Chapter 8
Assessment of Anthropogenic Load on the Talas River Watershed, Kazakhstan

E. D. Japarkulova and K. E. Kaliyeva

Abstract The analysis of water use features in the Talas River basin was performed. The main indicators of indirect types of anthropogenic impacts on water bodies are considered. The total anthropogenic load within the river basin was estimated based on demographic, agricultural, and industrial components. Agricultural loads are low in the Talas River basin. The average population density in the Talas River basin is 2.76 person/km^2. The level of plowing of the pool on average is 0.79%. The maximum value of the plowing of the territory has low values. The average livestock load in the basin is 0.033 kg goal/km^2, high load is observed throughout the basin. The density of industrial production has an average value of 9.55 thousand dollars/km^2.

Keywords Anthropogenic · Impact · Water bodies · Assessment · Water use · Talas River basin

8.1 Introduction

The objective of this article was to search for reserves to improve the use of water resources based on comparison of total anthropogenic loads with guaranteed water supply of the national economy and natural complexes.

8.1.1 Relevance and Object of Research

The Talas River basin belongs to the Aral Sea basin. The Talas River is mainly formed in Kyrgyzstan in the eponymous intermountain basin. The source of the Talas River is the confluence of the Karakol and Uchkoshoy Rivers at the junction of the Kyrgyz and Talas mountain ranges. Arriving at the plain after traveling through a small gorge, it flows from south to north, splitting into many branches. Further on, in the Sands of Moinkum, the surface flow of water stops and the river is lost in the Sands. The length

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of the river is 661 km, of which 444 km falls within the territory of Kazakhstan. The Talas River basin is divided into two parts—mountain (Taraz) and plain.

Economic activities are a set of factors that cause quantitative and qualitative changes in natural components, and as such, are subject to evaluation and rationing. The urgency of this problem increases due to the growth of negative impacts on the natural environment and the subsequent consequences.

The Talas River basin is located in Zhambyl region, within the sphere of activity of the Shu-Talas basin inspection (BI). Within what is considered the Kazakh part of the Talas River basin, there are six districts of Zhambyl region and the Taraz region, as well as one district of the South Kazakhstan region. The total area of the territory is 1915.1 thousand ha and covers parts of Zhambyl (1772.1 thousand ha), South Kazakhstan (Sozak district 143.0 thousand ha). In general, the Zhambyl region contains approximately 93% of the total area of the basin, and the South Kazakhstan region contains the other approximately 7% [1].

In economic terms, these areas have significant degrees of differentiation from agricultural and industrial to poorly populated and poorly developed (Fig. 8.1).

In this paper, the degree of anthropogenic load on water bodies and on territories of the Talas River basin is estimated on the basis of demographic, agricultural, and industrial components. All areas of the Talas River basin located in the Kazakh part are considered to be the subject of this research.

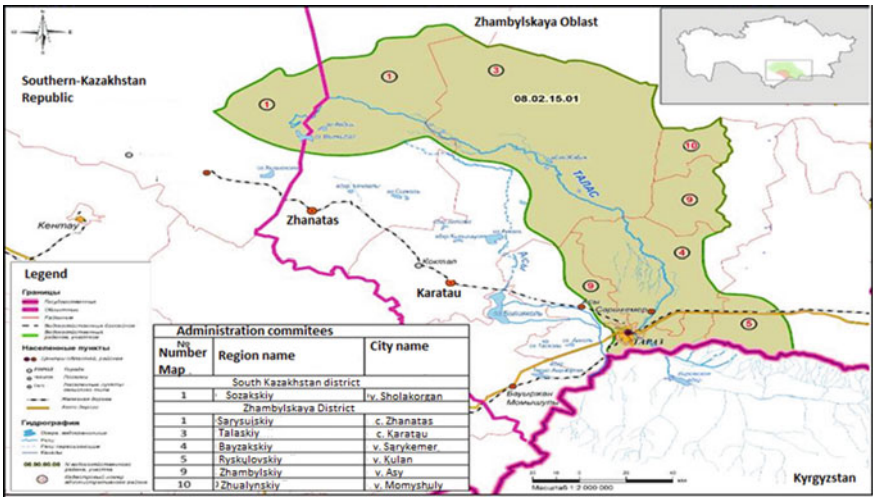

Fig. 8.1 Map-scheme of water management and administrative division of the Talas River basin [2]

8.1.2 Features of Water and Nature Management

The total surface water resources of the territory are under consideration amounts to an average of 808 million m^3 per year. Of these, the water resources form outside of the Republic of Kazakhstan at an annual rate of 716 million m^3 are reduced in low—water years by repeatability 1 time in 4 years ($P = 75\%$) to 637 million m^3, repeatability 1 time in 20 years ($P = 95\%$)—to 529 million m^3. Surface water resources formed in the Republic of Kazakhstan at an annual rate of 92 million m^3 are reduced in low-water years by repeatability 1 time in 4 years ($P = 75\%$) to 72.3 million m^3, repeatability 1 time in 20 years ($P = 95\%$) to 53.5 million m^3. The main source of the rivers of the researched basin is meltwater, specifically the meltwater of seasonal snows. The meltwater of "eternal" snows and glaciers play a significant role in feeding part of the rivers with high-mountain catchments. There are no surface water river tributaries in the Kazakh part of the basin. Therefore, the formation of surface water runoff here is due to the runoff of numerous "Karasu", wedging out channel filtration losses of Talas River water and return irrigation water from irrigation farming basin. It should be noted that the main flow of the Talas River is regulated by the Kirov Reservoir with the long-term goal of regulation being to design volume of filling at the NPU of 520.0 million m^3. The period of intensive filling of the reservoir occurs during the flood season of the Talas River, usually falling between February and April. The territory within Kazakhstan receives runoff according to the Regulations on Water Allocation of Water Resources adopted in 1983. Currently, water allocation limits for vegetation and non-vegetation periods are adopted by the Shu-Talas Interstate Commission [3, 4, 5].

The soil cover of the Talas River basin is characterized by great variety, due to the climatic heterogeneity of the territory, mountain-plain relief, and the presence of groundwater. The diversity of natural and geological conditions causes a complex picture of the distribution of soils and vegetation in the region. It covers a range of landscape zones, from hot and dry deserts to wet Alpine mountain meadows, due to the vertical division of the country, lying in the range from 300 to 4000 m in altitude. Most of the lands having the greatest economic development are located in the areas of low mountains, foothills, and deserts. These areas allow for the division of the pool of soil areas (agricultural areas, as the topography, with geology and moisture conditions determine the possibility of farming, and its systems usage of grassland, etc.).

The soil cover is represented by mountain dark chestnut and light chestnut, gray-earth, light gray-earth, loess and loess loam, meadow-gray-earth, meadow, meadow-marsh, salt marshes, salt flats, takyrovidnymi, and meadow-brown soils. The boundaries of the Talas River basin include the Moynkum sandy area, which occupies up to 30–50% of the basin.

The territory under consideration is considered one of the main industrial and agricultural regions of the Republic, and agriculture significantly affects the entire socioeconomic situation in the region.

The industry of the water management complex of the basin is represented by enterprises of the mining industry and manufacturing industries, producing food products, chemical industry, light, and leather industry.

The total area of agricultural land is 1411.62 thousand ha, including irrigated 55.19 thousand ha. The total fund of developed lands of regular irrigation is 51.06 thousand ha, estuary irrigation 4.13 thousand ha [6].

The population of the territory is 529,248 thousand persons. At the same time, the urban population is about 67.5%, the rural population is about 32.5% [2].

8.2 Research Methods

When characterizing and assessing anthropogenic loads on water bodies, two groups of indicators were taken into account: direct and indirect impact [6]. Direct impacts on water bodies were determined based on the volume of river flow withdrawal.

Indirect impacts on water bodies are manifested in the form of anthropogenic loads on the catchment associated with industrial and agricultural specialization of the economy. Indirect (areal) impacts are important for assessing the intensity of anthropogenic load. As the following parameters were used: population density area (person/km^2); density of industrial production (the volume produced in the region industrial production in thousand USD per 1 km^2) and agricultural development, including plowed (%) and the livestock load (the number of conditional heads of cattle per 1 km^2). The calculations were carried out with reference to the boundaries of the Talas River basin.

Each of these indicators adopted a conventional scale of 8 steps (Table 8.1), which was based on the gradation of the main indicators of anthropogenic load in the author's edition of Isachenko [6]. The applied indicators are grouped by types of anthropogenic impacts: demographic, industrial, and agricultural. The average value of each was estimated as the average level of the corresponding anthropogenic load in the Talas River basin. The agricultural load was obtained as the mean of the score estimates of the intensity of agricultural (plowing) and livestock loads.

8.2.1 Assessment of Anthropogenic Load

The calculations revealed the following features of differentiation of anthropogenic load. The population density within the Talas River basin is an average one (Table 8.2). The average population density in the Talas River basin is 2.76 person/km^2.

Agricultural loads are low in the Talas River basin. The level of plowing of the pool on average is 0.79%. The maximum value of the plowing of the territory has low values. The average livestock load in the basin is 0.033 kg goal/km^2, high load is observed throughout the basin.

Table 8.1 Scale of intensity of anthropogenic load on catchment areas of river basins

Index	The intensity of the load point							
	1	2	3	4	5	6	7	8
	Minor or absent	Very low	Low	Reduced	Average	Elevated	High	Very high
Population density, people/km^2	0.0	<0.10	0.20–1.0	1.10–1.50	5.10–10.00	1.10–25.00	25.10–50.0	>50.0
Density industrial production, thousand Dol/km^2	0.0	<0.35	0.36–3.50	3.60–35.00	36.00–105.0	106.0–140.0	141.0–170.0	>170.0
The plowed, %	0.0	<0.10	0.20–1.0	1.10–1.50	5.10–15.00	15.10–40.0	40.1–60.0	>60.0
Animal load, usl. goal/km^2	0.0	<0.10	0.20–1.0	1.10–2.00	2.10–3.00	3.10–6.0	6.10–10.0	>10.0

Table 8.2 Assessment of anthropogenic load on the catchment area of the Talas river basin

Index	Talas River basin
Total area, thousand km^2	191,51
Population, thousand person	529,248
Population density, person/km^2	2.76
Irrigated land area, thousand hectares	55.19
The plowed, %	0.79
Livestock, thousand heads	632.7
Livestock load, cond. heads/km^2	0.033
Industrial products, thousand dollars	1,828,653,3
Density of industrial production, thousand dollars/km^2	9.55
Available water resources, km^3	0.402
Specific water supply per inhabitant, thousand m^3/person	0.76

The density of industrial production has an average value of 9.55 thousand dollars/km^2. However, the loads associated with industrial production are significantly differentiated by territory and reach their maximum in the middle part of the Talas River, Taraz, where it is estimated as "high." Downstream industrial loads are rated as "reduced."

8.3 Conclusion

The comparative analysis of indirect impact indicators allows for a detailed picture of the total anthropogenic loads, to outline the directions of activities to reduce them. In general, when assessing the intensity of anthropogenic loads, the comparison of relative and specific indicators (such as population density and industrial production, livestock load, plowing of the territory, etc.) increases the objectivity of the results obtained. It allows for the identification of territorial formation patterns and of the functioning of water use systems. Assessment and regulation of anthropogenic loads will allow for the development and proposal of a system of compensatory measures within river basins.

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