a consequence of economic growth.

## Pressures

Table 47

### Land use/land cover in the Agstev basin

| Country              | Water bodies | Forest | Cropland | Grassland | Surfaces               |                              | Wetlands/ peatlands | Protected areas | Other forms of land use |
|----------------------|--------------|--------|----------|-----------|------------------------|------------------------------|---------------------|-----------------|-------------------------|
|                      |              |        |          |           | Urban/industrial areas | with little or no vegetation |                     |                 |                         |
| Armenia <sup>a</sup> |              | 26     | 9.0      | 19.0      | 3.2                    | 69.5                         |                     | 0.3             | 0.07                    |
| Azerbaijan           |              |        |          |           |                        |                              |                     |                 |                         |

<sup>a</sup> The percentages calculated from the hectare amounts reported summed up make about 127 per cent, i.e., more than the surface area of Armenia's part of the basin.

80. Ranked as severe and widespread in influence in the Armenian part of the basin, the Ijevan and Dilidzhane landfills are close to the river and not protected from the effects of wind. Waste gets into the river by wind. Also, drainage water from the landfills, either directly or by seeping into groundwater, damages water quality. Furthermore, in many rural areas located in the Armenian part of the aquifer Agstev–Tavush, landfills are not controlled. Recreational visitors also leave trash in nature, which adds to the pollution of the river.

81. The high concentration of heavy metals (Fe, Cu, Mn) is mainly due to natural background pollution, and Armenia assesses its influence as severe and widespread.

82. Domestic and municipal wastewaters are one of the main sources of anthropogenic pollution of the river in the territory of Armenia, assessed as severe and widespread in impact.

83. Another one of the main factors of anthropogenic pollution of surface water — ranked as severe and widespread by Armenia — is diffuse pollution from agriculture.

84. In the post-Soviet period, because of the economic crisis, deforestation was not controlled and it affected the flow regime and water quality in rivers. In recent years, deforestation has decreased with improved energy supply. The influence of this factor is severe according to Armenia, but remains local.

## Status and transboundary impact

85. According to Armenia, in the period 2006–2009 water quality in the Agstev was evaluated mainly as a “good”. In the Armenian part of the sub-basin, the Agstev is exposed to background contamination as a result of hydrochemical processes that leads to increased concentrations of heavy metals (V, Mn, Cu, Fe). These concentrations already exceed the MACs for the fish on top of the sub-basin. The main factors that have a negative impact on surface water resources are untreated urban wastewater (indicated by elevated levels of BOD and COD downstream from Ijevan, nitrogen, phosphorus and sulfate), contamination of agricultural products (e.g., nitrogen, phosphorus) and contamination by industrial wastewater (mostly with organic substances). The concentrations of several determinands such as Zn, Fe and sulphate decrease from their levels upstream by the monitoring station

just upstream from the border of Armenia and Azerbaijan indicating reduced potential for transboundary impact. At three out of four reported monitoring stations<sup>23</sup> in the Armenian part of the sub-basin, the amount of suspended solids has increased from 2006 to 2009. In 2006–2009, the mineral content at the border of Armenia and Azerbaijan was on average of 330 mg/l. In the period 2004–2006, the average mineral content at the border was 559 mg/l and the maximum 600 mg/l. At least by this indicator, there seems to have been some reduction in the loading from the previous assessment period.

## Trends

86. With the current trend of climate change, by 2030, according to the forecast, air temperature will rise by 1.1 ° C, while rainfall will decrease by 3.1 per cent. Under the influence of climate change, rainfall is predicted to decrease by 3–4 per cent and run-off to decrease by 5–10 per cent. Groundwater levels are expected to decrease by 10–15 per cent, with minor change in groundwater quality.

## VIII. Lake Jandari<sup>24</sup>

87. Lake Jandari, which through construction of Gardaban Canal was turned into a reservoir, is shared by Georgia and Azerbaijan. The volume of water is 51.15 million m<sup>3</sup>, with a maximum depth of 7.2 m and average depth of 4.8 m. Water comes mainly through the Gardaban Canal (maximum capacity 15 m<sup>3</sup>/s) from the Kura River and another canal starting from the Tbilisi (Samgori) water reservoir. The lake is quite rich in fish (carp and catfish).

Table 48

### Area and population in the Lake Jandari basin

| Basin                       | Country    | Area in the country |                   | Population density                    |         |
|-----------------------------|------------|---------------------|-------------------|---------------------------------------|---------|
|                             |            | (km <sup>2</sup> )  | Country's share % | Population (persons/km <sup>2</sup> ) |         |
| Lake Jandari basin          | Georgia    | 68                  | 67                | 14 000–15 000                         | 140–150 |
|                             | Azerbaijan | 34                  | 33                |                                       |         |
| <b>Sub-total</b>            |            | <b>102</b>          |                   |                                       |         |
| Lake Jandari (lake surface) |            | 12.5                |                   |                                       |         |

## Pressures and status

88. Pollution originates from various anthropogenic sources. Wastes from industry, residential areas and agriculture pollute water coming into the reservoir from the Kura River.

<sup>23</sup> Monitoring stations number 16 at Dilijan, 17 at Ijevan and 18 just upstream from the border with Azerbaijan.

<sup>24</sup> Based on information from Georgia and the First Assessment of Transboundary Rivers, Lakes and Groundwaters.

89. A channel was dug from the south-eastern bank of the lake for irrigating land in the territory of Azerbaijan.

90. In Georgia, the water of the lake is not used for industrial purposes, and there are no industrial enterprises in the surroundings. The lake is also an important area for commercial fisheries.

91. Lake Jandari does not have a good ecological or chemical status. Increased pollution from the Kura River and from reservoirs is affecting water quality in the lake. Moreover, expansion of irrigated land in both countries and uncoordinated use of water by various users have been decreasing the water level.

### Transboundary cooperation

92. According to the agreement concluded in 1993 between the State Committee of Irrigation and Water Economy of the Azerbaijan Republic and Department of Management of Melioration Systems of Georgia, 70 million m<sup>3</sup> of water is delivered annually to Jandari water reservoir from Georgia. This includes 50 million m<sup>3</sup> for irrigation of 8,500 hectares of land of the Akstaphi region of Azerbaijan and 20 million m<sup>3</sup> for maintaining ecological balance of the water reservoirs.

93. According to Article 6 of the Agreement on Collaboration in Environmental Protection between the Governments of Georgia and Azerbaijan (1997), the Parties of the Agreement shall consolidate their efforts and take all appropriate measures to ensure that the Kura River and the Lake Jandari waters are used with the aim of ecologically sound and rational water management, conservation of water resources and environmental protection.

## IX. Potskhovi/Posov sub-basin<sup>25</sup>

94. The sub-basin of the river Potskhovi/Posof<sup>26</sup> is shared by Turkey and Georgia. The 64-km river (35 km of the river length in Georgia) has its source in Turkey, from springs on the north-eastern slope of Goze Mountain (Göze Dağı) and discharges into the Kura River.

95. The sub-basin has a pronounced hilly, rough, and mountainous character on the Turkish side with an average elevation of about 2,100–2,200 m a.s.l. and is hilly on the Georgian side with an average elevation of about 1,700 m a.s.l., cut by deep and narrow gorges.

Table 49

#### Sub-basin of the Potskhovi/Posof

| Country      | Area in the country<br>(km <sup>2</sup> ) | Country's share % | Population          | Population density<br>(persons/km <sup>2</sup> ) |
|--------------|---|-------------------|---------------------|--|
| Turkey       | 601                                       | 31.1              | 11 851 <sup>b</sup> | 20   |
| Georgia      | 1 331 <sup>a</sup>                        | 68.9              | 46 650              | 35   |
| <b>Total</b> | <b>1 932</b>                              |                   |                     |  |

<sup>a</sup> Ministry of Environment Protection and Natural Resources of Georgia.

<sup>25</sup> Based on information from Georgia, Turkey, and the First Assessment of Transboundary Rivers, Lakes and Groundwaters

<sup>26</sup> The river is known as Potskhovi in Georgia and as Posof in Turkey.

<sup>b</sup> Posof Municipality, Turkey (2008).

## Hydrology and hydrogeology

96. Floods mostly occur in the middle or end of March and reach their maximum in April, sometimes in May; the average increase of water levels is on the order of 0.8–1.2 m.

97. Surface water resources in the territory of Turkey are estimated to be approximately 0.217 km<sup>3</sup>/year, which is 18,310 m<sup>3</sup>/year/capita. In the part of the basin that is Georgia's territory, the surface water resources are estimated based on observations from 1936 to 1990 to be approximately 0.6716 km<sup>3</sup>/year, which is 14,397 m<sup>3</sup>/year/capita.

Table 50

### Discharge characteristics of the Potskhovi/Posof at the Posof gauging station in Turkey (latitude: 41°30', longitude 42°44'; elevation:1,350 m a.s.l.)

| <i>Discharge characteristics</i> | <i>Discharge (m<sup>3</sup>/s)</i> | <i>Period of time or date</i> |
|----------------------------------|------------------------------------|-------------------------------|
| Q <sub>av</sub>                  | 5.67                               | 1990–2006                     |
| Q <sub>max</sub>                 | 47.0                               | 17.06.1999                    |
| Q <sub>min</sub>                 | 2.3                                | 02.09.2008                    |

Table 51

### Discharge characteristics of the Potskhovi/Posof at the Skhvilisi gauging station in Georgia (latitude: 41°38', longitude 42°56')

| <i>Discharge characteristics</i> | <i>Discharge (m<sup>3</sup>/s)</i> | <i>Period of time or date</i> |
|----------------------------------|------------------------------------|-------------------------------|
| Q <sub>av</sub>                  | 21.3                               | 1936–1990                     |
| Q <sub>av</sub>                  | 13.6                               | During 97% of the year        |
| Q <sub>max</sub>                 | 31.7                               | 1936–1990                     |
| Q <sub>min</sub>                 | 11.7                               | 1936–1990                     |

Table 52

### Discharge characteristics of the Potskhovi/Posof at the Skhvilisi gauging station in Georgia

| <i>Mean monthly discharges</i>  |                                  |                                   |
|---------------------------------|----------------------------------|-----------------------------------|
| October: 12.7 m <sup>3</sup> /s | November: 12.0 m <sup>3</sup> /s | December: 8.47 m <sup>3</sup> /s  |
| January: 7.09 m <sup>3</sup> /s | February: 7.29 m <sup>3</sup> /s | March: 14.1 m <sup>3</sup> /s     |
| April: 53.5 m <sup>3</sup> /s   | May: 73 m <sup>3</sup> /s        | June: 34.9 m <sup>3</sup> /s      |
| July: 15.1 m <sup>3</sup> /s    | August: 9.21 m <sup>3</sup> /s   | September: 9.22 m <sup>3</sup> /s |

## Pressures

Table 53

**Land cover/use (percentage of the part of the sub-basin extending in each country)**

| Country | Water bodies | Forest | Cropland | Grassland | Urban/industrial areas | Surfaces with little or no vegetation | Wetlands/peatlands | Protected areas | Other forms of land use |
|---------|--------------|--------|----------|-----------|------------------------|---------------------------------------|--------------------|-----------------|-------------------------|
| Turkey  | ~0.4         | 18     | 48.6     | 30        | N/A                    | N/A                                   | N/A                | N/A             | 3                       |
| Georgia | N/A          | 19.2   | 7.4      | 28.4      | N/A                    |                                       |                    | N/A             | N/A                     |

Table 54

**Mean annual water withdrawal by sector**

| Country | Total withdrawal<br>$\times 10^6$ m <sup>3</sup> /year | Agricultural | Domestic | Industry | Energy | Other |
|---------|--|--------------|----------|----------|--------|-------|
| Turkey  | 9.156  | 13           | 4        | 5        | 78     | –     |
| Georgia | N/A  | N/A          | N/A      | N/A      | N/A    | N/A   |

98. In the part of the basin that is Turkey's territory, human pressure on water resources is relatively low due to the small, rural population. Problems related to landslides and erosion are local and moderate. Animal husbandry and agriculture are the main source of income. Irrigation and animal production are on the increase, which is a general tendency in the Turkish part of the Kura basin. At present, there are no installed treatment plants for municipal wastewater, which results in a risk of surface and groundwater getting polluted by untreated wastewater from households. Turkey assesses the pressure from municipal wastewater as local and moderate in importance. The situation concerning the whole Turkish part of the Kura basin is elaborated in the section on the Kura.

99. Among activities affecting water quality in Georgia are diffuse pollution from fertilizers, which Georgia assesses as local and moderate. Both discharge of non-treated wastewater from settlements and illegal landfills on river banks, Georgia assesses as local but severe.

## Response

100. In Turkish part of the basin, households are generally connected to sewerage systems and a drinking water distribution network. However, a wastewater treatment plant for Posof Municipality has not been planned yet.

101. Afforestation campaigns and activities have been also carried out by Turkish Ministry of Environment and Forestry.

102. A project to construct new landfills is under development in Georgia.

## Status

103. According to the information of the Ministry of Environment Protection and Natural Resources of Georgia, the concentration of ammonium has increased in the period from 2007 to 2009 to be a few times higher than MAC: 1.5 times higher in 2008 and three times

higher in 2009. In general, Georgia estimates the ecological and chemical status of the river as satisfactory.

### Transboundary cooperation

104. The Posof wildlife development and management plan that was adopted by the Ministry of Environment and Forestry of Turkey was prepared within a Turkish-Georgian collaborative project titled “Enhancing Conservation in the West Lesser Caucasus through Trans-boundary Cooperation and Establishing a Training Program on Key Biodiversity Area Conservation”.<sup>27</sup> The Project has supported establishment of cooperation between the two countries.

105. There is no transboundary monitoring at present on the Potskhovi/Posof, but the possibility of starting such work in the framework of international projects is being looked into.

### Trends

106. Turkey predicts that pressure on the sub-basin’s water resources and water uses (both consumptive and non-consumptive) will likely increase due to economic development, population increase and climate change variability. According to long-term national prediction of climate change, a decrease in precipitation by between 10 per cent and 20 per cent by 2070–2100 and increased variability in seasonal precipitation will likely result in decreased average run-off. To address these issues, preparation of a river basin management plan is seen as essential for sustainable management of the Potskhovi/Posof sub-basin water resources.

## X. Kartsakhi Lake/Aktaş Gölü<sup>28</sup>

Table 55  
Mean annual water withdrawal by sector

| <i>Country</i> | <i>Area in the country (km<sup>2</sup>)</i>        | <i>Country’s share of the lake area %</i> | <i>Population</i>  |
|----------------|--|---|--------------------|
| Turkey         | Lake area: 13                                      | 48  | 735                |
| Georgia        | Lake area: 14                                      | 52  | 5 925 <sup>a</sup> |
| Total          | Lake area: 27 (basin areas – 158 km <sup>2</sup> ) |   |                    |

Sources: Turkish Statistical Institute, 2008; Resource of Surface Water 1974, Georgia.

<sup>a</sup> Within a radius of 7 km from the lake.

<sup>27</sup> Critical Ecosystem Partnership Fund (CEPF) Final Project Completion Report, 2009: “Enhancing Conservation in the West Lesser Caucasus through Trans-boundary Cooperation and Establishing a Training Program on Key Biodiversity Area Conservation

<sup>28</sup> Based on information from Georgia, Turkey and the First Assessment of Transboundary Rivers, Lakes and Groundwaters.

## Hydrology and hydrogeology

107. The average and maximum depths are 1.5 and 3.5 m, respectively

108. The basin is characterized by a very weakly developed hydrographical network, consisting mainly of seasonal streams. On the South-Western side (Turkish territory), there are some springs.

## Pressures and status

109. The lake is not designated as protected area but, being located in a military zone on the Turkish side, human activities are highly restricted. Therefore the quantity and quality of the lake water is preserved as in natural conditions. Only three villages are located near the lake in Turkish territory. There is no extraction of water from the lake in Turkey nor does Georgia use the lake water for industrial or household needs.

110. Lake water has naturally elevated salinity of 880 mg/litre, affected by volcanic rocks occurring in the area.

111. Lake Kartsakhi/Aktaş Gölü is part of the Javakheti Wetlands which are included in the Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention) List of Wetlands of International Importance. The lake is a breeding site for White Pelican (*Pelicanus Onocratus*) and the Dalmatian Pelican (*Pelicanus Crispus*), as well as for a variety of other bird species.

## XI. Wetlands of Javakheti Region (Armenia, Georgia, Turkey) <sup>29</sup>

### General description of the wetland area

112. The distinctive characteristic of the Javakheti region, which distinguishes it from the whole Caucasus, is the presence of numerous lakes. Most of them are connected by rivers, though groundwater interchange is also notable, so that all together they represent an ecological entity. Several lakes are of great importance for maintaining biodiversity of this region. These are, in particular, Lake Arpi in Armenia, which became a reservoir (2,120 ha) after building a dam in 1946–1950, Georgian high mountain shallow freshwater lakes Madatapa (870 ha), Khanchali (590 ha) and Bugdasheni (30 ha), and Lake Kartsakhi/Aktaş (2,660 ha) shared by Georgia and Turkey. Adjacent marshes and wet meadows as well as flood-plains also represent important wetland ecosystems.

<sup>29</sup> Sources:

Latest Information Sheet on Ramsar Wetlands (RIS), available at the Ramsar Sites Information Service: <http://ramsar.wetlands.org/Database/Searchforsites/tabid/765/language/en-US/Default.aspx>.  
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([www.jncc.gov.uk/worldwaterbirds](http://www.jncc.gov.uk/worldwaterbirds))  
Matcharashvili I. et al. Javakheti Wetlands: biodiversity and conservation, NACRES, Tbilisi. 2004.

## **Main wetland ecosystem services and supporting socio-economic services**

113. Lake Arpi is considered to play a significant role in sediment trapping. The lakes in this area are valuable sources of freshwater. Lake Arpi also provides water for irrigation, while cattle watering and fishing are also of major importance for the local economy. Lake Khanchali and springs fed by the lake are important sources of drinking and irrigation water for local villages; in Georgia some lakes are also used by the local population for fishing. Around all the mentioned lakes, adjacent meadows are traditionally used for mowing and cattle and sheep grazing. Javakheti landscapes are of high aesthetic value, and the region has good potential for recreation and nature tourism development.

## **Biodiversity values of the wetland area**

114. Javakheti natural wetland ecosystems, despite significant modification and human interference, support species-rich natural communities that include endemic species (e.g., reptiles, plants and Armenian Gulls *Larus armenicus*), as well as threatened biodiversity.

115. One of the main bird migration routes in the Caucasus crosses the Javakheti Plateau, with lakes Arpi, Madatapa, Bugdashen and Khanchali being the most important for migratory birds in this region. In Georgia alone, the lakes receive about 30,000–40,000 migratory birds each year. The lakes provide important feeding, resting and breeding habitats for grebes, pelicans, herons, geese, ducks, waders, gulls, terns and other waterfowl, as well as for birds of prey, including globally threatened species mentioned in the International Union for Conservation of Nature (IUCN) Red List: Dalmatian Pelican (*Pelecanus crispus*), Imperial Eagle (*Aquila heliaca*) and Greater Spotted Eagle (*Aquila clanga*). Many species are also covered by the African-Eurasian Waterbird Agreement and national Red Lists.

## **Pressure factors and transboundary impacts**

116. After construction of the dam, the surface of the lake/reservoir Arpi increased around five times, the volume around 20 times, and seasonal water-level fluctuation started exceeding 3 m (in comparison with natural fluctuations less than 0.5 m). The average turnover period became one year (while the natural one is one month). This caused loss of submerged, floating and emergent vegetation and degradation of habitats for waterfowl and fish. In addition, droughts downstream cause serious deterioration of spawning and nesting conditions for fish and birds. Organic pollution from agriculture (mainly livestock) in the form of nitrogen and phosphorus represents another threat.

117. On the Georgian side, large-scale draining of wetlands for agricultural purposes or transforming them into fish farms began in 1960's. Lake Khanchali was most affected of all the wetlands in the region: due to the drainage it lost two thirds of its surface area and later it was completely drained several times. The draining of Bugdasheni Lake began in 1998 due to draw-off for drinking water supply for the town Ninotsminda. The southern part of Lake Madatapa is dammed for fishing and agricultural needs; this prevents water exchange and facilitates eutrophication. Draining of lakes leads to the loss of habitats important for water-birds; another effect is decreasing humidity leading to changes in plant communities that may also affect agricultural production. Additional water loss occurs due to damaged irrigation systems. Disturbing factors for water-birds include illegal hunting in spring, as well as mowing on lakes shores and collecting eggs by locals in nesting period.

118. In Georgia, introduction of non-native fish species negatively affected local fish communities which used to be quite rich. In addition, Crucian Carp (*Carassius carassius*) which has minor economic value, has been accidentally introduced and has out-competed all native fish species. However, one positive result of this invasion is that these fish provide a food source for fish-eating birds on those lakes where there was no fish before.

### **Transboundary wetland management**

119. The “Eco-regional Nature Protection Programme for the South Caucasus Region”, part of the Caucasus Initiative launched by German Federal Ministry of Economic Cooperation and Development (BMZ), aims to promote cooperation on development of a coherent strategy to ensure biodiversity conservation in the region. A number of wetlands will be given the status of protected areas on both sides of Armenian-Georgian border. In Armenia, the Programme component “Establishment of Protected Areas in the Armenian Javakheti Region” is aimed at establishment of a National Park and its integration into the local context, as well as promotion of transboundary cooperation on biodiversity conservation in the Javakheti region. The National Park was established in 2009 and it includes Lake Arpi and its basin as well as flood-plains of the upper stream of the Akhuryan River. At present Ramsar site Lake Arpi covers 3,149 ha and includes the whole reservoir and surrounding marshes.

120. The project “Establishment of Javakheti Protected Areas in Georgia” is implemented by the Agency of Protected Areas of Georgia and the World Wildlife Fund (WWF) Caucasus Programme Office with financial support of BMZ and German Credit Bank of Reconstruction (KfW). The project aims at establishment of Javakheti National Park and Kanchali, Madatapa and Bugdasheni Managed Reserves.

## **XII. Araks/Aras sub-basin<sup>30</sup>**

121. The sub-basin of the 1,072-km river Araks/Aras<sup>31</sup> is shared by Armenia, Azerbaijan, the Islamic Republic of Iran and Turkey. The river has its source at 2,732 m a.s.l. and discharges into the Kura. The character of the basin ranges from mountain terrain in the upper part — with an elevation from 2,200 to 2,700 m a.s.l — to lowland.

122. Major transboundary tributaries to the Araks/Aras River include the rivers Akhuryan, Agstev, Arpa, Kotur, Voghji and Vorotan.

123. The reservoirs in the Iranian part of the sub-basin include Aras storage dam, Mill-Moghan diversion dam, Khoda-Afarin storage dam, Ghiz-Gale si diversion dam.

124. The following wetlands/peatlands are located in the Iranian part of the basin: Arasbaran protected area; Marakan protected area; Kiamaki wildlife preserve; Yakarat no-hunting zone; Aghaghol wetland and no-hunting zone; and Yarim Ghijel wetland. Also the protected areas the Ghare Boulagh wetland, Sari Sou wetland, Eshgh Abad wetland and Siah Baz wetland are located in the Iranian part.

<sup>30</sup> Based on information from Armenia, the Islamic Republic of Iran, Turkey and the First Assessment of Transboundary Rivers, Lakes and Groundwaters.

<sup>31</sup> The river is known as Aras in Azerbaijan, the Islamic Republic of Iran and Turkey.

Table 56  
**Araks/Aras sub-basin**

| <i>Country</i>           | <i>Area in the country (km<sup>2</sup>)</i> | <i>Population</i> | <i>Population density (persons/km<sup>2</sup>)</i> |
|--------------------------|---|-------------------|--|
| Armenia                  | 22 560 <sup>a</sup>                         |                   |  |
| Azerbaijan               | 18 140                                      |                   |  |
| Islamic Republic of Iran | 43 209 <sup>b</sup>                         | 3 240 675         | 75   |
| Turkey                   | 22 285 <sup>c</sup>                         | 763 226           | 34   |

<sup>a</sup> L.A. Chilingaryan et al., “Hydrography of rivers and lakes in Armenia”, Institute of hydro-technology and water problems, Armenia.

<sup>b</sup> Figure for the whole Kura-Araks sub-basin

<sup>c</sup> Total catchment area of the Kura-Araks sub-basin in Turkey is 27,548 km<sup>2</sup>.

125. In the part of the Araks/Aras sub-basin that is Turkey’s territory, surface water resources are estimated at 2.190 km<sup>3</sup>/year and groundwater resources at 0.144 km<sup>3</sup>/year, making up a total of 2.334 km<sup>3</sup>/year. If divided by the number of inhabitants, this is 3,058 m<sup>3</sup>/year/capita.

126. In the Iranian part of the basin, surface water resources are estimated at 1.327 km<sup>3</sup>/year and groundwater resources at 0.730 km<sup>3</sup>/year, making up a total of 2.057 km<sup>3</sup>/year. This is almost 854 m<sup>3</sup>/year/capita.

Table 57  
**Discharge characteristics of the Araks/Aras at the Khazangah gauging station in Iran (latitude: 45°4', longitude 39°08'; elevation: 746 m a.s.l.)**

| <i>Discharge characteristics</i> | <i>Discharge (m<sup>3</sup>/s)</i> | <i>Period of time or date</i> |
|----------------------------------|------------------------------------|-------------------------------|
| Q <sub>av</sub>                  | 42.01                              | 1999–2001                     |
| Q <sub>max</sub>                 | –                                  |                               |
| Q <sub>min</sub>                 | –                                  |                               |

Table 58  
**Mean monthly discharges of the Araks/Aras at the Khazangah gauging station in Iran (latitude: 45°4', longitude 39°08'; elevation: 746 m a.s.l.) based on observations from 1982 to 1999**

| <i>Mean monthly discharges</i>   |                                   |                                    |
|----------------------------------|-----------------------------------|------------------------------------|
| October: 23.52 m <sup>3</sup> /s | November: 35.52 m <sup>3</sup> /s | December: 38.15 m <sup>3</sup> /s  |
| January: 39.97 m <sup>3</sup> /s | February: 47.44 m <sup>3</sup> /s | March: 28.18 m <sup>3</sup> /s     |
| April: 113.35 m <sup>3</sup> /s  | May: 91.94 m <sup>3</sup> /s      | June: 46.97 m <sup>3</sup> /s      |
| July: 18.23 m <sup>3</sup> /s    | August: 10.15 m <sup>3</sup> /s   | September: 11.02 m <sup>3</sup> /s |
| Mean discharge                   | 42.01                             |                                    |

Table 59

**Discharge characteristics of the Araks/Aras at the Surmeli gauging station in Turkey (latitude: 40°04', longitude: 43°47'; elevation: 932 m a.s.l.)**

| <i>Discharge characteristics</i> | <i>Discharge (m<sup>3</sup>/s)</i> | <i>Period of time or date</i> |
|----------------------------------|------------------------------------|-------------------------------|
| Q <sub>av</sub>                  | 55.71                              | 2008                          |
| Q <sub>max</sub>                 | 290                                | 27/03/2008                    |
| Q <sub>min</sub>                 | 16                                 | January 2008                  |

Table 60

**Mean monthly discharges of the Araks/Aras at the Novruzlu gauging station in Azerbaijan based on observations from 1965 to 2008**

| <i>Mean monthly discharge</i>    |                                   |                                   |
|----------------------------------|-----------------------------------|-----------------------------------|
| October: 69.4 m <sup>3</sup> /s  | November: 93.6 m <sup>3</sup> /s  | December: 129.3 m <sup>3</sup> /s |
| January: 158.8 m <sup>3</sup> /s | February: 151.2 m <sup>3</sup> /s | March: 160.6 m <sup>3</sup> /s    |
| April: 249.5 m <sup>3</sup> /s   | May: 331.5 m <sup>3</sup> /s      | June: 196.3 m <sup>3</sup> /s     |
| July: 54.1 m <sup>3</sup> /s     | August: 42.5 m <sup>3</sup> /s    | September: 53.9 m <sup>3</sup> /s |
| Mean discharge                   | 140.9                             |                                   |

Table 61

**Nakhichevan/Larijan and Djebrail aquifer (No. 66)<sup>32</sup>: Type 3, alluvial aquifer connected to river, little transboundary impacts. Gravel-pebble, sand, boulder. Strong and shallow links with surface water**

|                                 | <i>Azerbaijan</i>  | <i>Islamic Republic of Iran</i> |
|---------------------------------|--|---------------------------------|
| Area                            | 1 480  |                                 |
| Thickness (mean, max)           | 60, 150  |                                 |
| Groundwater management measures | Need to be improved: abstraction management, quantity and quality monitoring, protection zones, good agricultural practices, mapping                         |                                 |
| Groundwater uses and functions  | Need to be applied: transboundary institutions, data exchange, integrated river basin management, treatment of urban and industrial wastewater               |                                 |
| Groundwater uses and functions  | Irrigation (55–60%) and drinking water (40–45%)  |                                 |
| Additional information          | 1) Joint monitoring programme is felt to be needed; 2) Increased water use is expected in Azerbaijan; 3) no water quality or quantity problems are reported. |                                 |

<sup>32</sup> In the first Assessment of Transboundary Rivers, Lakes and Groundwaters, the aquifer was called “Middle and Lower Araks” (aquifer no. 7).

## Pressures

127. There are pressures on water quality from mining, industrial and municipal wastewater, as well as natural geochemical processes. Agricultural pollution from return flows consisting of agrochemical waste, pesticides, nutrients and salts is a particular concern in both upstream and downstream sections of the Aras River.

128. Agriculture and animal husbandry are the main economic activities in the Turkish part of the basin, where there is need for development of irrigation and for modern irrigation techniques. Tourism (for skiing and sightseeing in particular) is growing in Turkey. The region in the Turkish part of the basin is not industrialized and manufacturing industry is limited to small- and medium-size factories.

129. Municipalities of the urban areas are connected to a sewerage network, but in general no wastewater treatment plants have been set up yet. Concerning solid waste disposal, in the Turkish part, only Erzurum province has a sanitary landfill. Controlled dump sites of the municipalities cause pollution risk to surface water and groundwater. The pressures from wastewater and solid waste are both assessed by Turkey as widespread but moderate in influence. Wastewater discharges from small and medium industries are reported to cause pollution in Turkey, but it is considered local and moderate in influence, whereas in the Islamic Republic of Iran discharges from industries are viewed to have a widespread and severe influence.

130. Flooding of the plain areas in Iğdır province in Turkey is a longstanding issue. The lower part of the Araks/Aras River in Turkey is at a risk of flooding during high flows in winter and spring. Turkey reports that bank and riverbed protection works in the main river and its tributaries have been carried out since 1960s.

131. Invasion of the river, particularly in the plain regions, has resulted in intense bank erosion. Generally erosion of the land in the basin is assessed by Turkey as not severe but in steep valleys and slopes the erosion rate is high, with sediments getting transported by snow and rain waters from tributaries into the main river course. Morphological changes and erosion in the riverbed and riverbanks have occurred due to aggregate mining, which is practiced for example in Armenia. Both Iran and Turkey assess the influence as severe, but Turkey views it rather as local than widespread like Iran. Soil degradation results from erosion. Medium- and small-scale quarrying in the Turkish part of the sub-basin result in morphological changes in landscape.

132. According to Iran, heavy metals (Cu, Mn, Fe etc.) from mining waste in left-side tributaries from Armenia, rank among the main sources of transboundary pollution in the Aras River. However, investments into improving the facilities in recent years, also by international companies, have improved the situation. Transfer of experience within the region could be beneficial, for example in controlling pollution from copper mines, in which the Islamic Republic of Iran has gained experience by developing closed water circulation in the processes. There is awareness that tailings dams are vulnerable to earthquakes.

Table 62  
Land use/land cover in the Araks/Aras sub-basin

| Country                  | Water bodies | Forest | Cropland          | Grassland | Urban/industrial areas | Surfaces with little or no vegetation | Wetlands/peatlands | Protected areas  | Other forms of land use |
|--------------------------|--------------|--------|-------------------|-----------|------------------------|---------------------------------------|--------------------|------------------|-------------------------|
| Armenia                  |              |        |                   |           |                        |                                       |                    |                  |                         |
| Azerbaijan               |              |        |                   |           |                        |                                       |                    |                  |                         |
| Georgia                  |              |        |                   |           |                        |                                       |                    |                  |                         |
| Islamic republic of Iran | N/A          | N/A    | 14.7 <sup>a</sup> | N/A       | N/A                    | N/A                                   | N/A                | N/A              | N/A                     |
| Turkey                   | 1.1          | 5      | 28 <sup>b</sup>   | 29        | N/A                    | N/A                                   | 2                  | 4.7 <sup>c</sup> | 30.2 <sup>d</sup>       |

<sup>a</sup> About 37 per cent of cropland in Iran is irrigated.

<sup>b</sup> About 20 per cent of cropland in Turkey is irrigated.

<sup>c</sup> Includes Lake Kuyucuk (Kuyucuk Gölü), 416 ha, Wetland of International Importance/Ramsar Site and designated natural park Mount Ararat (Ağrı Dağı), 1050 km<sup>2</sup>.

<sup>d</sup> Including urban areas and surfaces with little or no vegetation.

Table 63  
Water use in different sectors (percentage)

| Country                  | Total withdrawal × 10 <sup>6</sup> m <sup>3</sup> /year | Agricultural | Domestic | Industry | Energy | Other |
|--------------------------|---|--------------|----------|----------|--------|-------|
| Armenia                  |   |              |          |          |        |       |
| Azerbaijan               |   |              |          |          |        |       |
| Islamic Republic of Iran | 3 000   | 93           | 5.5      | 0.76     | 0      | 0.5   |
| Turkey <sup>a</sup>      | 507   | 89           | 11       |          |        |       |

<sup>a</sup> It should be noted that there are probably withdrawals also by other sectors in the Turkish part of the basin, but no information was available on them. Therefore, agriculture and domestic are not the only water-user sectors, but they are the two main ones.

133. Water supply for villages and municipalities in Turkey is mainly provided from groundwater sources and groundwater is also used by farmers for local irrigation. Allocation of groundwater is made according to estimated renewable water resources. Surface water is withdrawn for irrigation in Turkey. There are hydropower projects under development in Turkey, which may influence water availability for other sectors.

134. The Islamic Republic of Iran expects its water use to increase from 3,000 × 10<sup>6</sup> m<sup>3</sup>/year to 4,800 × 10<sup>6</sup> m<sup>3</sup>/year.

## Status

135. The ecological and chemical status is satisfactory for aquatic life, municipal and industrial uses, and other uses.

136. According to measurements by Armenia from 2006 to 2009 along the Araks/Aras, heavy metals such as Al, Fe, Mn, Cr and V occur in water in moderate amounts. Some of these are part of the typical geochemical background of the Araks/Aras. Iran rates the issue of naturally elevated metal concentrations as serious but local; Armenia, as widespread but moderate (considering the levels of the following elements: Al, Fe, Mn, V, Cr, cobalt (Co), nickel (Ni), Cu, Zn). Chrome (Cr) occurs at amounts exceeding MAC almost every year. Nitrate level did not exceed MAC during the same observation period.

137. Water quality monitoring results from the period 2006–2009 collected and analysed by Armenia downstream of river Araks/Aras indicate that there was a gradual increasing trend of BOD<sub>5</sub> (MAC: 3mg/l), especially during 2009. The concentration of total phosphorus was lower than MAC (MAC: 1–0.4 mg/l). The nitrite ion exceeded MAC (MAC: 0.024 mg N/l) during period 2006–2009 downstream of the Araks/Aras and the greatest influence of municipal wastewater on water quality in the river have been observed before and after mixing with waters of the tributary Razdan.

138. According to Turkish Inland Water Quality Standards, water quality in the Turkish part of the Araks/Aras River is in Class I and Class II, that is, unpolluted and/or less polluted water bodies, respectively.

### **Management response**

139. The monitoring network in the Turkish territory of the Aras River Basin includes some 55 monitoring stations distributed over the main course of the river and tributaries. Regular monitoring of water quantity and quality goes back to the 1960s. Some of the stored data are published in yearly statistical books but presently there is no database for the monitoring network in the Turkish part.

140. The Development of Water Resources Management Plan for the Aras River Basin is a part of Turkey's medium- to long-term national environmental strategies. Water and land development projects carried out in Turkish part of the Aras sub-basin are mainly oriented towards developing hydropower, irrigation and domestic water supply. There is at present time no river basin organization and council in the Turkish part of the Aras River Basin. In Turkey, conjunctive management of surface and ground waters is considered in determining water availability and allocation. A comprehensive integrated water resources management (IWRM) plan for the Aras Basin is under preparation according to Iran.

141. Wastewater treatment plants for municipalities will be installed in Turkey as a part of medium- and long-term national environment strategies (3–10 years). A wastewater treatment plant is required from new industrial facilities, and the existing small-medium industrial facilities are required to complete their wastewater treatment plants. Any direct discharges into groundwater bodies are not allowed.

142. Implemented measures in Turkey to tackle pollution from agriculture include introduction of efficient drainage systems for irrigated land, as well as limiting and controlling use of pesticides and fertilizers in agriculture. Efficient irrigation methods are one of the priorities of the Turkish Government in agricultural policy to be extended all over the country. Application of drip and sprinkle irrigation techniques has started in irrigation development projects in the Turkish part of the Aras sub-basin. Organic agricultural practices have been adopted for example in grain production, fruit growing and beekeeping by some local producers and farmers. The Organic Agriculture Law was adopted in 2004. The self-assessment in Iran is that irrigation is practised there with a high efficiency and productivity, and that the latest technology is in use. In most modern irrigation and drainage schemes — e.g., Moghan, Khodaafarin — wastewater reuse or

managed aquifer recharge are applied. Demand management is seen as something that should be developed more.

143. Afforestation of land has been carried out on land with little or without vegetation by Turkey's Ministry of Environment and Forestry and on the drainage area of existing reservoirs. Erosion control measurements are made in the Turkish part of the catchment area of the Aras River and sediments are dredged in certain parts of the river as part of river protection works.

### **Transboundary cooperation**

144. Bilateral transboundary collaborative projects on water quality monitoring are ongoing between the Islamic Republic of Iran and Armenia, as well as between Iran and Azerbaijan. A related database has also been established in cooperation.

145. Iran and Armenia and Iran and Azerbaijan have some river training<sup>33</sup> and flood control projects on the Aras River. Each country prepares its river training plan and delivers it to the other side. The other side then investigates the plan and gives its ideas about it (i.e., modifications or changes regarding border protocols or changes of river regime due to the execution of project).

146. The following are felt to be lacking in the current institutional frameworks in the Araks/Aras sub-basin:

- A regional strategy for integrated management and planning (for preventing and reducing pollution in particular);
- A multilateral agreement between the riparian countries;
- A transboundary basin council/

147. Strengthening cooperation in water quality control as well as risk and crisis management in man-made or natural disasters is called for.

### **Trends**

148. In the sub-basin of the Araks/Aras, in the Iranian part, average annual temperature is predicted to increase by 1.5 to 2°C by 2050. A reduction of 3 per cent in precipitation is expected. More frequent floods and droughts are predicted. The impacts on land use and cropping patterns, as well as agricultural water requirements are expected to be considerable. Groundwater quality is expected to deteriorate.

149. Turkey reports that in the region in general, with results not specific to the Araks/Aras basin, precipitation is predicted to decrease from 10 per cent to 20 per cent by 2070–2100 and its seasonal variability is predicted to increase. By 2030, a decrease of 10 per cent to 20 per cent in run-off is predicted, with increased variability in both precipitation and run-off. Based on expert knowledge, groundwater level is predicted to decrease and groundwater quality affected negatively. Flood/drought risk is expected to increase. Both consumptive and non-consumptive water uses are foreseen to increase.

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<sup>33</sup> River training refers to engineering river-works that are built in order to direct the flow.

150. According to adaptation strategies identified in National Climate Change Strategy<sup>34</sup> of Turkey, the possible negative impacts of climate change on vulnerable ecosystems, urban biotopes and biological diversity will be identified and a vulnerability assessment will be carried out. Development and implementation of preventive and preparedness measures in Turkey will be made using scenarios and risk maps to be prepared.

151. In Turkey, the water resources of Aras sub-basin have been used mainly for irrigation, domestic supply and hydropower purposes. In recent years, particularly hydropower projects have been owned by private enterprises according to Turkish Electricity market law. Therefore involvement and investment of the private sector in water projects in the sub-basin has increased.

### XIII. Akhuryan sub-basin<sup>35</sup>

152. The sub-basin of the 186 km long river Akhuryan/Arpaçay<sup>36</sup> is shared by Armenia and Turkey. The river has its source in Armenia and discharges to the Araks/Aras. The Karkachun /Karahaneh, which is 55 km long and has a catchment area of 1020 km<sup>2</sup>, is the biggest transboundary tributary. Gukasjan (length 26 km) and Illiget (length 16 km) are other transboundary tributaries.

153. The basin has a pronounced mountainous and highland character with an average elevation of about 2,010 m a.s.l. in the Armenian part and 1,500–1,600 m a.s.l. in the Turkish part.

Table 64

#### Akhuryan/Arpaçay sub-basin

| Country      | Area in the country<br>(km <sup>2</sup> ) <sup>a</sup> | Country's share % | Population           | Population density<br>(persons/km <sup>2</sup> ) |
|--------------|--|-------------------|----------------------|--|
| Turkey       | 6 798  | 71                | 262 226 <sup>b</sup> | 39   |
| Armenia      | 2 784  | 29                | 281 000              | 101  |
| <b>Total</b> |  |                   |                      |  |

<sup>a</sup> L.A. Chilingaryan et al. "Hydrography of rivers and lakes in Armenia", Institute of hydro-technology and water problems, Armenia.

<sup>b</sup> Turkish Statistical Institute, 2008

154. In the part of the basin that is Turkey's territory, the surface water resources are estimated at 0.781 km<sup>3</sup>/year and groundwater resources at 0.020 km<sup>3</sup>/year, which make up a total of 0.801 km<sup>3</sup>/year. If divided by inhabitant, the total is 3,055 m<sup>3</sup>/capita/year. In the part of the sub-basin that is Armenia's territory, the surface water resources are estimated at 1.093 km<sup>3</sup>/year (based on data from 1983 to 2008) and groundwater resources at 0.369 km<sup>3</sup>/year (based on data from 1983 to 2008), which make up a total of 1.462 km<sup>3</sup>/year. The total can also be expressed as 5,200 m<sup>3</sup>/capita/year, approximately.

<sup>34</sup> Ministry of Environment and Forestry of Turkey, 2009: "National Climate Change Strategy", December 2009, Ankara, Turkey.

<sup>35</sup> Based on information from Armenia, Turkey and the First Assessment of Transboundary Rivers, Lakes and Groundwaters.

<sup>36</sup> The river is known as Arpaçay in Turkey and as Akhuryan in Armenia.

155. The river flow of the Akhuryan is heavily regulated by reservoirs: Akhuryan Reservoir (volume 525 million m<sup>3</sup>) and Arpilits Reservoir (105 million m<sup>3</sup>).

Table 65

**Discharge characteristics of the Akhuryan/Arpaçay at Bagaran gauging station in Armenia (0.4 km upstream from the river's mouth)**

| <i>Discharge characteristics</i> | <i>Discharge (m<sup>3</sup>/s)</i> | <i>Period of time or date</i> |
|----------------------------------|------------------------------------|-------------------------------|
| Q <sub>av</sub>                  | 34.7                               | 1983–2008                     |
| Q <sub>max</sub>                 | 195                                |                               |
| Q <sub>min</sub>                 | 0.55                               |                               |

Table 66

**Monthly mean discharges of the Akhuryan/Arpaçay at Bagaran gauging station**

| <i>Mean monthly discharges</i>  |                                  |                                   |
|---------------------------------|----------------------------------|-----------------------------------|
| October: 23.1 m <sup>3</sup> /s | November: 19.6 m <sup>3</sup> /s | December: 18.9 m <sup>3</sup> /s  |
| January: 19.1 m <sup>3</sup> /s | February: 17.3 m <sup>3</sup> /s | March: 26.5 m <sup>3</sup> /s     |
| April: 63.5 m <sup>3</sup> /s   | May: 90.5 m <sup>3</sup> /s      | June: 55.8 m <sup>3</sup> /s      |
| July: 30.2 m <sup>3</sup> /s    | August: 26.8 m <sup>3</sup> /s   | September: 25.1 m <sup>3</sup> /s |

Table 67

**Leninak-Shiraks aquifer (No. 67)<sup>37</sup>: [None of the described aquifer types] Lavas, basalts and andesitic basalts of Upper Miocene, Quaternary and Upper Pliocene age. Two aquifer layers. Groundwater flow from Akhuryan basin to Ararat valley. Medium links with surface water**

|  | Armenia   | Turkey |
|--|---|--------|
| Area   | 925   |        |
| Renewable groundwater resource (m <sup>3</sup> /d) | 612 000   |        |
| Thickness (mean, max)                              | 18, 85  |        |
| Number of inhabitants                              |   |        |
| Population density                                 |   |        |
| Groundwater uses and functions                     | Community water supply, (industrial) production, irrigation and fisheries |        |

<sup>a</sup> Turkey reports that it has not carried out any study regarding to transboundary aquifers in this region

<sup>37</sup> The aquifer did not appear in the First Assessment of Transboundary Rivers, Lakes and Groundwaters.

## Pressures

Table 68

**Land cover/use in the Akhuryan/Arpaçay basin (per cent of the part of the basin extending in each country)**

| Country | Water bodies | Forest | Cropland          | Grassland | Urban/industrial areas | Surfaces with little or no vegetation | Wetlands/peatlands | Protected areas | Other forms of land use |
|---------|--------------|--------|-------------------|-----------|------------------------|---------------------------------------|--------------------|-----------------|-------------------------|
| Turkey  | 1.3          | 3.7    | 34.8 <sup>a</sup> | 39.1      | 4                      | –                                     | N/A                | 0.04            | 17 <sup>b</sup>         |
| Armenia | <sup>c</sup> | 2.0    | 28.9              | 64.7      | 4.0                    | N/A                                   | N/A                | N/A             | N/A                     |

<sup>a</sup> Of the cropland in Turkey, 10.4 per cent is irrigated.

<sup>b</sup> Including surfaces with little or no vegetation.

<sup>c</sup> The waterbodies include the rivers Karkazun, Illiget and Gukasjan, as well as reservoirs Akhurian, Arpa, Artik and Mantash.

156. Surface water is mainly used for irrigation purposes in the Turkish part of the sub-basin. In Iğdır Plain, 70,530 ha of land has been irrigated from Arpaçay reservoir. Water supply for municipalities is generally provided from groundwater sources and groundwater is also used for local irrigation by farmers.

Table 69

**Mean annual water withdrawal by sector (percentage) in the Akhuryan/Arpaçay sub-basin**

| Country | Total withdrawal<br>$\times 10^6$ m <sup>3</sup> /year | Agricultural (%) | Domestic (%) | Industry (%) | Energy (%) | Other (%) |
|---------|--|------------------|--------------|--------------|------------|-----------|
| Turkey  | 913 <sup>a</sup>                                       | 97               | 3            | 0            | 0          | N/A       |
| Armenia |  |                  |              |              |            |           |

<sup>a</sup> Represents the 2009 situation, including withdrawal from storage water of Arpacay reservoir. The water use can be considered insignificant as there are no substantial industrial facilities in the Turkish part of the sub-basin and the existing small factories are supplied generally with water from municipalities or with groundwater from wells.

157. The main pressure factors in the Akhuryan/Arpaçay basin include agriculture and animal husbandry, as well as discharge of untreated or insufficiently treated urban/municipal wastewater. Municipalities of urban areas are generally connected to a sewerage network, but they mostly do not have wastewater treatment plants in place for the time being. Controlled dump sites of municipalities also cause a pollution risk for surface and groundwater resources in the basin. Morphological changes and erosion in the riverbed are also a concern. Geochemical processes are also a factor that affects water quality.

## Pressures

158. According to predictions reported by Armenia, the air temperature is expected to increase by 1.1°C, and precipitation to decrease by 3.1 per cent, by 2030. The amount of precipitation (rain and snow) is predicted to decrease by 7 to 10 per cent. As a result of climate change, groundwater level is expected to decrease by 15 to 20 per cent. River

discharges are predicted to decrease by 10–15 per cent. The impact on water use is also expected to be significant.

159. Turkey reports that there is no existing study and research involving climate change modelling for the sub-basin of the Arpaçay River based on observations. However, according to national prediction and long-term scenarios, both precipitation and river runoff are expected to decrease by 10 to 20 per cent — the former by 2070–2100 and the latter by 2030 — with increased seasonal variability in precipitation and flood/drought risk. Water use is foreseen to increase.

#### **XIV. Akhuryan/Arpaçay dam and reservoir<sup>38</sup>**

160. The Akhuryan/Arpaçay dam<sup>39</sup> was jointly constructed by Turkey and the Soviet Union between the period from 1979 to 1983 along the boundary river Akhuryan/Arpaçay in accordance with the Cooperation Agreement of 1975 between the two countries (see ECE/MP.WAT/2010/WG.1/3–ECE/MP.WAT/2010/WG.2/4, Annex 3). Up until the 1990s the dam was operated jointly by Turkey and the Soviet Union and, since then, by Turkey and Armenia.

161. The dam was constructed mainly for irrigation and flood protection purposes and it has an active storage capacity of 525 hm<sup>3</sup>/year.

#### **Pressures**

162. In Turkey, the water of Arpaçay Reservoir and the flow of the Aras River is used for irrigation of Iğdır Plain (70,530 ha). The Serdarabat Regulator for diverting irrigation water was constructed in 1937 downstream of the dam, on the main course of the Aras River, in accordance with an agreement of 1927 between Turkey and the Soviet Union.

163. Since 2004, there is an Interstate Commission of Armenia and Turkey on the Use of Akhuryan Water Reservoir.

#### **XV. Arpa sub-basin<sup>40</sup>**

164. The sub-basin of the 92-km river Arpa is shared by Armenia and Azerbaijan. The river has its source at an elevation of 3,200 m a.s.l. and discharges into the Araks/Aras River. In the Armenian part, the rivers Elegis (47 km long, river basin area 516 km<sup>2</sup>), Gerger (28 km long, river basin area 174 km<sup>2</sup>) and Darb (22 km long, river basin area 164 km<sup>2</sup>) are major transboundary tributaries of the Arpa.

165. The sub-basin has a pronounced mountainous character with an average elevation of about 2,090 m a.s.l.

<sup>38</sup> Based on information from Armenia, Turkey and the First Assessment of Transboundary Rivers, Lakes and Groundwaters.

<sup>39</sup> The dam is called “Arpaçay Barajı” and the reservoir “Arpaçay Baraj Gölü” in Turkey.

<sup>40</sup> Based on information from Armenia and the First Assessment of Transboundary Rivers, Lakes and Groundwaters under the UNECE Water Convention

Table 70  
**Area and population in the Arpa sub-basin**

| <i>Country</i> | <i>Area in the country<br/>(km<sup>2</sup>)</i> | <i>Country's share %</i> | <i>Population</i>   | <i>Population density<br/>(persons/km<sup>2</sup>)</i> |
|----------------|---|--------------------------|---------------------|--|
| Armenia        | 2 080   | 79                       | 54 000 <sup>a</sup> | 26   |
| Azerbaijan     | 550   | 21                       |                     |  |
| Total          | 2 630   |                          |                     |  |

*Sources:* L.A. Chilingarjan et al. "Hydrography of rivers and lakes in Armenia", Institute of hydro-technology and water problems, Armenia.

<sup>a</sup> Statistical management, Armenia; <http://www.armstat.am/>

### Hydrology and hydrogeology

166. Reservoirs on the Arpa include Gerger (volume 26.0 million m<sup>3</sup>) and Kechoot (volume 25.0 million m<sup>3</sup>). The flow is strongly regulated by the reservoirs and there are several hydroelectric power plants on the river.

167. Surface water resources in the Armenian part of the Arpa sub-basin, as run-off generated from precipitation within the area, are estimated at 0.751 km<sup>3</sup>/year (based on data from 1931 to 2008) and groundwater resources at 0.084 km<sup>3</sup>/year (average for the years from 1991 to 2008), making up a total of 0.835 km<sup>3</sup>/year. This equals about 15,460 m<sup>3</sup>/year/capita.

Table 71  
**Discharge characteristics of the Arpa River at the Areni gauging station in Armenia (upstream from the border with Azerbaijan)**

| <i>Discharge characteristics</i> | <i>Discharge (m<sup>3</sup>/s<sup>1</sup>)</i> | <i>Period of time or date</i> |
|----------------------------------|--|-------------------------------|
| Q <sub>av</sub>                  | 22.1   | 1931–2008                     |
| Q <sub>max</sub>                 | 340  | 1931–2008                     |
| Q <sub>min</sub>                 | 0.30   | 1931–2008                     |

Table 72  
**Mean monthly discharges of the Arpa River at the Areni gauging station in Armenia.**

| <i>Mean monthly discharges</i>  |                                  |                                   |
|---------------------------------|----------------------------------|-----------------------------------|
| October: 12.4 m <sup>3</sup> /s | November: 9.29 m <sup>3</sup> /s | December: 9.08 m <sup>3</sup> /s  |
| January: 9.10 m <sup>3</sup> /s | February: 8.61 m <sup>3</sup> /s | March: 14.5 m <sup>3</sup> /s     |
| April: 36.5 m <sup>3</sup> /s   | May: 76.0 m <sup>3</sup> /s      | June: 48.2 m <sup>3</sup> /s      |
| July: 18.5 m <sup>3</sup> /s    | August: 12.1 m <sup>3</sup> /s   | September: 10.7 m <sup>3</sup> /s |

Table 73

**Herher, Malishkin and Jermuk aquifers (No. 68)<sup>41</sup>: Does not correspond with described aquifer types. volcanic rocks of Upper and Middle Eocene age. Weak links with surface water**

|  | Armenia   | Azerbaijan |
|--|---|------------|
| Area (km <sup>2</sup> )                    | N/A   |            |
| Thickness – mean, max (in m)               | N/A   |            |
| Groundwater resource (m <sup>3</sup> /day) |   |            |
| Groundwater management measures            |   |            |
| Groundwater uses and functions             | Domestic water supply and irrigation  |            |
| Pressure factors                           | Agriculture?  |            |
| Additional information                     | In the Armenian part of the aquifer, groundwater storage is estimated to be about 40 million m <sup>3</sup> . |            |

## Pressures

Table 74

**Land use/land cover in the Arpa sub-basin**

| Country    | Water bodies | Forest | Cropland | Grassland | Surfaces with little or |               |                    | Protected areas | Other forms of land use |
|------------|--------------|--------|----------|-----------|-------------------------|---------------|--------------------|-----------------|-------------------------|
|            |              |        |          |           | Urban/industrial areas  | no vegetation | Wetlands/peatlands |                 |                         |
| Armenia    | N/A          | 3      | 7.7      | N/A       | N/A                     | N/A           | N/A                | N/A             | N/A                     |
| Azerbaijan |              |        |          |           |                         |               |                    |                 |                         |

168. Untreated urban wastewater containing pollutants are discharged into the Arpa River from drainage systems, which is ranked by Armenia as both severe and widespread in influence on water resources. There are several towns and villages along the Arpa River in the Armenian part. There are several recreation areas in the river basin and trash is not necessarily properly disposed of by visitors, which impacts moderately on water quality.

169. Pressures related to agriculture, demonstrated as increased levels of nutrients (e.g., nitrate), are reported to be significant and widespread in the Armenian part, but at moderate level in impact.

170. According to monitoring by Armenia, V, Cr and Cu concentrations along the river remain almost constant, indicating naturally elevated background levels. Heavy metal concentrations except V and Cu were within the MAC (for fish life) level. The MAC levels were exceeded in the central part of the river basin.

<sup>41</sup> Based on information provided by Armenia. These aquifers did not appear in the First Assessment of Transboundary Rivers, Lakes and Groundwaters.

## Status and transboundary impact

171. The river has been assessed to be very clean. There was almost no human impact, and the ecological and chemical status has been viewed as “normal and close to natural conditions”. In the period from 2004 to 2006, the average mineral content on the border is 315 mg/l with a maximum of 439 mg/l.

172. Increased anthropogenic impact can be observed in monitoring results from 2009 as nitrogen compound concentrations — nitrate ( $\text{NO}_3^-$ ), nitrite ( $\text{NO}_2^-$ ), ammonium ( $\text{NH}_4^+$ ) — increasing up to three times in the Armenian part of the basin from above the Jermuk tributary down to the Areni monitoring station (upstream from the border with Azerbaijan). This is reported to be due the influence of agriculture. The levels nevertheless remain lower than the MAC norms for fish life.

## Trends

173. Armenia predicts that under the influence of climate change, precipitation will decrease 5–10 per cent within the next 20 years. Surface flow is predicted to decrease by 7–10 per cent and groundwater levels by 5–10 per cent. Deterioration of groundwater quality is expected. Impact on water use is projected to be noticeable, and indirect impacts are projected to be evident in connection with reducing precipitation and increasing air temperature.

## XVI. Vorotan sub-basin<sup>42</sup>

174. The sub-basin of the 111-km river Vorotan<sup>43</sup> is shared by Armenia and Azerbaijan. The river has its source at a height of 3,080 m a.s.l. and discharges into the Araks/Aras. Major transboundary tributaries to the Vorotan include the Gorisget (25 km, 146 km<sup>2</sup>), the Sisian (length 33 km, basin area 395 km<sup>2</sup>), the Tsghook, the Vagoodi and the Loradzor, among others. The sub-basin has a pronounced mountainous character with an average elevation of about 2,210 m a.s.l.

Table 75

### Area and population in the Vorotan sub-basin

| Country      | Area in the country (km <sup>2</sup> ) | Country share % | Population density |                            |
|--------------|--|-----------------|--------------------|----------------------------|
|              |  |                 | Population         | (persons/km <sup>2</sup> ) |
| Armenia      | 2 575                                  | 41.6            | 72 800             | 28                         |
| Azerbaijan   | 3 620                                  | 58.4            |                    |                            |
| <b>Total</b> | <b>6 195</b>                           |                 |                    |                            |

175. Surface water resources in the Armenian part of the Vorotan sub-basin are estimated at 0.748 km<sup>3</sup>/year (based on the periods from 1988–1991 and 1999–2008). Groundwater resources are estimated at 0.218 km<sup>3</sup>/year. Total water resources in the Armenian part of the Vorotan sub-basin are estimated at 0.966 km<sup>3</sup>/year. This is about 13,270 m<sup>3</sup>/year/capita.

<sup>42</sup> Based on information from Armenia and the First Assessment of Transboundary Rivers, Lakes and Groundwaters.

<sup>43</sup> The river is also known as Bargushad.

Table 76

**Discharge characteristics of the Vorotan at the Tatev hydroelectric station in Armenia (Upstream of the border with Azerbaijan)**

| <i>Discharge characteristics</i> | <i>Discharge (m<sup>3</sup>/s)</i> | <i>Period of time or date</i> |
|----------------------------------|------------------------------------|-------------------------------|
| Q <sub>av</sub>                  | 22.2                               | 1988–1991, 1999–2008          |
| Q <sub>max</sub>                 | 141                                | 1988–1991, 1999–2008          |
| Q <sub>min</sub>                 | 1.00                               | 1988–1991, 1999–2008          |

Table 77

**Mean monthly discharges of the Vorotan at the Tatev hydroelectric station in Armenia**

| <i>Mean monthly discharges</i>   |                                  |                                   |
|----------------------------------|----------------------------------|-----------------------------------|
| October: 9.08 m <sup>3</sup> /s  | November: 11.3 m <sup>3</sup> /s | December: 10.1 m <sup>3</sup> /s  |
| January: 13.01 m <sup>3</sup> /s | February: 15.1 m <sup>3</sup> /s | March: 15.6 m <sup>3</sup> /s     |
| April: 40.5 m <sup>3</sup> /s    | May: 58.3 m <sup>3</sup> /s      | June: 46.1 m <sup>3</sup> /s      |
| July: 20.1 m <sup>3</sup> /s     | August: 13.8 m <sup>3</sup> /s   | September: 12.9 m <sup>3</sup> /s |

176. The flow in the river is heavily regulated and there are several hydroelectric power stations on the river.

Table 78

**Vorotan-Akora aquifer (No. 69)<sup>44</sup>: Type does not correspond with the described types. Volcanic rocks such as lava of Upper and Middle Eocene age. Two artesian aquifer horizons<sup>45</sup>. Groundwater flow direction is from Armenia to Azerbaijan. Weak links with surface water**

|  | <i>Armenia</i>   | <i>Azerbaijan</i> |
|--|--|-------------------|
| Area (km <sup>2</sup> )                            | 1 100  |                   |
| Renewable groundwater resource (m <sup>3</sup> /d) | 637 000  |                   |
| Thickness in m                                     |  |                   |
| Number of inhabitants                              |  |                   |
| Population density                                 |  |                   |
| Groundwater uses and functions                     | Used for water supply, irrigation, power engineering and fisheries |                   |
| Other information                                  |  |                   |

<sup>44</sup> Based on information provided by Armenia. The aquifer did not appear in the First Assessment of Transboundary Rivers, Lakes and Groundwaters.

<sup>45</sup> The first aquifer is located at the depth of 63–76 m and the second one at a depth of 151–177 m.

## Pressures

177. Agriculture is one of the main pressure factors in the Vorotan sub-basin, assessed as widespread but moderate in influence by Armenia. Pollution from discharging untreated urban and rural wastewaters into the river is another severe pressure factor, but more local in the extent of influence. There are several villages in the Armenian part of the sub-basin.

178. Influence of hydropower generation and related infrastructure on the river are considered as local and moderate.

179. Natural hydro-geochemical processes cause elevated vanadium concentrations in the basin.

Table 79

### Land use/land cover in the Vorotan sub-basin

| Country    | Water bodies | Forest | Cropland | Grassland | Surfaces                      |                                    | Wetlands/<br>peatlands | Protected<br>areas | Other forms<br>of land use |
|------------|--------------|--------|----------|-----------|-------------------------------|------------------------------------|------------------------|--------------------|----------------------------|
|            |              |        |          |           | Urban/<br>industrial<br>areas | with little or<br>no<br>vegetation |                        |                    |                            |
| Armenia    | N/A          | N/A    | N/A      | N/A       | N/A                           | N/A                                | N/A                    | N/A                | N/A                        |
| Azerbaijan |              |        |          |           |                               |                                    |                        |                    |                            |

## Status

180. At the time of the first Assessment (2007), there was almost no human impact on the river. Then, the ecological and chemical status was assessed as “normal and close to natural conditions”. The average mineral content was at the time reported at the border to be 199 mg/l with a maximum of 260 mg/l during the period from 2004 to 2006.

181. The anthropogenic impact on the river water quality is manifested by the fact that the concentrations of  $\text{NO}_3^-$ ,  $\text{NO}_2^-$ ,  $\text{NH}_4^+$ , phosphate ( $\text{PO}_4^{3-}$ ) ions and  $\text{COD}_{\text{Cr}}$  (dichromate as oxidizing agent) increased 1.5–2.5 times from source to river mouth, but remains lower than the MAC norms for fish life<sup>46</sup>. The increases in concentrations may be due to diffuse pollution from agriculture and/or point-source pollution from municipal wastewater. In the results of monitoring in Armenia in 2009, the concentrations of both nitrogen compounds and phosphate peak below the confluence of the Sisian tributary. BOD and dissolved oxygen remained approximately unchanged along the length of the river in the Armenian part.

182. Heavy metal concentrations except V and Cu were within the MAC (for fish life) level in the Armenian part of the basin. The MAC levels were exceeded in the central part of the river basin. The consistency of Cd, Cu, Fe and Cr along the course of the river seems to suggest that their concentrations may be influenced by the natural geochemical background. In 2009, V and arsenic (As) concentration were clearly more elevated on Sisian tributary and below its confluence. Mn, molybdenum (Mo) and lead (Pb) were highest on the main course of the river, below the confluence of Sisian, and Cu reached its highest concentration at the monitoring station of Tatev hydroelectric station, just upstream from the border with Azerbaijan.

<sup>46</sup> In Armenia, water classification is based on MAC values for maintenance of aquatic life and which are more stringent than the MAC values for other uses.

## Transboundary cooperation

183. An agreement was signed in 1974 between the Soviet Socialist Republic of Armenia and the Soviet Socialist Republic of Azerbaijan on the joint utilization of the waters of the river Vorotan (see document ECE/MP.WAT/2010/WG.1/3–ECE/MP.WAT/2010/WG.2/4, Annex 3).

## Trends

184. According to predictions reported on by Armenia, precipitation is predicted to decrease in the area by 5–10 per cent within the next 20 years due to climate change. Surface flow is predicted to decrease by 8–10 per cent. Under the influence of climate change, groundwater level is expected to decrease by 5 to 10 per cent. Some deterioration of groundwater quality is expected. Some indirect or secondary impacts, such as impacts on land use and agriculture, are expected in connection with reducing of precipitation and increasing of air temperature.

## XVII. Voghji sub-basin<sup>47</sup>

185. The sub-basin of the 82-km river Voghji is shared by Armenia and Azerbaijan. The river has its source at a height of 3,650 m and discharges into the Araks/Aras. The Geghi is the most important tributary. Other major transboundary tributaries include the rivers Norashenik (length 29 km, river basin area 130 km<sup>2</sup>), Vachagan (length 11 km, river basin area 35.5 km<sup>2</sup>) and Geghanoosh (length 17 km, river basin area 51 km<sup>2</sup>). The sub-basin has a pronounced mountainous character with an average elevation of about 2,337 m a.s.l. Lakes Gazana and Kaputan are located in the sub-basin.

186. At present, the river flow is not regulated. Geghi Reservoir in the Armenian part is unfinished.

Table 80

### Area and population in the Voghji sub-basin

| <i>Country</i> | <i>Area in the country (km<sup>2</sup>)</i> | <i>Population</i> | <i>Population density (persons/km<sup>2</sup>)</i> |
|----------------|---|-------------------|--|
| Armenia        | 880 (70%)                                   | 50 300            | 57   |
| Azerbaijan     | 377 (30%)                                   |                   |  |
| <b>Total</b>   | <b>1 257</b>                                |                   |  |

187. Surface water resources in the Armenian part of the Voghji sub-basin — estimated as run-off generated from precipitation within the Armenian territory in the basin — are approximately 0.472 km<sup>3</sup>/year (based on the periods from 1965–1991 and 2000–2008). Groundwater resources are estimated at 0.036 km<sup>3</sup>/year (average for years from 1991–2008). Total water resources in the Armenian part of the Voghji basin are estimated at 0.508 km<sup>3</sup>/year. This is about 10,100 m<sup>3</sup>/year/capita.

<sup>47</sup> Based on information from Armenia and the First Assessment of Transboundary Rivers, Lakes and Groundwaters.

Table 81

**Discharge characteristics of the Voghji at the Kapan hydroelectric station in Armenia**

| <i>Discharge characteristics</i> | <i>Discharge (m<sup>3</sup>/s)</i> | <i>Period of time or date</i> |
|----------------------------------|------------------------------------|-------------------------------|
| Q <sub>av</sub>                  | 13.1                               | 1965–1991; 2000–2008          |
| Q <sub>max</sub>                 | 118                                | 1965–1991; 2000–2008          |
| Q <sub>min</sub>                 | 0.30                               | 1965–1991; 2000–2008          |

Table 82

**Discharge characteristics of the Voghji at the Kapan hydroelectric station in Armenia**

| <i>Mean monthly discharges</i>  |                                  |                                   |
|---------------------------------|----------------------------------|-----------------------------------|
| October: 7.31 m <sup>3</sup> /s | November: 5.66 m <sup>3</sup> /s | December: 3.32 m <sup>3</sup> /s  |
| January: 2.70 m <sup>3</sup> /s | February: 2.95 m <sup>3</sup> /s | March: 5.27 m <sup>3</sup> /s     |
| April: 18.0 m <sup>3</sup> /s   | May: 35.0 m <sup>3</sup> /s      | June: 38.1 m <sup>3</sup> /s      |
| July: 21.9 m <sup>3</sup> /s    | August: 10.8 m <sup>3</sup> /s   | September: 5.95 m <sup>3</sup> /s |

*Source:* L.A. Chilingaryan et al., “Hydrography of rivers and lakes in Armenia”, Institute of hydro-technology and water problems, Armenia.

**Pressures**

188. In the Armenian part of the Voghji sub-basin, arable lands are mainly on slopes, especially in Kapan region, which limits mechanization of land cultivation and effective working of the land. Therefore, arable lands in high sloping parts are commonly turned into, for example, grasslands and pastures. Under these conditions, agriculture is not a significant pressure factor in the sub-basin.

189. In the Voghji sub-basin, groundwater discharging from springs is used for domestic water supply and for irrigation. Groundwater occurs in intrusive rocks and metamorphic slates of Upper Jurassic and Middle Devonian age. Links with surface water systems are medium.

190. Pollution from discharges of untreated or insufficiently treated municipal wastewater into the river, in addition on industrial activities, is among the main pressure factors. Their influence is assessed as widespread and severe.

191. Water seeping from Artsvanik tailings dam in Kapan affects the river water quality, mainly by increasing heavy metal concentrations (V, Mn, Zn, Mo, Cd).

192. The influence of hydropower generation and related infrastructure on the river are considered as local and moderate in Armenia.

193. Visitors to the recreational area located upstream commonly do not dispose of their wastes properly, and this leads to moderate impacts on water quality locally.

Table 83  
Land use/land cover in the Voghji basin.

| Country    | Water bodies | Forest | Cropland | Grassland | Surfaces               |                              | Wetlands/<br>peatlands | Protected areas | Other forms of land use |
|------------|--------------|--------|----------|-----------|------------------------|------------------------------|------------------------|-----------------|-------------------------|
|            |              |        |          |           | Urban/industrial areas | with little or no vegetation |                        |                 |                         |
| Armenia    | N/A          | 18     | N/A      | N/A       | N/A                    | N/A                          | N/A                    | N/A             | N/A                     |
| Azerbaijan |              |        |          |           |                        |                              |                        |                 |                         |

## Status

194. At the time of the first Assessment (2007), the ecological and chemical status of the Voghji River system was reported to be “not satisfactory for aquatic life”, but appropriate for other uses. The average mineral content was at the time reported to be 296 mg/l with a maximum of 456 mg/l during the period from 2004 to 2006.

195. Upon comparison of the average annual values measured in Armenia at the source of the Voghji River and at the downstream monitoring site located close to the border, it seems that the concentrations of  $\text{NO}_3$ ,  $\text{NO}_2$  and  $\text{NH}_4$  increased from upstream to downstream by 2.7–7.8 times. This demonstrates anthropogenic impact, mainly from pollution by municipal wastewater and/or agriculture. At the monitoring site located close to the border,  $\text{NH}_4^+$  concentrations exceed the MAC norms (for fish life)<sup>46</sup>. 1.3 times, but  $\text{NO}_3^-$  and  $\text{NO}_2^-$  ion concentrations remain within the MAC norms. In particular at the monitoring station located at the mouth of the Norashenik tributary (No. 96),  $\text{NO}_2^-$  ion concentrations were clearly higher compared with the rest and  $\text{NO}_3^-$  also to some degree.  $\text{PO}_4^{3-}$  concentration in the boundary site was 100 times lower than MAC value.

196. Natural hydro-geochemical processes in the areas of ore deposits affect water quality, causing elevated metal concentrations, but this influence is rated as local and moderate by Armenia. Rather uniform levels of Pb, Fe and Cr observed (e.g., in 2009) seem to suggest that their occurrence is due to natural background. But as an increase in concentrations of heavy metals such as Zn, Cd, Mn and Cu has been observed in 2009 from upstream to downstream, increasing markedly below Kapan and staying at elevated levels down to the last monitoring station upstream from the border (No. 94), some influence of sewage and industrial effluents containing pollutants is inferred in the Armenian part of the Voghji sub-basin.

## Trends

197. According to predictions reported on by Armenia, precipitation is predicted to decrease in the area by 3–5 per cent within the next 20 years due to climate change. Surface water flow is predicted to decrease by 2–3 per cent. Under the influence of climate change, groundwater level is predicted to decrease by 5–7 per cent. It is expected that there will be a marked impact from climate change on water use. Some indirect or secondary impacts, such as impacts on land use and agriculture, are expected in connection with reducing of precipitation and increasing of temperature.

## XVIII. Sarisu sub-basin <sup>48</sup>

198. The basin of the river Sarisu /Sari Su<sup>49</sup> is shared by Turkey and the Islamic Republic of Iran. The river has its source from Tandurek mountains in Turkey and discharges into the Aras River in Iran.

199. The sub-basin has a pronounced volcanic mountainous and high plain land character with an average elevation of about 1,900–2,000 m a.s.l.

Table 84

### Area and population in the Sarisu basin

| <i>Country</i>           | <i>Area in the country (km<sup>2</sup>)</i> | <i>Population</i> | <i>Population density (persons/km<sup>2</sup>)</i> |
|--------------------------|---|-------------------|--|
| Islamic Republic of Iran | 241   | 19 156            | 79   |
| Turkey                   | 2 230                                       | 113 048           | 47   |
| <b>Total</b>             | <b>2 471</b>                                | <b>132 204</b>    |  |

## Hydrology

200. In the part of the Sarisu basin that is Turkey's territory, surface water resources are estimated at 0.054 km<sup>3</sup>/year (based on data from 1988–1996) and groundwater resources at 0.028 km<sup>3</sup>/year, making up a total of 0.082 km<sup>3</sup>/year. This equals 725 m<sup>3</sup>/year/capita.

Table 85

### Discharge characteristics of the Sarisu at the Gulveren gauging station in Turkey (latitude: 39°56'; longitude 40°4'; Elevation: 1,702 m a.s.l.).

| <i>Discharge characteristics</i> | <i>Discharge (m<sup>3</sup>/s)</i> | <i>Period of time or date</i> |
|----------------------------------|------------------------------------|-------------------------------|
| Q <sub>av</sub>                  | 1.72                               | 1988–1996                     |
| Q <sub>max</sub>                 | 19.05                              | 1988–1996                     |
| Q <sub>min</sub>                 | 0.012                              | 23/06/1996                    |

Table 86

### Discharge characteristics of the Sarisu at the Bazargan gauging station in the Islamic Republic of Iran (latitude: 44°26'; longitude 39°45').

| <i>Discharge characteristics</i> | <i>Discharge (m<sup>3</sup>/s)</i> | <i>Period of time or date</i> |
|----------------------------------|------------------------------------|-------------------------------|
| Q <sub>av</sub>                  | 1.60                               | 1980–2005                     |
| Q <sub>max</sub>                 | 5.46                               | 1980–2005                     |
| Q <sub>min</sub>                 | 0.00                               | 1980–2005                     |

<sup>48</sup> Based on information from Turkey, Iran and the First Assessment of Transboundary Rivers, Lakes and Groundwaters.

<sup>49</sup> The river is known as Sarisu in Turkey and Sari Su in Iran.

## Status

Table 87

### Land use/land cover in the Sarisu basin

| Country                  | Water bodies | Forest | Cropland         | Grassland | Urban/industrial areas | Surfaces with little or no vegetation | Wetlands/peatlands | Protected areas | Other forms of land use |
|--------------------------|--------------|--------|------------------|-----------|------------------------|---------------------------------------|--------------------|-----------------|-------------------------|
| Islamic republic of Iran |              |        |                  |           |                        |                                       |                    |                 |                         |
| Turkey                   | 1            | 0.2    | 7.8 <sup>a</sup> | 73        | 0.7                    | N/A                                   | N/A                | N/A             | 17.3                    |

<sup>a</sup> Of the cropland in Turkey, 23 per cent is irrigated.

201. The riparian countries have signed a protocol entitled “Iranian-Turkish Protocol on the Use of the Waters of the Sari Su and Kara Su” in 1955. This protocol includes, for example, the basic principles of the water use in the border region, minimum water flow and water allocation.

## XIX. Flood-plain marshes and fishponds in the Araks/Aras River Valley (Armenia, Azerbaijan, Islamic Republic of Iran, Turkey)<sup>50</sup>

### General description of the wetland area

202. The Araks/Aras River Valley harbours a big number of natural and man-made wetlands, including extensive permanent freshwater marshlands and brackish seasonally wet marshlands, lakes and fishponds. On the Armenian side, particularly noteworthy are Khor Virap Marsh occupying the ancient Araks/Aras riverbed and Armash fishponds to the south, as well as Metsamor wetland system that includes Lake Aighr and River Sevjur (one of the tributaries of the Araks/Aras), together with surrounding marshlands and fishponds. Other parts of this vast river valley ecosystem are located in Azerbaijan, the Islamic Republic of Iran and Turkey.

### Supporting socio-economic services

203. Over the past decades, fish farming in Armenia has become an important part of the economy. Armash fishponds used to be the biggest fish farming enterprise in the South Caucasus, with a total capacity of several thousand tons of fish per year. This complex contains 25 big ponds (1,700 ha of water surface area) and a number of smaller ponds

<sup>50</sup> Sources:

Jenderedjian, K., Jenderedjian, A., Salathe, T., Hakobyan, S., 2004. About Wetlands, and around Wetlands in Armenia. Yerevan.

Jenderedjian, K.. Transboundary management of Kura Basin wetlands as an important step towards waterbird conservation in the South Caucasus region in Boere, G.C., Galbraith, C.A. & Stroud, D.A. (eds). Waterbirds around the world. The Stationery Office, Edinburgh, UK. 2006.

(www.jncc.gov.uk/worldwaterbirds)

surrounded by extensive reed stands and muddy areas. Other large enterprises are Aygherlich, Yeghegnut and Masis, with a total surface area of 1,000 ha. Fish species being farmed in wide and shallow “lacustrine” fishponds with emergent vegetation and soft bottom are carp (*cyprinus carpio*), silver carp (*hypophthalmichtys molitrix*) and grass carp (*ctenopharygodon idella*). In the narrow “riverine” fishponds with concrete walls and bottom, main commercial species are rainbow trout (*parasalmo mykiss*), brown trout (*salmo trutta m. fario*), sevan trout (*salmo ischchan*) and Siberian sturgeon (*acipenser baeri*).

204. Marshes of the Metsamor wetland system are used for cattle grazing, amateur hunting and fishing.

### **Cultural values of the wetland area**

205. The Old Testament records that it was on Ararat Mountain that Noah’s Ark came to rest after the Great Flood. On the opposite side of the River Araks/Aras, on top of a hill, sits the complex of Khor Virap Monastery (built in the ninth to twelfth centuries), which nowadays is one of the most popular tourism destinations in Armenia. Moreover, excavations at Metsamor and its museum demonstrate that the area had been a vibrant cultural centre from roughly 4,000 to 3,000 B.C.

### **Biodiversity values of the wetland area**

206. Khor Virap Marsh and Armash fishponds are among the Caucasus’s richest ornithological hotspots. Both sites provide important nesting areas for numerous cormorants, geese, ducks, ibises, waders and other water-birds, including globally threatened species such as the marbled teal (*marmoronetta angustirostris*) and the white-headed duck (*oxyura leucocephala*). Other man-made “lacustrine” fishponds and the Metsamor wetland system also play an important role for nesting waterfowl that lost their breeding habitats when the water level in lakes Sevan and Gilli dropped. The same wetlands provide stopover sites for migrating birds. Ornithofauna is especially rich during the fall migration, when more than 100 species can be registered here.

### **Pressure factors and transboundary impacts**

207. Due to increasing demand for trout, many enterprises redesign existing earth ponds into concrete pools that are more effective for intensive trout breeding. This leads to loss of habitats for nesting and migrating waterfowl.

208. In the 1950’s Khor Virap Marsh was drained and reclaimed as agricultural land. However, as early as the 1980’s the uncared-for drainage system ceased to work properly and marsh habitats recovered; but traces of canals are still visible inside the marsh. On Armash fishponds the main threat to waterfowl is intensive poaching, while in Metsamor wetland system grazing represents a disturbance for birds.

### **Transboundary wetland management**

209. There are several ongoing programmes initiated by the European Commission and the United Nations Development Programme to improve water management in the Kura-Araks sub-basin through the harmonization of legislation, monitoring and regional planning. The “Eco-regional Nature Protection Programme for the South Caucasus Region”, part of the Caucasus Initiative launched by German Federal Ministry of Economic

Cooperation and Development (BMZ), aims to promote cooperation in the development of a coherent strategy to ensure biodiversity conservation in the region.

210. The Critical Ecosystem Partnership Fund (CEPF) is developing a strategy based on the results of stakeholder workshops and background reports coordinated by the WWF Caucasus Programme Office. CEPF provides special attention to wetlands and international cooperation.

211. In 2007, the Government of Armenia designated part of Khor Virap Marsh (50.28 ha) as a sanctuary to be managed by the Khosrov Forest Reserve authorities and as a Wetland of International Importance (Ramsar site). Documentation is under preparation for formal submission to the Secretariat of the Ramsar Convention on Wetlands.

## XX. Samur River Basin<sup>51</sup>

212. The basin of the river Samur is shared by Azerbaijan and the Russian Federation. The river has its source in Dagestan, Russian Federation, and discharges into the Caspian Sea. The average elevation of the basin is 1,970 m a.s.l.

213. A transboundary aquifer called Samur is linked to the surface waters in the basin.

Table 88

### Area and population in the Samur Basin

| <i>Country</i>           | <i>Area in the country (km<sup>2</sup>)</i> | <i>Country's share %</i> |
|--------------------------|---|--------------------------|
| Azerbaijan               | 340   | 4.6                      |
| Russian Federation       | 6 990                                       | 95.4                     |
| <b>Total<sup>a</sup></b> | <b>7 330</b>                                |                          |

<sup>a</sup> Including the tributary Giolgerykhay.

### Hydrology and hydrogeology

214. The common border on the river between the Russian Federation and Azerbaijan is 38 km long. Before flowing into the Caspian Sea, the river divides into several branches, located both in Azerbaijan and the Russian Federation. Some 96 per cent of the river flow originates on Russian territory.

215. Spring floods cause damage in the Russian part of the basin.

<sup>51</sup> Based on information from Azerbaijan, the Russian Federation and the First Assessment of Transboundary Rivers, Lakes and Groundwaters.

Table 89  
**Discharge characteristics of the Samur at the Usukhchay gauging station in Azerbaijan, based on observations from 1949 to 2006**

| <i>Mean monthly discharges</i>  |                                  |                                   |
|---------------------------------|----------------------------------|-----------------------------------|
| October: 49.7 m <sup>3</sup> /s | November: 35.5 m <sup>3</sup> /s | December: 26.7 m <sup>3</sup> /s  |
| January: 21.6 m <sup>3</sup> /s | February: 20.4m <sup>3</sup> /s  | March: 23.4m <sup>3</sup> /s      |
| April: 53.4 m <sup>3</sup> /s   | May: 115 m <sup>3</sup> /s       | June: 163 m <sup>3</sup> /s       |
| July: 130 m <sup>3</sup> /s     | August: 77.4 m <sup>3</sup> /s   | September: 61.1 m <sup>3</sup> /s |
| Mean discharge                  | 68.8 m <sup>3</sup> /s           |                                   |

216. The estimated renewable groundwater resources in the foothill plains of the Samur-Hussar amount to 3,471 m<sup>3</sup>/day (about 0.00127 km<sup>3</sup>/year). The depth of a typical well ranges from 150 to 200 m.

Table 90  
**Samur aquifer (No. 70)<sup>52</sup>: Type 3 (Alluvial aquifer connected to the river, little transboundary impacts). The upper, alluvial aquifer consists of gravel-pebble, sand and boulders of Neogene-Quaternary age (N-Q); the lower aquifer consists of fractured sandstones and siltstones of Jurassic and Cretaceous age (J-K). In the alluvial aquifer groundwater flow is from Azerbaijan and the Russian Federation to the Samur River. In the lower aquifer the flow direction is from Azerbaijan to the Russian Federation. Both aquifers have strong links with surface water**

|  | <i>Azerbaijan</i>  | <i>Russian Federation</i>  |
|--|--|--|
| Area (km <sup>2</sup> )                    | 2 900  | 699  |
| Thickness: mean, max (in m)                | 50, 100  | N-Q: 50, 100<br>J-K: 40, 90  |
| Groundwater resource (m <sup>3</sup> /day) |  |  |
| 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 |  |
| Groundwater uses and functions             | Drinking water (90–92%)<br>Irrigation (5–8%)<br>Industry (2–3%)  | Drinking water (90%)<br>Irrigation (7%)<br>Industry (3%)   |
| Pressure factors                           | No pressure factors, no problems related to groundwater quantity and no substantial problem related to groundwater quality                     | No pressure factors, no problems related groundwater quantity and no substantial problems related to groundwater quality |

<sup>52</sup> Based on information provided by the Russian Federation and the first Assessment of Transboundary Rivers, Lakes and Groundwaters. In the first Assessment, the number of the aquifer was 6.

|                        |   |
|------------------------|---|
| Additional information | Groundwater management measures: Improvement of water management system, coordination of groundwater monitoring network, procedures for information exchange) |
|                        | Joint monitoring programme is felt to be needed. Azerbaijan predicts increased water use as a consequence of economic growth.                                 |

217. Use of the water for irrigation (currently some 90,000 ha in Azerbaijan and 62,000 ha in the Russian Federation)<sup>53</sup> and to supply drinking water to the cities of Baku and Sumgait in Azerbaijan (up to 400 million m<sup>3</sup>/a) and settlements in Dagestan (Russian Federation) has led to pressure on water resources.

### Status and transboundary impact

218. At the time of the first Assessment (2007), the river was classified as “moderately polluted”. Natural background concentrations of some heavy metals and trace elements are elevated, but the influence is assessed by the Russian Federation as local. In three areas in the Russian part of the basin groundwater pollution has been identified. Groundwater monitoring is carried out at nine points of observation in the Russian part of the basin at a frequency of three times per month.

219. The total water demand of both countries considerably exceeds the available resources, indicated by the considerable decrease of water flow from source to mouth and the drop in the groundwater table which has adverse ecological effect in the river valley and the delta. For about six months in a year, there is a more severe shortage with almost no water flow downstream from the hydrotechnical installation at Samursk. Otherwise, the impact of groundwater level decrease is assessed by the Russian Federation as widespread but moderate in influence.

### Transboundary cooperation

220. An intergovernmental agreement on joint use and protection of the transboundary Samur River was negotiated between Azerbaijan and the Russian Federation in the period 2000–2004. However, the negotiations did not result in the signing of an agreement.<sup>54</sup>

221. At the present time there is no exchange of monitoring information.

### Trends

222. Concluding a bilateral agreement is of crucial importance for ensuring that the transboundary waters of the Samur are used in a reasonable and equitable way and for guaranteeing the ecological minimum flow in the delta region.

<sup>53</sup> The countries' irrigation inventory indicates 210,000 ha for Azerbaijan and 155,700 ha for the Russian Federation.

<sup>54</sup> UNECE (2009), River basin commissions and other institutions for transboundary water cooperation (ECE/MP.WAT/32).

## XXI. Sulak River Basin<sup>55</sup>

223. The basin of the river Sulak is shared by Georgia and the Russian Federation. The river has its source in the confluence of the Avarsk-Koisu (Russian Federation) and the Andis-Koisu (transboundary river shared by Georgia and the Russian Federation) and discharges into the Caspian Sea. The Sulak River itself flows entirely in the Russian Federation.

224. The Georgian part of the basin is traversed by very deep gorges and ravines. The difference between the depressions of the topography and ridges reaches 1,000 m. The lower part of the basin has a pronounced meandering lowland character. The average elevation of the basin is about 1,800 m a.s.l.

Table 91

### Area and population in the Andis-Koisu sub-basin

| <i>Basin</i>                                     | <i>Country</i>     | <i>Area in the country (km<sup>2</sup>)</i> | <i>Country's share %</i> | <i>Population</i> | <i>Population density (persons/km<sup>2</sup>)</i> |
|--|--------------------|---|--------------------------|-------------------|--|
| Andis-Koisu tributary                            | Georgia            | 869   | 18                       | 2 000             | 2  |
|  | Russian Federation | 3 941                                       | 82                       |                   |  |
| <b>Andis-Koisu subtotal</b>                      |                    | <b>4 810</b>                                |                          |                   |  |
| <b>Sulak basin, including tributaries, total</b> |                    | <b>15 200</b>                               |                          |                   |  |

### Hydrology and hydrogeology

225. In the part of the Andis-Koisu sub-basin that is Georgia's territory, total water resources are estimated at 0.802 km<sup>3</sup>/year (based on data from 1951–1977). This equals 400,827 m<sup>3</sup>/year/capita. The surface water resources in the Russian part of the basin are estimated at some 2.26 × 10<sup>6</sup> m<sup>3</sup>/year (equals 0.00226 km<sup>3</sup>/year; based on data from 1929–1980), and groundwater resources at 0.26 km<sup>3</sup>/year.

226. Andis-Koisu is a major transboundary tributary, shared by Georgia and the Russian Federation (basin area 4,810 km<sup>2</sup>). Andis-Koisu River originates in the territory of Georgia at the confluence of the rivers Pirikita Alazani and Tushetskaya Alazani.

Table 92

### Discharge characteristics of the Andis-Koisu at the Shenako gauging station in Georgia (at the border with Russia, 143 km from the mouth of the river; elevation: 2,600 m a.s.l.)

| <i>Discharge characteristics</i> | <i>Discharge (m<sup>3</sup>/s)</i> | <i>Period of time or date</i> |
|----------------------------------|------------------------------------|-------------------------------|
| Q <sub>av</sub>                  | 25.4                               | 1951–1977                     |
| Q <sub>max</sub>                 | 37.7                               | 1951–1977                     |
| Q <sub>min</sub>                 | 18.8                               | 1951–1977                     |

<sup>55</sup> Based on information from Georgia, the Russian Federation and the First Assessment of Transboundary Rivers, Lakes and Groundwaters

Table 93  
**Mean monthly discharges of the Andis-Koisu at the Shenako gauging station in Georgia**

| <i>Mean monthly discharges</i>  |                                  |                                   |
|---------------------------------|----------------------------------|-----------------------------------|
| October: 18.0 m <sup>3</sup> /s | November: 12.3 m <sup>3</sup> /s | December: 10.2 m <sup>3</sup> /s  |
| January: 10.0 m <sup>3</sup> /s | February: 8.92 m <sup>3</sup> /s | March: 7.86 m <sup>3</sup> /s     |
| April: 18.2 m <sup>3</sup> /s   | May: 43.1 m <sup>3</sup> /s      | June: 56.4 m <sup>3</sup> /s      |
| July: 57.6 m <sup>3</sup> /s    | August: 36.4 m <sup>3</sup> /s   | September: 24.6 m <sup>3</sup> /s |

Table 94  
**Mean monthly discharges of the Pirikita Alazani at the Omalo gauging station in Georgia based on observations from the period from 1951 to 1977**

| <i>Mean monthly discharges</i>  |                                  |                                   |
|---------------------------------|----------------------------------|-----------------------------------|
| October: 7.74 m <sup>3</sup> /s | November: 5.52 m <sup>3</sup> /s | December: 4.39 m <sup>3</sup> /s  |
| January: 3.82 m <sup>3</sup> /s | February: 3.47 m <sup>3</sup> /s | March: 3.24 m <sup>3</sup> /s     |
| April: 5.22 m <sup>3</sup> /s   | May: 11.6 m <sup>3</sup> /s      | June: 19.8 m <sup>3</sup> /s      |
| July: 25.8 m <sup>3</sup> /s    | August: 18.7 m <sup>3</sup> /s   | September: 11.4 m <sup>3</sup> /s |
| Mean charges                    | 10.1 m <sup>3</sup> /s           |                                   |

Table 95  
**Mean monthly discharges of the Tushetskaya Alazani at the Hahabo gauging station in Georgia based on observations from the period from 1951 to 1977**

| <i>Mean monthly discharges</i>  |                                  |                                   |
|---------------------------------|----------------------------------|-----------------------------------|
| October: 6.23 m <sup>3</sup> /s | November: 4.28 m <sup>3</sup> /s | December: 3.23 m <sup>3</sup> /s  |
| January: 2.92 m <sup>3</sup> /s | February: 2.97 m <sup>3</sup> /s | March: 3.03 m <sup>3</sup> /s     |
| April: 7.11 m <sup>3</sup> /s   | May: 18.7 m <sup>3</sup> /s      | June: 21.4 m <sup>3</sup> /s      |
| July: 16.3 m <sup>3</sup> /s    | August: 10.2 m <sup>3</sup> /s   | September: 7.46 m <sup>3</sup> /s |
| Mean discharge                  | 8.71 m <sup>3</sup> /s           |                                   |

Table 96  
**Mean monthly discharges of the Andis-Koisu at the Shirkota gauging station in the Russian Federation based on observations from the period from 1951 to 1977 (8.8. km from the river's mouth)**

| <i>Discharge characteristics</i> | <i>Discharge (m<sup>3</sup>/s)</i> | <i>Period of time or date</i> |
|----------------------------------|------------------------------------|-------------------------------|
| Q <sub>av</sub>                  | 71.8                               | 1929–1980                     |

Table 97

**Quaternary aquifer (No. 71)<sup>56</sup> (name?) Type 2. The upper aquifer consists of sand and gravel of Quaternary age (Q); the lower aquifer consists of sandstone, siltstone and limestone of Jurassic and Cretaceous age (J-K). In the upper aquifer groundwater flow is from Georgia and the Russian Federation to the Sulak River. In the lower aquifer the flow direction is from Georgia to the Russian Federation. Both aquifers have medium links with surface water**

|  | <i>Georgia</i> | <i>Russian Federation</i>   |
|--|----------------|---|
| Area (km <sup>2</sup> )                    |                |   |
| Thickness – mean, max (in m)               |                | Q: 30, 50<br>J-K: 25, 50  |
| Groundwater resource (m <sup>3</sup> /day) |                |   |
| Groundwater management measures            |                |   |
| Groundwater uses and functions             |                | Some 20 × 10 <sup>6</sup> m <sup>3</sup> /year of groundwater is abstracted for drinking water and for irrigation.                                  |
| Pressure factors                           |                | Six areas of groundwater contamination have been identified   |
| Additional information                     |                | Transboundary groundwaters not seen to have specific uses and functions, because in the Russian Federation the resource is considered insignificant |

### Pressures and status

227. Irrigation and human settlements constitute the main pressure factors in the sub-basin of the Andis-Koisu River. Transboundary impact is assessed to be insignificant. The Andis-Koisu River has a good ecological and chemical status.

228. Increased pumping lifts or costs for groundwater abstraction are an issue in the Russian Federation, but this concerns a limited area. The State groundwater monitoring network in the Russian part of the basin consists of six monitoring points and the frequency of observations is 3–10 times per month.

229. There have been plans to construct a number of hydropower stations in the Russian part of the Andis-Koisu sub-basin.

### Trends

230. Based on research studies and expert knowledge, a decrease in precipitation is expected in Georgia in the next 50 years: by 7 per cent in eastern part of the country (where the Sulak basin is also located) during fall, winter and spring, and by 30 per cent in the

<sup>56</sup> Based on information provided by the Russian Federation. The aquifer did not appear in the First Assessment of Transboundary Rivers, Lakes and Groundwaters.

summer. Increase in drought frequency is expected in the eastern part of Georgia, but no data is available.<sup>57</sup>

## XXII. Terek River Basin<sup>58</sup>

231. The basin of the river Terek is shared by Georgia and the Russian Federation. The 623-km-long river has its source in the slopes of Mount Kazbek in Georgia and discharges into the Caspian Sea. The river flows through North Ossetia/Alania, Kabardino-Balkaria, the Stavropol Krai, Chechnya and Dagestan (Russian Federation). In the Georgian part, the basin is characterized by mountainous, glacial topography.

232. The Assa (total basin area 2,060 km<sup>2</sup>) and the Argun (total basin area 3,390 km<sup>2</sup>) are transboundary tributaries to the Terek. Tributaries of the Terek within Georgia are the rivers Gamaradoni, Desikamidoni, Suatisi Doney, Mnasidoni, Snostskali, Chheri, Corot, Amalie and Hdistskali.

Table 98

### Area and population in the Terek Basin

| Country            | Area in the country<br>(km <sup>2</sup> ) | Country's share % | Population | Population density<br>(persons/km <sup>2</sup> ) |
|--------------------|---|-------------------|------------|--|
| Georgia            | 1 559                                     | 3.6               | 4 900      | 0.17   |
| Russian Federation | 41 641                                    | 96.4              |            |  |
| <b>Total</b>       | <b>43 200</b>                             |                   |            |  |

*Sources:* Ministry of Environment Protection and Natural Resources (Georgia) and Federal Agency for Water Resources (Russian Federation).

### Hydrology and hydrogeology

233. The period of high water levels in spring-summer is very long (end of March to September). Spring floods cause damage, especially in the Russian part of the basin.

234. In the part of the Terek Basin that is Georgia's territory, surface water resources are estimated at 0.761 km<sup>3</sup>/year (based on data from 1928–1990). This equals 155,223 m<sup>3</sup>/year/capita. In the Russian Federation, water resources amount to 11.0 km<sup>3</sup>/year in an average year (based on data from 1912–1980). The groundwater resources are estimated at 5.04 km<sup>3</sup>/km in the Russian part of the basin.

<sup>57</sup> *Sources:* Second National Communication of Georgia to the UNFCCC; UNECE and WHO (2008) Adaptation to Climate Change in Eastern Europe, Caucasus and Central Asia and South-Eastern Europe  
[http://www.unece.org/env/water/meetings/Water.and.Climate/workshop/Report\\_survey\\_260608.doc](http://www.unece.org/env/water/meetings/Water.and.Climate/workshop/Report_survey_260608.doc)

<sup>58</sup> Based on information from Georgia, the Russian Federation and the First Assessment of Transboundary Rivers, Lakes and Groundwaters

Table 99

**Discharge characteristics of the Terek at Stepantsminda (Kazbeki) gauging station in Georgia (latitude 44° 38', longitude 42° 39'; elevation: 1,140 m a.s.l.)**

| <i>Discharge characteristics</i> | <i>Discharge (m<sup>3</sup>/s)</i> | <i>Period of time or date</i> |
|----------------------------------|------------------------------------|-------------------------------|
| Q <sub>av</sub>                  | 24.1                               | 1928–1990                     |
| Q <sub>max</sub>                 | 30.4                               | 1928–1990                     |
| Q <sub>min</sub>                 | 18.6                               | 1928–1990                     |

Table 100

**Mean monthly discharges of the Terek at the Stepantsminda gauging station in Georgia**

| <i>Mean monthly discharges</i>  |                                  |                                   |
|---------------------------------|----------------------------------|-----------------------------------|
| October: 17.1 m <sup>3</sup> /s | November: 12.1 m <sup>3</sup> /s | December: 9.81m <sup>3</sup> /s   |
| January: 8.48 m <sup>3</sup> /s | February: 7.92 m <sup>3</sup> /s | March: 8.03 m <sup>3</sup> /s     |
| April: 13.7 m <sup>3</sup> /s   | May: 34.7 m <sup>3</sup> /s      | June: 54.9 m <sup>3</sup> /s      |
| July: 56.7 m <sup>3</sup> /s    | August: 40.2 m <sup>3</sup> /s   | September: 25.0 m <sup>3</sup> /s |

Table 101

**Discharge characteristics of the Terek at the Stepnoe (Hangishyurt) gauging station in the Russian Federation (165 km from the river's mouth)**

| <i>Discharge characteristics</i> | <i>Discharge (m<sup>3</sup>/s)</i> | <i>Period of time or date</i> |
|----------------------------------|------------------------------------|-------------------------------|
| Q <sub>av</sub>                  | 296                                | 1912–1990                     |
| Q <sub>max</sub>                 | 2000                               | 1912–1990                     |
| Q <sub>min</sub>                 | 68.0                               | 1912–1990                     |

Table 102

**Quaternary aquifer (No. 72)<sup>59</sup> (name?): Type 2/3. The aquifer consists of sand and gravel of Quaternary age (Q). Groundwater flow is from Georgia and the Russian Federation to the Terek. Strong links with surface water**

| <i>Georgia</i>                             | <i>Russian Federation</i>   |
|--|---|
| Area (km <sup>2</sup> )                    | [length 12 km]  |
| Thickness: mean, max (in m)                | 20, 50  |
| Groundwater resource (m <sup>3</sup> /day) |   |
| Groundwater management measures            |   |
| Groundwater uses and functions             | Some 409 × 10 <sup>6</sup> m <sup>3</sup> /year of groundwater is abstracted for drinking water and for irrigation.                 |
| Pressure factors                           | 75 areas of groundwater contamination have been identified  |
| Additional information                     | Transboundary groundwaters not seen to have specific uses and functions, because in Russia the resource is considered insignificant |

### Pressures and status

235. Irrigational water use and human settlements are the main pressure factors in the Georgian part of the basin. More than a half of the Georgian territory in the basin is grassland (53.6 per cent) and only about 1 per cent is cropland. In the Russian part of the basin, pressure arises from irrigation (>700,000 ha), industry, aquaculture/fisheries and human settlements.

236. At the time of the first Assessment of Transboundary Rivers, Lakes and Groundwaters (2007), the river had a good ecological and chemical status at the border. According to data provided by the Russian Federation, the Terek has been in the “polluted” category of the Russian water quality classification from 2005 to 2008 without significant variation.

<sup>59</sup> Based on information provided by the Russian Federation. The aquifer did not appear in the First Assessment of Transboundary Rivers, Lakes and Groundwaters.