Specific features of the use of water resources on the model territories of Russia, Mongolia, China and Kazakhstan in the zone of influence of the Silk and the Tea Roads

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Abstract. Currently, there are a number of major subcontinental and ocean projects on the continental territory of Eurasia and the oceanic area adjacent to it, among which are the Belt and Road Initiative and “Northeast Passage” and “Greater Eurasia” projects. The most actively implemented today, at least in the geopolitical and research contexts, is the Belt and Road megaproject, geographically tied to the Silk Road in its various versions. The Tea Route also falls into the zone of influence of the Silk Road. A common geographical feature of the countries of Greater Eurasia, geographically tied to these land transport corridors, is the unique ultra-continental position of their inner territories, which include a number of subjects of Russia, Mongolia, China and Kazakhstan.

1. Introduction
Within the framework of the presented material, model territories are defined in the zone of influence of the Silk Road and the Tea Road: in Russia - the Altai Republic, Altai Krai, the Republic of Buryatia and Zabaikalsky Krai; in China - Xinjiang Uygur Autonomous Region and Inner Mongolia Autonomous Region; in Kazakhstan - Almaty region and East Kazakhstan region; in Mongolia - Selenge, Dornogovi and Bayan-Olgii aimags. This is due to the fact that these subjects of these countries are border areas and the implementation of the Belt and Road Initiative will have the greatest socio-economic and environmental impact on these territories [1]. In addition, these territories are united by the fact that most of the economically active territory is occupied by agricultural land, which places special demands on the provision of water resources.

2. Models and Methods
For the areas mentioned above, the use of water resources, which are clearly transboundary in nature, is of great importance. The above-mentioned ultra-continentality of the considered territories also makes special demands on the availability and use of water resources for the border areas. Another feature of the model territories is that the specified subjects of the Russian Federation are located downstream of the large water bodies flowing on the subjects of neighboring states bordering on them. The same applies to the model territory of Kazakhstan. All this in aggregate imposes special requirements on the use and reproduction of water resources in these territories.
3. Results and Discussion

3.1. Russia

3.1.1. The Republic of Altai. This republic is rich in water resources, represented by rivers, lakes, glaciers, swamps and groundwater. Large rivers (length over 500 km) are the Katun and Charysh. The major rivers of the republic, the Katun and the Biya, at the confluence form one of the greatest rivers of the world, the Ob river. Long-time average annual river runoff – 34 km$^3$/year. The predicted groundwater resources of the Republic of Altai are 21,369 thousand m$^3$/day. (8.52% of the total predicted groundwater resources of the Siberian Federal District and 2.46% of Russia).

The provision of the republic’s population with river flow resources is 180.795 thousand m$^3$/year per person, which is higher than the average Russian indicator (31.717 thousand m$^3$/year per person) and the indicator of the Siberian Federal District (75.274 thousand m$^3$/year per person). Provision of predicted groundwater resources - 99.316 m$^3$/day per person, which is significantly higher than both the average Russian indicator (5.94 m$^3$/day per person) and the indicator of the federal district (12.984 m$^3$/day per person). Water abstraction from all types of natural sources in the Altai Republic in 2015 amounted to 9.62 million m$^3$. Most of the water is taken from groundwater sources - 6.22 million m$^3$ or 64.66%. Direct water consumption is 8.87 million m$^3$. Most of the water is used for drinking and household needs and irrigation (39.57% and 14.09%, respectively), industrial and agricultural needs account for 9.92% and 2.25%, respectively. The volume of recycled and reused water consumption in the region is 6.26 million m$^3$. Discharge of sewage into water bodies of the Republic of Altai - 3.19 million m$^3$, 87.77% of which are conditionally clean and standard-treated wastewater and 12.23% are polluted and insufficiently treated.

3.1.2. Altai Krai. The water bodies of the region belong to the basin of the largest Russian river - the Ob (70% of the territory), as well as the drainless area between the Ob and Irtysh rivers (30% of the territory). Long-time average annual river runoff is 55.1 km$^3$/year. Due to the uneven distribution of surface water resources, networks of irrigation and irrigation canals have been created in arid regions of the region, the largest of which are the Kulunda and Alei main canals. The predicted groundwater resources of Altai Krai are 3,233 thousand m$^3$/day. (13.25% of the total predicted groundwater resources of the Siberian Federal District and 3.82% - Russia).

Provision of the krai population with resources of river flow is 23.814 thousand m$^3$/year per person, which is lower than the average Russian indicator (31.717 thousand m$^3$/year per person) and the indicator of the Siberian Federal District (75.274 thousand m$^3$/year per a person). Provision of predicted groundwater resources - 13.982 m$^3$/day per a person, which is higher than the average Russian indicator (5.94 m$^3$/day per a person) and the indicator of the federal district (12.984 m$^3$/day per a person).

Water abstraction from all types of natural sources in the Altai Territory is 406.46 million m$^3$. Most of the water is taken from surface water sources - 317.83 million m$^3$ or 78.19%, which is 0.56% of the annual river flow. Direct water consumption - 386.55 million m$^3$. Most of the water is used for production, as well as drinking and household needs (62.15 % and 20.38 %, respectively), the share of water used for irrigation and agricultural needs is 8.94% and 0.75%, respectively. The volume of recycled and reused water consumption in the region is 908.24 million m$^3$ or 70.15 % of the total water consumption of the region. Wastewater discharges into water bodies of the Altai Territory is 287.78 million m$^3$, of which 94.36 % are conditionally clean and standard-treated wastewater and 5.64 % are polluted and not sufficiently treated.

3.1.3. The Republic of Buryatia. More than 50 % of the territory of the republic is located in the basin of Lake Baikal. In accordance with the federal law “On the Protection of Lake Baikal”, this territory became part of the Baikal Natural Territory (BNT), which has a special regime of economic and other activities.
The long-time average annual river runoff is 97.1 km$^3$/year. The predicted groundwater resources of Buryatia are 22,000 thousand m$^3$/day. (8.77 % of the total predicted groundwater resources of the Siberian Federal District and 2.53 % of Russia).

The provision of the republic’s population with river flow resources is 71.772 thousand m$^3$/year per person, which is higher than the average Russian indicator (31.717 thousand m$^3$/year per a person) and the indicator of the Siberian Federal District (75.274 thousand m$^3$/year per a person). Provision of predicted groundwater resources - 22.397 m$^3$/day per a person, which is also higher as the average Russian indicator (5.94 m$^3$/day per a person) and the indicator of the federal district (12.984 m$^3$/day per a person). Water abstraction from all types of natural sources in Buryatia - 563.59 million m$^3$. Most of the water is taken from surface water sources - 485.69 million m$^3$ or 86.18 %, which is 0.69 % of the annual river flow. Direct-flow water consumption - 534.22 million m$^3$. Most of the water used for industrial needs (84.86 %), the share of water used for drinking and household needs, irrigation and agricultural needs is 6.37 %, 5.14 % and 0.51 %, respectively. The volume of recycled and reused water consumption in the region is 292.79 million m$^3$ or 35.4 % of the total water consumption of the region. Discharge of sewage into water bodies of Buryatia - 563.59 million m$^3$, of which 93.04 % are conditionally clean and standard-treated wastewater and 6.96 % are polluted and insufficiently treated.

3.1.4. Zabaikalsky Krai. There are the upper sources of the main waterways of Siberia, the Far East and Central Asia on the territory of the region. This is the source of the Amur, Lena and Yenisei. The most important feature of the western part of the region is its belonging to the lake Baikal basin, declared World Heritage Site. About 55 % of the territory of Zabaikalsky Krai belongs to the Amur, 30.4 % to the Lena and 13.3 % to the Yenisei basins.

The average annual flow of rivers of the region is 65.4 km$^3$, including the Amur basin - 29.0 km$^3$, the Lena basin - 28.9 km$^3$ and the Yenisei basin - 7.5 km$^3$. About 34 % of the total flow of rivers in Zabaikalsky Krai (103.3 km$^3$/year) is formed outside of its borders, mainly in Buryatia, Mongolia and China. The predicted groundwater resources of Zabaikalsky Krai are 5,315 thousand m$^3$/day (2.12 % of the total predicted groundwater resources of the Siberian Federal District and 0.61 % - Russia).

Provision of the population with river flow resources is 61,403 thousand m$^3$/year per a person, which is higher than the average Russian indicator (31.717 thousand m$^3$/year per a person), but lower than the rate of the Siberian Federal District (75.274 thousand m$^3$/year per a person). Provision of predicted groundwater resources - 4,908 m$^3$/day per a person, which is lower than the average Russian indicator (5.94 m$^3$/day per person) and the indicator of the federal district (12.984 m$^3$/day per a person).

Water abstraction from all types of natural sources in Zabaikalsky Krai - 276.07 million m$^3$. Most of the water is taken from surface water sources - 158.17 million m$^3$ or 57.29 %, which is 0.24 % of the annual river flow. Direct-flow water consumption - 229.72 million m$^3$. Most of the water is used for production, as well as drinking and household needs (78.47 % and 20.25 %, respectively), the share of water used for agricultural needs and irrigation is 0.31 % and 0.22 %, respectively.

The volume of recycled and reused water consumption in the region is 1,093.57 million m$^3$ or 82.64 % of the total water consumption of the region. Wastewater discharges into water bodies of the Zabaikalsky Krai - 200.43 million m$^3$, of which 82.32 % are conditionally clean and standard-treated wastewater and 17.68 % are polluted and not sufficiently treated.

3.2. China
3.2.1. Xinjiang Uygur Autonomous Region (XUAR) or East Turkestan is located in the center of the Eurasian continent. The water resources of the XUAR are 930.3 billion m$^3$, of which surface water is 61.76 %, and ground water is 38.24 % [2]. There are 570 rivers on the territory of East Turkestan. The Tarim river with the length of 2,179 km is the drainless river, the largest not only in XUAR, but also in all of China, its basin area is 200 thousand km$^2$, which puts Tarim in fifth place among
the largest rivers that do not have access to the sea. The Irtysh River is the only river of XUAR flowing into the Arctic Ocean. The deepest river of the XUAR is the Ili.

XUAR has considerable glacial resources. It is estimated that there are 18.6 thousand glaciers with a total area of 250 thousand km² in the mountains of Kunlun, Tianshan and Altai, which is 21.6 % of all glacial resources of Asia. Water reserves in these glaciers are estimated at 2,850 billion m³, 60 % of all surface water in the XUAR is replenished by melting glaciers.

XUAR is regarded as a strategic hub, the main region in the framework of the implementation of the construction strategy of the Silk Road Economic Belt (SREB). At the same time, XUAR is the most water-deficient region of the PRC. To cover this deficit, the Black Irtysh-Karamay Canal was built in the XUAR, along which part of the water from the headwaters of the Irtysh is transferred to the area of the oil field near the city of Karamay. Along with the construction of the canal in XUAR, a significant increase in planted areas with water-intensive crops (grain, cotton) is planned. The development project of the western regions of China also includes the construction of canals, reservoirs, dams, hydroelectric power plants and other hydraulic structures (HS). The goal of the Chinese leadership is to transform XUAR into the largest trade and economic center in Central Asia. These plans of the PRC are a matter of special concerns of Kazakhstan and Russia, since the implementation of projects developed by China will lead to an environmental disaster in the Eastern and Central regions of Kazakhstan, an acute water deficit in the Omsk region of the Russian Federation and further shallowing of the Irtysh. As a result, water intake facilities that supply water to cities in Western Siberia may be above water.

A similar situation was on another major transboundary Ili River, which originates in China and flows through the territory of Kazakhstan, where it flows into Lake Balkhash. Like the river Irtysh, the Ili river is also an important source of fresh water for the Republic of Kazakhstan. Today, China carries out water intake from the Ili River in the amount of 3.5 km³/year. However, taking into account China’s plans for the development of the XUAR, an increase in the water intake up to 5 km³/year from the Ili River, providing about 80 % of the water inflow into Lake Balkhash, is expected. This will inevitably lead to a significant shallowing and salinization of the lake, which environmentalists are already predicting today to repeat the fate of the Aral Sea. [3].

According to the structure of water use in XUAR, in 2015 agricultural water supply and irrigation prevail (94.66 %), the area of irrigated land to the total area of the district is 29.8 %, the industry uses only 2.04 % of water, housing and public utilities - 2.29 % and environmental protection - 1.01 % (Table 1) [2].

The volume of wastewater discharged in 2015 was 23.6 million tonnes, which was significantly higher than in 2010 (254.1 million tonnes). In 2010, about 57% of the waste water was treated to standard requirements.

3.2.2. Inner Mongolia Autonomous Region (IMAR). The region is rich in water resources, over 1000 large and small rivers, including the Yellow River, flow through its territory. There are also about 1000 large and small lakes. The total sock of surface water is 67.1 billion cubic meters.

Water resources for 2015 amounted to 537.0 billion m³, of which 64.16 % is surface water, 35.84 % - groundwater. Water resources per capita are 2,141.2 m³/person [2].

Water is mainly used in agriculture (75.44 %), in industry - 10.12 %, for the population - 5.6 % and for environmental protection - 8.84 %. From 18,580.0 million m³, 9,519.0 million m³ was recovered from surface water, 8,830.0 million m³ from underground sources and 230.0 million m³ from other sources.

The discharge of wastewater from 2010 to 2015 increased in IMAR by 2.8 times (Table 1). The main pollutants in 2015 are: COD – 835,600 tons, ammonium nitrogen – 46,900 tons, total nitrogen – 189,300 tons, total phosphorus – 21,500 tons, petroleum products 1,214.8 tons, volatile phenols 150.3 tons, lead 11.9 tons, mercury - 0.038 tons, cadmium - 1.6 tons, arsenic - 19.7 tons, etc. [2].
Table 1. Comparative indicators of water use in model territories of the Russian Federation, China, the Republic of Kazakhstan and Mongolia.

| Indicators                                                                 | The Russian Federation | China | The Republic of Kazakhstan | Mongolia |
|---------------------------------------------------------------------------|-----------------------|-------|----------------------------|----------|
| The average annual volume of all surface water bodies and watercourses, km³/year | 34                    | 55.1  | 97.1                       | 75.6     | 930.3  | 537.0  | 25.13  | 35.92 |
| Average annual precipitation amount, mm                                   | 120- 100- 136- 200- 1,000 2,000 100 600 165 50- 300- 1,000 | 1,500 |
| Water consumption volume, 2015, mln. m³                                   | 9.62 411.90 660.95 276.10 57,720.00 18,580.00 3,473.50 644.60 0.553 5.292 3.644 |
| Water use, total                                                          | 8.87 386.73 534.42 229.90 57,720.00 14,010.00 2,754.00 549.00 |
| Including                                                                 | 3.51 78.78 34.02 45.70 1,320.00 1,040.00 |
| - industry                                                                | 0.88 240.25 453.36 180.00 1,180.00 1,880.00 |
| - agricultural water supply                                              | 3.09 2.75 1.20 54,640.0 14,010.0 |
| - watering                                                                | 1.25 34.54 27.45 |
| - irrigation                                                              | 3.23 30.07 16.84 3.00 580.00 1,640.00 |
| The volume of recycled and reused water                                   | 6.26 908.24 292.79 1,093.57 |
| Volume of polluted water discharge, mln. m³                               | 3.19 287.78 563.59 200.43 999.50 1,108.61 220.80 118.97 |

3.3. Kazakhstan

3.3.1. Almaty region is located in the south-east of Kazakhstan. In the north and northwest there is almost no surface runoff; the only river here is the Ili river, forming a strongly developed marshy delta and flowing into the western part of Lake Balkhash. In the south, the foothills of the river network is relatively dense; most of the rivers originate in the mountains and usually do not reach the river Ili; rivers are lost in the sands or taken up for irrigation. In the mountains there are many small fresh lakes (Big Almaty and others) and mineral springs (Alma-Arasan, etc.). The long-term average annual total river flow in the Almaty region is 25.13 km³/year, for one person 9.3 thousand m³/year for 1 person [4].

3.3.2. East Kazakhstan region (EKR). More than 40% of all water reserves of Kazakhstan are concentrated in the East Kazakhstan region. About 885 rivers more than 10 km long flow on the territory of East Kazakhstan. The main waterway is the Irtysh River with high-water tributaries (4,248 km long, 1,311 km within the region) - the mountain rivers Ulba, Uba, Karakaba, Kaldzhir, Kurchum, Narym, Bukhtarma and others, on which 3 hydroelectric power stations are located - Bukhtarma, Shulbinsk and Ust-Kamenogorsk stations. The long-term average river runoff in the East Kazakhstan region is 35.92 km³/year, and is 23.4 thousand m³ per person. East Kazakhstan is famous for the presence of large reserves of groundwater. The total volume of natural groundwater resources in the mountains is 10 billion m³ [4].
3.4. Mongolia

3.4.1. Bayan-Olgii Aimag. In the northeast the aimag has an administrative border with the Uvs aimag, in the east and southeast with the Khovd aimag, in the north it borders with Russia, in the west, south and southwest with the People's Republic of China. The total area is 45,704.9 km². The aimag is located among the mountains of the Mongolian Altai at an altitude of 1300 meters above sea level. One percent of the entire territory is covered by forests. On the territory of the aimag there are more than 20 small and large lakes, about 400 rivers, streams and sources. Altai-Tavan-Bogd National Park is located within the borders of the aimag. The global watershed passes through the Mongolian Altai: on the south-western slope originates in the river Irtysh, belonging to the basin of the Arctic Ocean, and on the opposite slope originates in the river Khovd, carrying its waters into the drainless lakes of Central Asia.

The main branch of the national economy in the aimag is livestock. There are 11,078 pastoral herding farms engaged in distant pasture cattle breeding, each of which has an average of 133 head of cattle (2006, 2005–120, 2004–117), which is the lowest among all aimags of Mongolia (the national average is 204). According to the 2015 data, the volume of water consumption in the aimag was 0.553 million m³/year.

3.4.2. Selenge aimag. Selenge aimag is located in the very north of Mongolia. Its northern border is also the state border of Mongolia and Russia. The Bulgan aimag is in the west of Selenge, Tov in the south, and Khentii in the east. In the central part of the aimag is the Darkhan aimag, formed in 1994 from 4 somons of the Selenge aimag and the city of the central subordination of Darkhan. At the present time, Selenge consists of 17 somons. The area of the aimag is 41,152.6 km². The population is 95,804 people (at the end of 2010). The population density is 2.33 people/km².

The main industries in the aimag are livestock, crops, mining. The total volume of water consumption according to 2015 data in the aimag was 5.292 million m³/year.

3.4.3. Dornogovi aimag. Dornogov aimag was formed in 1931. The area of the aimag is 109,472 km². The population is 57,930 people (at the end of 2010). The population density is 0.53 people/km². The administrative center of the aimag is Sainshand, where approximately. 20 % of the total population of the aimag. The aimag is subdivided into 14 somons. The volume of water consumption according to the data of 2015 in the aimag was 3,644 million m³/year.

In general, annually renewable water resources in Mongolia make up 35 km³, water supply is 13.5 thousand m³/person in year. The annual water intake is 0.4 km³ (1993), of which 53 % of water is used in agriculture, 27 % in industry, and 20 % in housing and public water supply. More than 80 % of water consumption comes from underground sources.

4. Conclusion

The selected model territories are different in terms of area, population and water consumption indicators. These territories are characterized by mainly agricultural use of water, except for three Russian regions (Altai, Trans-Baikal Territories, the Republic of Buryatia), where water is used mainly for industry purposes.

Unfortunately, it was not possible to study the structure of water consumption in the Mongolian regions. For Russia it is important to study the water consumption of the upstream territories, since basically the river flow comes to Russia from Mongolia, China and Kazakhstan (and from China to Kazakhstan). Taking into account the fact that there are high levels of water consumption in the neighboring countries (with planned increasing), it is necessary to constantly monitor the consumption levels in order to take timely measures. In addition, such combination of these territories within the zone of influence of the Silk and the Tea Roads is considered for the first time, so their in-depth investigation should be continued.
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