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# Руководство по проблемам трансграничного выделения квот воды в Центральной Азии

## Аннотация

Авторы рассматривают пограничные воды, которые являются делимыми ресурсами, а распределение их квот имеет важное значение для оптимизации водоснабжения в государствах бассейна. Предметом интереса ограничивается водными объектами в части Средней Азии, покрытой бассейнами крупных рек, таких как Амударья и Сырдарья. Эта тема имеет огромное значение для всего субконтинента, а исторический аспект водоснабжения очень важен.

**Ключевые слова:** Аральское море, гидрологический режим, водные ресурсы, использование воды, регулирование стока рек.

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# Compendium problems of trans-boundary water quota allocation in Central Asia

## Abstract

The authors study trans-boundary waters as divisible resources and their quota allocation is essential to streamline water supply in basin states. The subject of interest is limited to water bodies in the part of Central Asia covered with basins of major rivers such as the Amudarya and Syrdarya. Although this topic is also important for the entire subcontinent. A historical aspect of water supply is important.

**Keywords:** the Aral Sea, hydrological regime, water resources, water use, river flow regulation.

The data of hydrological observations have made it possible to outline three stages of water resources creation and use. The first stage is natural dating back to time before the new era. The second stage is conditionally natural, which began in antiquity and ended in the first half of the 20th century due to large-scale extraction of river waters. The third stage is characterized with exhaustion of available resources, mainly, for the benefit of irrigated agriculture. This being said, the river network has been functioning as the framework for the water management systems. This framework on the Amudarya River ensured seasonal regulation of the flow with a coefficient of ~ 0.8–0.85. On the Syrdarya River, multi-year regulation with a coefficient of ~ 0.9–0.93 was achieved. Hydroelectric complexes on the rivers were made complete with hydropower plants and generated electricity in accordance with an irrigation schedule. The main part of the hydroelectric complexes and water reservoir has been situated in the mountainous parts of the subcontinent. Upon gaining independence in the country, mountainous basin states changed mode of operation from water use to hydropower generation. Considering this and because plain states have no waterworks facilities for counter-regulation during the irrigation mode of operation resulting in the detriment to water supply for irrigated agriculture. During average water availability during a year, these damages reach up to 6–8 km$^3$ on the Amudarya and Syrdarya Rivers, while during the low-water years, the river flow during the vegetation period in the middle and lower reaches reduce even more. The hydrological process, which is stochastic in its nature, become even more unstable.

It should be noted, however, that upper reaches still remain areas for flow formation and use; middle reaches – transit and extraction of flow with lateral inflow or without it whatsoever; lower reaches are areas for dispersion of the remaining flow across cultivated landscapes. However, the sustain runoff basin – the Aral Sea – no longer exists. The major Amudarya River has «acquired» a blind end, while the major Syrdarya River still «flows into» the eastern part of the impoundment, which remains from the Aral Sea.

These are the resulting draft quota schedules, which are discussed below.

A new geopolitical context in Central Asia has changed the status of water bodies and their water resources. They have now turned into trans-boundary water bodies, so their economic use should be regulated in line with the ratios contained in the international law. However, the ratios emanating from the international laws are, apparently, intended to be also based on the specific features pertaining to the formation and distribution of water resources, and, equally importantly, on centuries-old customs and subcontinent-specific legal traditions of water use and water consumption.

The current sub-continental trend of water formation and water use remains ambiguous for a number of reasons. Elimination of uncertainties will, primarily, call for clarification of the water formation regime in the context of global warming and streamlining water use. With this in mind, there is also a need to address the issue of transboundary water quota allocation. This will, in some way or the other, this will facilitate the resolution of stratified collisions emanating from water use and water consumption. Proceeding from these arguments, we shall briefly outline a working version of key provisions pertaining to the issues mentioned above.

*1. Available water resources and precedents of water quota arrangement (limitation)*

The southern slope of the Aral Sea basin, river waters are formed and used in the basins of major rivers such as the Amudarya and Syrdarya [1; p. 360]. River water in this part of the subcontinent have been and still remain key sources of water supply.

Table 1 represents data on available primary resources in these transboundary rivers. These data were sourced from [2, p. 139] and checked against estimations in [3, p. 127] and estimations in [4, p. 178]. In addition, changes in river water content due to global warming anticipated in accordance with the represented estimations [5, p. 125] have been «digitized». This effort showed that, in the near future, there is a likelihood of a shift in the «climatic norm» of 90% in the current water availability. This estimation, albeit very crude, still indicates the need for «countermeasures». The time will show how effective they will be, if implemented.

Table 2 shows provisions of a pre-design water apportioning carried out in the past [6, p. 124]. The water was apportioned following the Helsinki rules on the uses of the waters of International rivers (Helsinki, 1966), but to ensure development, primarily, irrigation, which is still a precedent, which cover or fail to cover post-Soviet interest of countries in the basin.

Table 2 summarizes data about quota arrangement of primary water resources with, but, as it was observed, that river water intake occurred through return and «two and more times return» water. The meets the demand of water users, while available water resources are used on non-returnable consumption and losses pointing to depletion of water resources and leading to a conclusion about non-admissibility of this situation for arid countries with high water intensity of water resources utilization complex.

Table 1

Available water resources in Amudarya and Syrdarya rivers (across years, 50% of water availability or norm) on characteristic stages of water resources development and forecasted estimates before the beginning of the II quarter of the 21st century, ($km^3$/year)

| No. | Characteristic river stations | In the1950s | By 2050s | Beginning of the 21st century | Beginning of the II quarter of the 21st century |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| 1. | Total for the Amudarya river basin including: | | 66.5<br>67.9 | 69.8<br>– | |
| 1.1 | Upper reaches, of which: | | 67.9<br>– | 69.8<br>– | 52.4 ± 5.8 |
| 1.1.a | Afghanistan and Iran *) | | | 19.9 | |
| 1.1.b | Kyrgyzstan*) | | | 1.6 | |
| 1.1.c | Tajikistan*) | | | 45.3 | |
| 1.1.d | Uzbekistan*) | | | 3.0 | |

| | | | | | |
|---|---|---|---|---|---|
| 1.2 | Middle reaches, of which: | 63.6<br>– | 63.6<br>~ 50.9 | | 46 ± 5 |
| 1.2.a | Turkmenistan*) | | ~ 21.0 | | |
| 1.2.b | Uzbekistan**) | | ~ 11.0 | | |
| 1.3 | Lower reaches, of which: | 47.9 ***)<br>– | 31.6<br>24.0 | | |
| 1.3.a | Turkmenistan**) | | 7.0 / 5.0 | | |
| 1.3.b | Uzbekistan**) | | 17.3 / 16.0 | | |
| 1.3.c | Discharge into the Aral Sea – water consumption according to Kyzyljar gauging station | 38.0<br>– | 6.1 | | ? |
| 2. | Total for the Syrdarya river basin, including: | 37.8 [21] | 33.4 | 37.2 | 27.2 ± 3.1 |
| 2.1.a | Kyrgyzstan*) | | | 23.9 | |
| 2.1.b | Tajikistan*) | | | 1.0 | |
| 2.1.c | Uzbekistan*) | | | 3.7 | |
| 2.2 | Middle reaches, o)<br>of which: | 23.9 (17.0) + 6.9 and minor rivers) | 14.0 | 21.5 | 5.3 ± 0.6oo) |
| 2.2.a | Kyrgyzstan*) | | 3.7 | 3.7 | |
| 2.2.b | Kazakhstan*) | | 2.4 | 2.4 | |
| 2.2.c | Tajikistan*) | | 0.6 | | |
| 2.2.d | Uzbekistan*) | | 2.5 | 2.5 | |
| 2.3 | Lower reaches, Kazakhstan | | 11.0 / 7.5 | 10.8 / 7.5 | 1.8 ± 0.2 |
| 2.3.a | Discharge into the Aral Sea – consumption according to Kazalin gauging station | 14.5 | | 2.0 (?) | |
| 3 | Total for the southern slope of the Aral Sea basin | | 99.9 | 106.4 | 79.6 ± 8.9 |

Notes:
*) assessment of water formation;
**) water intake assessment;
***) at the latitude of Nukus city without water intake for Karakalpakstan, Khorezm and Dashthauz according to the year of 90% availability;
o) Farkhadski gauging station irrigates tracts of agricultural lands on the right and left banks in the middle reaches;
oo) plus the tributary along the stem stream of the Syrdarya river.

Table 2

Key provisions of predesign water apportioning of the Amudarya [7, p. 221] and Syrdarya [6, p. 124] rivers, (km3/year)

| No. | Characteristic river stations | River flow at 90% water availability | River water intake | Return water (to the rivers) | Non-returnable consumption and losses |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | Upper reaches of Amurdarya and Pyandzh rivers Including: | 59.5*) | 20.1 | 6.5 | 13.6 |
| 1.1.a | Tajikistan + Afghanistan | 55.0 | 14.8 | 4.6 | 10.2 |
| 1.1.b | Uzbekistan | 3.5 | 4.9 | 1.8 | 3.1 |
| 1.1.c | Kyrgyzstan | 1.0 | 0.4 | 0.1 | 0.3 |
| 1.2 | Middle reaches | 45.9 | 28.1 | 2.1 | 26.0 |
| | Of which: | | | | |
| 1.2.a | Uzbekistan | | 11.7 | 1.4 | 10.3 |
| 1.2.b | Turkmensitan | | 16.4 | 0.7 | 15.7 |
| 1.3 | Lower reaches | 18.5 | 18.5 | 0.7 | 17.8 |
| | Including: | | | | |
| 1.3.a | Uzbekistan, | | 14.3 | 0.7 | 13.6 |
| | Of which: | | | | |
| 1.3.a' | Tuyamuyun | | 5.3 | | 5.3 |
| 1.3.a" | Takhiatash | | 9.0 | 0.7 | 8.3 |
| 1.3.b | Turkmenistan, | | 4.2 | | 4.2 |
| | Of which: | | | | |
| 1.3.b' | Tuyamuyun | | 2.6 | | 2.6 |
| 1.3.b" | Takhiatash | | 1.6 | | 1.6 |
| 1.3.c | Discharge into the Aral Sea | | | 2.1 | |
| 1.4 | Total for the Amudarya river | 59.5 | 66.7 | 9.3 | 57.4 |
| 1.4.1 | Kyrgyzstan | 1.0 | 0.4 | 0.1 | 0.3 |
| 1.4.2 | Tajikistan (+ Afghanistan) | 55.0 | 14.8 | 4.6 | 10.2 |
| 1.4.3 | Turkmenistan | - | 20.6 | 0.7 | 19.9 |
| 1.4.4 | Uzbekistan | 3.5 | 30.9 | 3.9 | 27.0 |
| 2 | Upper reaches of the Syrdarya and Naryn rivers | 23.0*) | 19.0 | 9.4 | 9.6 |
| | Including: | | | | |
| 2.1.a | Kyrgyzstan | | 5.0 | 2.5 | 2.5 |
| 2.1.b | Tajikistan | | 2.0 | 1.0 | 1.0 |
| 2.1.c | Uzbekistan | | 12.0 | 5.9 | 6.1 |
| 2.2 | Middle reaches of the Chirchik-Ahangaran-Keles irrigation district | 20.6**) | 16.5 | 7.2 | 9.3 |
| | Including: | | | | |
| 2.2.a | Kyrgyzstan | 3.7 | 0.2 | 0.1 | 0.1 |
| 2.2.b | Kazakhstan | 0.7 | 2.5 | 0.7 | 1.8 |
| 2.2.c | Tajikistan | | 1.2 | 0.4 | 0.8 |
| 2.2.d | Uzbekistan | 2.8 | 12.6 | 6.0 | 6.6 |
| 2.3 | Lower reaches | 13.8 | 13.8 | | 11.8 |
| | Including: | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 2.3.a | Kazakhstan (lower than Chardara) | 11.3 | | | |
| 2.3.b | Aryz + Bugun | 2.5 | | | |
| 2.3.c | Discharge into the Aral Sea | | | 2 | |
| 2.4 | Total for the Syrdarya river | 32.7 | 49.3 | 18.6 | 30.7 |
| | Including: | | | | |
| 2.4.1 | Kyrgyzstan | 26.7 | 5.2 | 2.6 | 2.6 |
| 2.4.2 | Tajikistan | | 3.2 | 1.4 | 1.8 |
| 2.4.3 | Uzbekistan | 2.8 | 24.6 | 11.9 | 12.7 |
| 2.4.4 | Kazakhstan | 3.2 | 16.3 | 2.7 | 13.6 |
| 3 | Total for the southern slope of the Aral Sea basin | 92.2 | 116.0 | 27.9 | 88.1 |
| | Including: | | | | |
| 3.1 | Afghanistan | +12 | 16.6 | 3.5(+3) | 10.1 |
| 3.2 | Kazakhstan | 3.2 | 16.3 | 2.7 | 13.6 |
| 3.3 | Kyrgyzstan | 27.6 | 5.6 | 2.7 | 2.9 |
| 3.4 | Tajikistan | 38.4 | 12.4 | 6.0 | 6.4 |
| 3.5 | Turkmenistan | - | 20.6 | 0.7 | 19.6 |
| 3.6 | Uzbekistan | 6.3 | 55.5 | 15.8 | 39.7 |
| 3.7 | Discharge into the Aral Sea | | | 4.1 | |

Notes:
*) at regulation coefficient ~ 0.9;
**) including a tributary along the course of the Syrdarya river – 13.4 km$^3$

*2. Carrying capacity of water bodies and water quality*

Carrying capacity of a water body is its intrinsic ability to maintain water quality and other properties within admissible and permissible limits in order to sustain life of the original population of aquatic organisms under different types of impacts.

Functionally, the carrying capacity of major rivers and their tributaries also determines quality of natural sources of drinking water for Homo sapiens(a) communities. Availability and functioning of these sources from since ancient times has been beneficial for specific settlement patterns of ethnic groups across the subcontinent and development of distinctive ecological niches.

However, depletion of water resources described above has quite a full effect on the status of carrying capacity of the water bodies as it is as depleted in lower and partly in middle reaches of major and in some parts of middle and minor rivers. At least, water quality checked at controlled river stations fails to meet the drinking water standards established by the World Health Organization. This situation applies, if not annually, but definitely so during low-water phases of the hydrological regime. This mainly happens because of return water [2] because this water, essentially, is agricultural effluent. Effluents of this kind are also saturated with pollutants from industrial and household sources. The bans should have been imposed on agricultural effluent discharge a long time ago, or, preferably, determine limits for water intake and discharge taking into account carrying capacity of water bodies and thus regulate quality of river water. This calls for technological upgrade of hydrotechnical infrastructure of irrigated land tracts and, in general, streamlining water management systems.

*3. Forms of transboundary impacts*

Intersectoral, interregional and temporal external factors (external effects and impacts) that have taken place on the subcontinent have transformed into transboundary impacts of various level organizations once the basin countries became independent and sovereign.

The greenhouse effect leading to climate change determine global external factors manifested on the subcontinent. Climate change consequences, as expected [8, p. 114–122], will result in reduced water content. These forecasts will come true, if average river flow decreases. These expectations are «digitized» in table 1 (Column 6).

Interregional external factors, felt on the subcontinent since ancient times and up until now have resulted from river water intake. In the past, this was characteristic for minor and medium rivers, while currently this affects major rivers as well. The fact that the Amudarya river changed into «a river with blind ends» (continental river) is the evidence hereof. Table 2 illustrates this situation.

Temporal external factors come from development level of production forces in the basin states and their specialization. The criterion to measure the magnitude of impact is the state of the Aral Sea. Before World War II and during the first postwar decade, the subcontinent developed nearly four million hectares of cropland for irrigation, while average river discharge into the Aral Sea amounted to about 52 ± 5 $km^3$/year at that time. Postwar development of new water and land complexes completed (except for Turkmenistan) with the increase in irrigated cropland up to seven million hectares and practical discontinuation of river discharge into the Aral Sea. Turkmenistan, upon achieving independence, has increased the area of irrigated land by 1.7 million hectares [5]. The subcontinent entered into the 21 century with, approximately, eight million hectares of irrigated cropland. As compared to rain-fed agriculture, irrigated agriculture is much more productive, but as it was cultivated it is extremely resource-intensive, so it is extensive. Because the Asian «green revolution» circumvented the subcontinent, it is expected that, we will, apparently, join intensive farming technologies.

Intersectoral external factors are associated with competition for resources. Most important of them include confrontation of irrigation and hydropower industry [9]. It evolved during the Soviet period and still remains during the post-Soviet times. During the Soviet period, hydropower industry functioned in the context of domination of irrigation, while during the post-Soviet period, countries in the upper reaches of the basis prefer to meet their energy needs [5]. Without counter-regulating structure, energy-associated water releases during non-vegetation periods that surpass drought flow, for which existing water reservoirs are designed, are a loss for irrigation.

Hydropower industry, which prevails in upper reaches, alters intra-annual flow distribution in developed rivers both with respect to natural and to irrigation regime [9]. Consequently, irrigated agriculture in countries located in lower reaches of the Amudarya river faces damages because of Vakhsh river cascade, so far, at about 4–5 $km^3$ during one growing season and those located along the Syrdarya river also lose around 4–5 $km^3$ per season because of Lower Naryn Cascade. The construction of Dashti-Jum Hydrological Network on the Pyandzh river will increase outlet to the power stations by 8 km3 during a non-vegetative season.

However, all of the afore-mentioned assessments are based on observed hydrological events during the past climatic epoch and the new situation is, as noted above, still uncertain. Therefore, regulation and counter-regulation of river flow to meet water demands remains a pressing issue. Although it is clear that the planning horizon under the prevailing circumstances in the short and the longer run is rather limited.

The above external factors manifest themselves not only in isolation, but also in combination, spatially and temporally. This integration leads to the fact that complicates the state of flow and transforms it into a non-linear flow regime. To some extent, this is due to short-term nature and magnitude of the negative effects pertaining to randomness of water use on the subcontinent. An «unexpected» increase in water availability on the subcontinent during the last decade of the twentieth century due to the melting of mountain glaciers delayed the timely adoption of the new regulation of water use and water consumption, rather than made wary.

*4. Optimization of water use and water consumption, development of a hydrographic network between the two rivers*

The new water use and water consumption schedule on subcontinent, primarily, requires scientific and technical justification. This justification should, apparently, start with a critical analysis of more than one-century-long history of water management events and evaluation of their positive and negative aspects, including the «post-Soviet innovations."

The need for prudent use and protection of water on the subcontinent has been well understood in scientific and technical community, at least, since the last quarter of the nineteenth century. The first predesign for the river basins or their parts came in the first half of the last century and they became formalized as legal and regulatory documents after World War II. These results and basic provisions of the «circuit» elaborations are reflected in [1] and duly piloted as in legal and regulatory documents during those years [6, p. 124].

The targets in these documents were to ensure the priority development of cotton growing, i.e. production of cotton that could compete then and now on the global world market. It is equally important for domestic production and other purposes. Therefore, water allocation norms among the union states were dominated with limits on irrigation, while the maximum of irrigated area was taken as the main effect of planned designs. Up to 90–95% of available water resources was allocated for irrigation. To this end, the river flow was regaled, which guaranteed water availability and sustainability of irrigation. Moreover, return water was included into available water resources and used to ensure water supply. However, the hydropower resources of the rivers of the subcontinent were used to the fullest extent, when possible, but followed the irrigation schedule.

Table 2 presents data on water intake from rivers, return (discharged) and irrecoverable consumption and flow losses that have taken place in the past in order to meet the targets. Now, as it turned out, this situation with the water allocation, water use and water consumption does not correspond to the interests of the mountainous basin states [4].

Since 1992, the basin states located in the belt of river flow formation that have developed complex cascade of water reservoirs during the same period, have change, de facto, the existing irrigation use of these river section into energy use. They began to generate their benefits in the energy sector from this change. Contrastingly, countries in lower reaches located along the belt of flow transit and dispersion incurred direct losses from lack of irrigation. However, in this context, hydropower industry experts of countries in the upper reaches attribute the costs and damages from hydropower generation to the states in the lower reaches as if flow is regulated solely for the benefit of irrigation [10, p. 180]. They demanded fees for undelivered services and have received them until recently [5]. Thus, the prevailing circumstances associated with the use and protection of transboundary water is far from being acceptable for the basin states. This is especially important considering available scanty transboundary water resources, which are bound to decrease in the nearest future according to the forecast.

River water quality is also obvious because the rivers have been drinking water sources for the local population since olden times. Therefore, river water quality regulation is an urgent need during the optimization process of water use and water consumption. Recent experience, for example, when water intake from the Syrdarya and Naryn rivers and their tributaries equaled the volume of formed river flow [2], while discharge of return water into them was unlimited, also supports the urgency of actions. Back then, water quality at the outlet from the upper stream (Farkhadski gauging station) did not meet current State Standard of «Drinking water». Therefore, all sites on the left bank of middle reaches and all sites along the lower reaches, with minor exceptions when underground freshwater deposits or freshwater resources of minor rivers were available, did not have access to good quality drinking water.

The above allows for setting a goal of optimization, which comes down to maximally full use of useful properties and purposes of river flow and minimization of resulting or genetically related harmful and hazardous manifestations, especially, deterioration of water quality, destruction of water bodies, degradation of irrigated land and built-up areas, etc [11].

To achieve the goals, it is necessary to optimize the development of the hydrographic network including reservoirs. New reservoirs are needed to organize and provide counter-regulation and outlets of power plants in the total transformation of the hydrological regime to meet the requirements of irrigation and hydropower industry.

The problem of counter-regulation of the power generation regime of river flow in upper reaches into irrigation regime in middle and lower reaches of major rivers was address at Gidroproekt (HydroDesign) Institute in the 1950s – 1970s [1]. Based on the developments of the Institute, Upper Amudarya Integrated Hydrological Network with a water reservoir that has a capacity of about 11–12 $km^3$. However, because of considerable inundated area (about 1,100 $km^2$) including part of «Tigrovaya Balka» Reserve, the construction of this water reservoir still remains a problem.

Less capital-intensive and less problematic option is Kelif Hydrological Network [1]. It comes second to Upper Amudarya Hydrological Network only by 1/3 with respect to energy indicators, but helps to solve the problem of counter-regulation and modernization of water intake sites in middle reaches and adds to their reliability and cost-efficiency.

Amu-Bukhara gravity canal may start from this hydrological network [1], while Karakum is a regulated water intake. From this hydrological network, Afghanistan may be able to develop irrigated agriculture in the northern borderline area.

In this option, off-stream lakes Dengizkul (with a capacity of 3.5 $km^3$) and Sultandag could serve as reservoirs for regulating outlets for power generation facilities on the Vakhsh river.

There will be a need to implement a project for the Right Bank Collector [3] along with the diversion of not only return water from Karshi and Bukhara oases, but also from the Zarafshan river basin.

It is possible that in the middle reaches of the Syrdarya river, there will not be a way to accommodate for energy releases. Then, there will be a need to divert them into North Agitmin off-stream reservoir and out of it into Daryasay in order to irrigate Bukhara oasis or Tuprakkala land tract or Turtkul oasis [12, p. 19–20.].

Right Bank Main Collector as a water inlet of marginal water is designed to improve the reclamation situation between the two rivers [3] in order to ensure their diversion into regional basis of the river flow into the Aral Sea.

This is a general sketch of the scheme for development and modernization of the hydrographic network in the part of the subcontinent in question.

*5. Quota arrangement – tentative scheme*

The quota is, as it is known, a share or allowance of something permissible, whereas the limit is the marginal rate. Differences in these terms are apparently still present. Therefore, we agree that the quota of water (water apportioning) is establishing permissible shares of water resources of water bodies taking into account their carrying capacities for entities, who are water users. The essence of this argument is clearly characterized by the goals and ways to optimize the management of water resources, their use and consumption [13 p. 164–178]. Based on the logic of the given judgments and expectations, produced the first version of the approximate quota of transboundary waters (Table 3). It certainly needs to be reworked by a team of experts to objectively weigh the «pros and cons» before advancing to the level of guiding pre-design document.

Table 3

Tentative water apportioning in the transition period of potentially low-water period, (km3/year)

| Item No. | Water course name, country | Possible quotas in the nearest future | | |
|---|---|---|---|---|
| | | WC) / WI | discharge) of RW into the river | NRCL) |
| 1 | 2 | 3 | 4 | 5 |
| 1 | The Amudarya river basin | 52.4 / 58.4 | 11.4 | 47.0 |
| | Including: | | | |
| 1.1 | Upper reaches | 52.4 / 16.3 | 5.4 | 10.9 |

| | | | | |
|---|---|---|---|---|
| 1.1.a | Pyandzh | 28.2 / 4.8 | 1.5 | 3.2 |
| 1.1.b | Vakhsh | 16.4 / 5.7 | 1.9 | 3.8 |
| 1.1.c | Kafirnigan | 4.2 / 1.3 | 0.4 | 0.8 |
| 1.1.d | Surkhandarya | 3.6 / 4.5 | 1.5 | 3.0 |
| | Of which: | | | |
| 1.1.1 | Afghanistan | 14.1 / 4.8 | 1.5 | 3.2 |
| 1.1.2 | Tajikistan | 33.8 / 6.8 | 2.3 | 4.5 |
| 1.1.3 | Uzbekistan | 3.6 / 4.5 | 1.5 | 3.0 |
| 1.1.4 | Kyrgyzstan | 0.9 / 0.2 | 0.1 | 0.1 |
| 1.2 | Middle reaches | 41.5 / 20.7 | 2.5 | 18.2 |
| | Including: | | | |
| 1.2.a | Karakum canal | – / 10.3 | – | 10.3 |
| 1.2.b | Karshi canal | – / 3.5 | (0.9)[)] | 2.6 |
| 1.2.c | Amu-Bukhara canal | – / 3.7 | (0.9)[)] | 2.8 |
| 1.2.d | Middle Amudarya water management System (Turkmenistan) | – / 3.2 | 0.7 | 2.5 |
| | Of which: | | | |
| 1.2.1 | Turkmenistan | – / 13.5 | 0.7 | 12.8 |
| 1.2.2 | Uzbekistan | – / 7.2 | 1.8[)] | 5.4 |
| 1.3 | Lower reaches | 11.0 / 21.4 | 3.5 | 17.9 |
| | Including: | | | |
| 1.3.a | Tashdhauz canal | – / 7.2 | – | 7.2 |
| 1.3.b | Khorezm | – / 3.6 | 0.9 | 2.7 |
| 1.3.c | South Karakalpakstan | – / 1.8 | 0.4 | 1.4 |
| 1.3.d | Right Bank in North Karakalpakstan | – / 4.4 | 1.1 | 3.3 |
| 1.3.e | Left Bank in North Karakalpakstan | – / 4.7 | 1.1 | 3.3 |
| 1.3.f | Discharge into the Aral Sea | | 2.2 | |
| | Of which: | | | |
| 1.3.1 | Turkmenistan | – / 7.2 | – | 7.2 |
| 1.3.2 | Uzbekistan | 11.0(?) / 14.2 | 4.0(+1.8) | 12.0 |
| 2 | The Syrdarya river basin | 27.2[)] / 39.3 | 14.8 | 24.5 |
| | Including: | | | |
| 2.1 | Upper reaches | (20.1) / 14.1 | 6.9 | 7.2 |
| 2.1.a | Naryn | 11.2 / 3.8 | | |
| 1.2.b | Karadarya | 3.2 / 2.8 | | |
| 1.2.c | Minor (and medium) rivers in Fergana | 8.6 / 7.5 | | |
| | Of which: | | | |
| 2.1.1 | Kyrgyzstan | (20.1) / 3.8 | 1.9 | 1.9 |
| 2.1.2 | Tajikistan | (12.9) / 1.5 | 0.7 | 0.8 |
| 2.1.3 | Uzbekistan | (12.9) / 8.8 | 4.3 | 1.5 |
| 2.2 | Middle Reaches of the Chirchik-Ahangaran-Keles irrigation district, | (18.2) / 12.2 | 5.2 | 7.0 |
| | Including | | | |
| 2.2.a | Tributary along the Syrdarya river | (12.9) | | |
| 2.2.b | Discharge of of the Chirchik-Ahangaran-Keles irrigation district | 5.3 | | |
| | Of which: | | | |
| 2.2.1 | Kazakhstan | 0.5 / 1.8 | 0.5 | 1.3 |
| 2.2.2 | Kyrgyzstan | 2.7 / 0.2 | 0.1 | 0.1 |
| 2.2.3 | Tajikistan | – / 1.0 | 0.2 | 0.8 |
| 2.2.4 | Uzbekistan | 2.1 / 9.2 | 4.4 | 4.8 |

| | | | | |
|---|---|---|---|---|
| 2.3 | Lower reaches | (13.0) / 13.0 | 2.7 | 10.3 |
| | Including: | | | |
| 2.3.a | Tributary along the Syrdarya river | 11.2 / 11.2 | 2.7 | 8.5 |
| 2.3.b | Minor rivers in Karatau | 1.8 / 1.8 | – | 1.8 |
| 2.3.c | Discharge into the Aral Sea | – | 2.7 | – |
| | Of which: | | | |
| 2.3.1 | Kazakhstan | 13.0 / 13.0 | 2.7 | 10.3 |
| 3 | for the southern slope of the Aral Sea basin | 79.6[)] / 97.7 | 26.2 | 71.5 |
| | Including: | | | |
| 3.1 | Afghanistan | 14.1 / 4.8 | 1.5 | 3.2 |
| 3.2 | Kazakhstan | 13.5 / 14.8 | 3.2 | 11.6 |
| 3.3 | Kyrgyzstan | 22.8 / 4.2 | 2.1 | 2.1 |
| 3.4 | Tajikistan | 33.8 / 9.3 | 3.2 | 6.1 |
| 3.5 | Turkmenistan | 20.7 / 20.7 | 0.7 | 20.0 |
| 3.6 | Uzbekistan | 25.0/ 43.9 | 15.5 | 28.4 |
| 3.7 | Discharge into the Aral Sea | | 6.7[)] | |

Notes:
[)] possible magnitude of river flow;
[)] including discharge at the Right Bank collector 1.8 km3 from the middle reaches;
[)] WU – water use;
WI – water intake;
RW – return water;
NRCL – non-returnable consumption and losses.

*Conclusion*

The above data and opinions allowed to propose a water apportioning scheme with respect to transboundary waters considering the expected «normal» flow in the future. However, flow formation usually takes place cyclically and this property will manifest itself clearly in the future. It is possible that the energy factor in the context of global warming will be more powerful, which will, apparently, be reflected in flow formation and causing greater scope of its fluctuations.

Supposedly, the Amudarya river flow will, eventually, amount to 42.2 and 68.2 km$^3$ in the coming years at 90% and 10% availability of the river flow, while the Syrdarya river flow – 19.3 and 33.2 km$^3$, respectively. In general, the amplitude of fluctuations in flow formation will, probably, range from 61.5–101.4 km$^3$/year.

Preliminary estimations of the flow lead to the conclusion that there is a likelihood of severe water shortages when water volume will halve as compared to the «norm» calculated using data from more than hundred-year cycle of observations may occur. This water deficit will affect all sectors of the basin water management systems including both water users (hydropower, recreation, etc.), and water consumers (irrigated agriculture, thermal power systems, etc.). Particular emphasis should be placed on drinking water supply, although even now its condition is a concern in a number of territories.

The expected water management situation strongly requires that we overcome the existing conflicts related to the use of transboundary waters. This, however, is achievable through reasonable and equitable use of existing legal practices over the centuries on the subcontinent and developed international law. All this can only be achieved on a new technological level of water basin systems – water-saving. The introduction of water saving technologies in all sectors of water management systems for arid countries is an urgent need. By the way, if the forecasts for water deficit given in [5] fail to come true, but «countermeasures» are implemented, then released (saved) water resources will find their application in the development of the economies of the basin states and when they reach the ecological wellbeing.

This rough outline is hardly «the ultimate truth.” However, this is a schematic description of initial conditions for overcoming the contradictions between the riparian states – users and consumers of transboundary waters of the subcontinent – in the face of imminent manifestation of global warmingeffect.

The delay in the adoption of «countermeasures» to overcome the effects of the predicted water shortage, the symptoms of which have somehow manifested themselves, is unacceptable, as otherwise possible large-scale disasters or catastrophes are unavoidable. Imminent dangers, can, apparently, be minimized appreciably well in advance.

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