Hydrological regime and runoff formation of the Chulym river and its analysis

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Abstract. One of the main problems of hydrology is the formation of rainfall floods and the assessment of the hydrological regime of rivers. Analysis of the factors of river runoff formation helps to calculate the main hydrological characteristics even in the river sections not illuminated by field data. One of the regional methods for calculating hydrological characteristics is the calculation of the dependences of runoff characteristics on the physical and geographical factors of the catchment area. Such calculations are based on the results of generalizing the data of hydrometeorological observations in the design area. There is often a need for runoff characteristics in the design section of the river where there are no field data of hydrometric observations, and this problem is considered in the proposed study. This is the first time this approach has been implemented for the Chulym River. This article examines the analysis of the factors of the river runoff of the Chulym river, which makes it possible to make objective calculations of the main hydrological characteristics in the sections of the rivers not illuminated by field observations.

1. Introduction
The formation of river runoff is a complex process, and its study should be based on the analysis of all influencing factors of the natural environment.

Runoff in hydrology, runoff into the seas and lowering of the relief of rain and melt waters, occurring both along the earth's surface and in the soil. The drainage process is one of the links in the water cycle on Earth. Consequently, river runoff is primarily a product of the climate and affects: change in relief, chemical processes, development of soil cover, distribution of vegetation. The runoff regime depends on: the amount of precipitation, evaporation, temperature conditions, the nature of the relief, soil and vegetation cover.

The study of regional hydrological characteristics is necessary to use regional dependences of runoff characteristics in practice, for example, engineering and hydrological calculations. In addition, of a purely applied nature, the issue of the sufficiency of the volume of observations of hydrometeorological characteristics in the river section for objective accounting of the features of the water and ice regime is being studied. Regional hydrological characteristics are used both in the implementation of economic activities in the riverbed zone, and in the tasks of regulating river flow. Based on these data, it is possible to judge the need to develop the observation network in areas with abrupt changes in characteristics in order to reduce the level of generalization, and vice versa, on the reduction of points in areas with smoothly varying flow conditions [2, 6].
2. Problem statement

Study of the formation and variability of the hydrological regime patterns in the Chulym river basin.

2.1. Water regime of the Chulym river

The Chulym river basin is located in the southwestern part of the Krasnoyarsk Territory, the northern part of the Kemerovo Region and the Tomsk Region. Chulym is formed from the confluence of the White and Black Iyus rivers, which originate in the Kuznetsk Alatau.

By the nature of the water regime of the river, Chulym belongs to the West Siberian type, a distinctive feature of which is a high, extended in time flood, a rather high summer-autumn runoff and a stable low winter low-water period. The rise in the water level begins even with freeze-up in April. The highest levels are observed both with an open channel and with ice phenomena (ice drift, jams). The duration of the flood reaches 3-4 months. The highest annual levels often do not coincide with the highest costs. Rain floods, which are usually observed in autumn, are significantly inferior in volume and height of the level rise to high water. The lowest levels during the open channel period and the lowest summer water discharge are most often observed in September [1-4].

2.2. Conditions for the spring flood formation

Due to the location of the Chulym river basin in various orographic and partly climatic regions, the water regime, especially during the spring flood, is affected by the influence of one region or another [12].

The beginning of the spring flood is usually observed 2-3 days after the steady transition of the average daily air temperature to positive values in the area of the gauging station. The onset of high water in the mountains at an altitude of 1200-1500 m occurs 10-20 days later than in the foothill regions. At the beginning of snowmelt, when the snow cover lies over most of the basin, each subsequent intense warming entails an increasingly significant increase in water discharge. This is due to an increase in the intensity of melting and the inclusion of a larger area of simultaneous melting of higher mountainous zones. A steady decrease in the inflow of melt water occurs when the reduction in the area of snow melting ceases to be compensated by an increase in the inflow of heat.

The snow cover is growing very slowly, reaching an average thickness of less than 30 cm. The low thickness of the snow cover at very low winter temperatures (the average long-term January temperature is from -180 to -220 C), leads to deep freezing of soils, in connection with which individual spots in small valleys, in peaty hummocky bogs, permafrost occurs at a depth of 3-4 m during the whole summer. In most of the rivers in the territory under consideration, floods occur from April to June [4,5,9].

3. Research questions

Relevance of the topic: the research carried out is relevant since such information is needed in the practice of engineering and hydrological calculations, namely, the hydrological characteristics of river flows. Also relevant is the question of the sufficiency of the volume of hydrological observations in the basin of the studied river in order to objectively take into account the features of both the water and ice regime.

Such observations are usually necessary in the implementation of economic activities in the river basin, as well as in the tasks of regulating river flow and warning of rain floods. Therefore, in this study, a scheme was developed for calculating the characteristics of the annual and maximum flow of the Chulym River in the absence of data from hydrometric observations. In addition, an assessment was made of the sufficiency of meteorological stations for carrying out hydrometric observations along the Chulym River. Such a study was carried out for the first time for this basin.
4. Purpose of the study
The purpose of this study is: first, to analyze the hydrological characteristics of the river flow of the Chulym river and, second, to assess the sufficiency of meteorological stations for conducting hydrometric observations on the Chulym river.
To achieve the goal, the following main tasks are solved:

- collect baseline information: annual characteristics of the average annual, maximum and minimum winter runoff at 14 points;
- study and analysis of the factors of river flow formation in the Chulym river basin;
- calculation of the main characteristics of the Chulym river at fourteen observation points;
- construction of regional dependencies of flow characteristics on the Chulym River at 14 points of hydrometric observations.

The study was carried out on the basis of the Federal State Budgetary Institution “Central Siberian UGMS”. The duration of the data series was from 4 to 82 years. The following points were selected for the analysis: 1 - village Kop’yevo, 2 - village Balakhta, 3 - village Krasny Zavod, 4 - village Tegul’det, 5 - village Zyryanskoie, 6 - village Sergeevo, 7 - village Baturino, 8 - B. Iyus, 9 - M. Syya, 10 - Ch. Iyus-Sarala, 11 - village Podsosnoe Nazarov, 12 - n.b.d. Ershovo, 13 - village Kazanka, 14 - village Borsuk [4,7,9].

5. Research methods
When performing this study, the following methods were used: observation method, analogy method, correlation method and regression method.

5.1 Observation method
The observation method makes it possible to assess the variability of the hydrometric characteristics from year to year; therefore, the year-by-year characteristics of the average annual, maximum and minimum winter runoff along the main channel of the Chulym River, as well as the morphometric characteristics of the catchment area were selected. Data collection was carried out on the basis of the Federal State Budgetary Institution “Central Siberian UGMS” in Krasnoyarsk [4,7,9].

As a result of the work on data collection, long-term series of the average annual, maximum and minimum winter runoff of the Chulym River were prepared at 13 points on the Chulym River and one each on the Black and Bely Iyus rivers. The duration of the data series ranged from 4 to 82 years. For each gaging site, the values of the catchment area and the length of the river from the source to the observation point were selected.

5.2 Analogy method
The analogy method allows us to carry out the procedure for bringing the series to a multi-year period, since the length of the series of data on the runoff for most points, according to the current regulatory documents, was not sufficient and did not allow starting directly with statistical processing, therefore, it was necessary to carry out a procedure for bringing the series to a multi-year period.

According to SP 33-101-2003 [10], in case of insufficient data of hydrometric observations, the parameters of the probability distribution curves of hydrological characteristics, as well as the main elements of the calculated hydrograph, must be brought to a long-term period with the involvement of observation data from analogous points.

5.3 Correlation method
When choosing an analogue point, the main criterion is the presence of synchronicity in the fluctuations of the river runoff of the calculated section and the analogous section, which are quantitatively expressed through the coefficient of pair or multiple correlation between the runoff at these points. The calculated
pair correlation coefficients for the runoff characteristics of the Chulym river are presented in tables 1-3.

**Table 1.** Correlation coefficients of the Chulym river average annual flow.

| Point | Kopyevo village settlement | Balakhta | v. Krasny zavod | v. Teguldet | v. Zaryanskoie | v. Sergeev | settlement Baturino | B. Iyus-M. Syya | Ch. Iyus-Sarala | v. Podsosnove | Nazarovo n.b. | v. Ershovo | v. Kazanka | v. Borsuk |
|-------|-----------------------------|----------|-----------------|-------------|----------------|------------|---------------------|-----------------|-----------------|-------------|--------------|------------|-----------|-----------|
| Kopyevo village | 1.00 | 0.95 | 0.84 | 0.62 | 0.68 | 0.76 | 0.64 | 1.80 | 0.91 | 0.90 | 0.74 | 0.77 | 0.72 |
| Balakhta v. Krasny plant | - - | 1.00 | 0.84 | 0.38 | 0.51 | 0.75 | 0.61 | 1.88 | 0.88 | 0.84 | 0.76 | 0.71 | 0.43 | 0.96 |
| v. Teguldet v. Zaryanskoie | - - - | 1.00 | 0.73 | 0.74 | 0.85 | 0.69 | 1.70 | 0.70 | 0.88 | 0.81 | 0.95 | 0.82 | 0.91 |
| v. Sergeev settlement Baturino B. Iyus-M. Syya Ch. Iyus-Sarala v. Podsosnove Nazarovo n.b. v. Ershovo v. Kazanka v. Borsuk | - - - - - - - - 1.00 | 0.70 | 0.54 | 0.58 | 0.66 | 0.64 | 0.56 |
| Kopyevo village | 1.00 | 0.91 | 0.07 | 0.31 | 0.32 | 0.49 | 0.43 | 0.41 | 0.89 | 0.74 | 0.56 | 0.36 | 0.25 | 1.00 |
| Balakhta v. Krasny plant | - - | 1.00 | 0.04 | 0.20 | 0.37 | 0.53 | 0.39 | 0.44 | 0.80 | 0.70 | 0.47 | 0.28 | 0.08 | 0.74 |
| v. Teguldet v. Zaryanskoie v. Sergeev settlement Baturino B. Iyus-M. Syya Ch. Iyus-Sarala v. Podsosnove Nazarovo n.b. v. Ershovo v. Kazanka v. Borsuk | - - - - - - - - 1.00 | 0.77 | 0.44 | 0.47 | 0.41 | 0.48 |
| v. Zaryanskoie v. Sergeev | - - - - - - - - 1.00 | 0.84 | 0.60 | 0.16 | 0.61 | 0.58 | 0.54 | 0.62 | 0.88 |

**Table 2.** Correlation coefficients of the Chulym river maximum flow.

| Point | Kopyevo village settlement | Balakhta | v. Krasny zavod | v. Teguldet | v. Zaryanskoie | v. Sergeev | settlement Baturino B. Iyus-M. Syya Ch. Iyus-Sarala v. Podsosnove Nazarovo n.b. v. Ershovo v. Kazanka v. Borsuk |
|-------|-----------------------------|----------|-----------------|-------------|----------------|------------|---------------------|-----------------|-----------------|-------------|--------------|------------|-----------|-----------|
| Kopyevo village settlement Balakhta | 1.00 | 0.91 | 0.07 | 0.31 | 0.32 | 0.49 | 0.43 | 0.41 | 0.89 | 0.74 | 0.56 | 0.36 | 0.25 | 1.00 |
| v. Krasny plant v. Teguldet v. Zaryanskoie v. Sergeev settlement Baturino B. Iyus-M. Syya Ch. Iyus-Sarala v. Podsosnove Nazarovo n.b. v. Ershovo v. Kazanka v. Borsuk | - - | 1.00 | 0.04 | 0.20 | 0.37 | 0.53 | 0.39 | 0.44 | 0.80 | 0.70 | 0.47 | 0.28 | 0.08 | 0.74 |
| v. Teguldet v. Zaryanskoie v. Sergeev | - - - - - - - - 1.00 | 0.84 | 0.60 | 0.16 | 0.61 | 0.58 | 0.54 | 0.62 | 0.88 |


Table 3. Correlation coefficients of the minimum winter runoff of the Chulym river.

| Point                  | Kopyevo village | settlement Balakhta | v. Krasny zavod | v. Teguldet | v. Zyryanskoe | v. Sergeevo | settlement Baturino | B. Iyus-M. Syya | Ch. Iyus-Sarala | v. Podosnoe | Nazarovo n.b. | v. Ershovo | v. Kazanka | v. Borsuk |
|------------------------|-----------------|---------------------|-----------------|-------------|---------------|-------------|--------------------|----------------|----------------|-------------|---------------|-------------|-------------|-----------|
| Kopyevo village        | 1.00            | 0.65                | 0.73            | 0.25        | 0.36          | 0.74        | 0.19               | 0.54           | 0.72           | 0.59        | 0.27          | 0.16        | 0.57        | -         |
| settlement Balakhta    | -               | 1.00                | 0.60            | 0.34        | 0.35          | 0.63        | 0.21               | 0.47           | 0.61           | 0.60        | 0.13          | 0.46        | -           | 0.66      |
| v. Krasny zavod        | -               | -                   | 1.00            | 0.46        | 0.65          | 0.75        | 0.18               | 0.49           | 0.62           | 0.35        | 0.29          | 0.21        | 0.55        | 0.26      |
| v. Teguldet            | -               | -                   | -               | 1.00        | 0.40          | 0.83        | 0.26               | 0.38           | 0.52           | 0.27        | 0.21          | 0.32        | 0.25        | -         |
| v. Zyryanskoe          | -               | -                   | -               | -           | 1.00          | 0.56        | 0.06               | 0.25           | 0.42           | 0.10        | 0.14          | 0.10        | 0.13        | 0.90      |
| v. Sergeevo            | -               | -                   | -               | -           | -             | 1.00        | 0.45               | 0.35           | 0.75           | 0.70        | 0.40          | 0.73        | -           | -         |
| settlement Baturino    | -               | -                   | -               | -           | -             | -           | 1.00               | 0.12           | 0.11           | 0.11        | 0.13          | -           | -           | -         |
| B. Iyus-M. Syya        | -               | -                   | -               | -           | -             | -           | -                  | 1.00           | 0.44           | 0.42        | 0.34          | 0.12        | 0.26        | -         |
| Ch. Iyus-Sarala        | -               | -                   | -               | -           | -             | -           | -                  | -              | 1.00           | 0.65        | 0.21          | 0.51        | 0.51        | 0.62      |
| v. Podosnoe            | -               | -                   | -               | -           | -             | -           | -                  | -              | -              | 1.00        | 0.26          | 0.27        | 0.24        | -         |
| Nazarovo n.b.          | -               | -                   | -               | -           | -             | -           | -                  | -              | -              | -           | 1.00          | 0.31        | 0.07        | -         |
| v. Ershovo             | -               | -                   | -               | -           | -             | -           | -                  | -              | -              | -           | -             | 1.00        | -           | 0.11      |
| v. Kazanka             | -               | -                   | -               | -           | -             | -           | -                  | -              | -              | -           | -             | -           | 1.00        | -         |
| v. Borsuk              | -               | -                   | -               | -           | -             | -           | -                  | -              | -              | -           | -             | -           | -           | 1.00      |

The calculations presented in tables 1, 2, 3 show the presence of a tight relationship between the runoff characteristics and the possibility of bringing the series to a long-term period, to a greater extent, for the average annual runoff and, to a lesser extent, for the maximum and minimum low-water runoff.
5.4 Analytical method. Regression analysis

When choosing analogues, one should take into account both the longest possible duration of observations at these points, and closer connections between the runoff at the point reduced to a multiyear period and the runoff at the analogous points.

When calculating the distribution parameters and runoff values for individual years Qᵢ, analytical methods based on regression analysis were used similarly to [8,9]. Moreover, with such an analysis, the following conditions must be met:

\[ n' \geq (6-10); R \geq R_{cr} \]

where: \( n' \) - the number of joint years of observations at the given point and points-analogues (\( n' \geq 6 \) with one analogue, \( n' \geq 10 \) with two or more analogues) or the number of points-analogues when recovering with the involvement of short-term observations (\( n' \geq 6 \));

\( R \) is the coefficient of paired or multiple correlation between the flow values of the investigated river and the flow values at the analogue points;

\( R_{cr} \) is the critical value of the pair or multiple correlation coefficient (usually set \( \geq 0.7 \)).

Regional dependences of the flow characteristics of the Chulym river on hydrographic characteristics are obtained in this work.

\[ Q'_i = (Q_i - Q_n)/R + Q_n, \]

where: \( Q'_i \) - annual values of hydrological characteristics calculated by the regression equation;

\( Q_n \) is the average value of the given series for the period compatible with the analogue point.

The obtained linear equations for the reconstruction of data series are given in tables 4-6.

### Table 4. Recovery of the average annual flow.

| Point        | Analogue point       | Observation period | Equation                     |
|--------------|----------------------|--------------------|------------------------------|
| Kazanka      | Krasny zavod         | 1952-1961          | QK=0.816*QK+19.12            |
| Borsuk       | Balakhta             | 1939-2016          | QB=0.872*QB+35.6             |
| Ershovo      | Krasny zavod         | 1952-1996          | QE=0.730*QE+10.48            |
|              | Zyryanskoe           | 1931-1951          | QE=0.168*QE+41.63            |
| Nazarovo     | Krasny zavod         | 1952-2014          | QH=0.5836*QH+41.374          |
| Podsoesnoe   | Kopyevo              | 1962-1996          | QPI=1.6838*QK+46.063        |
|              | Balakhta             | 1939-1961          | QPI=0.3197*QB+107.02         |
| Ch. Iyus-Sarala | Balakhta             | 1939-1958          | QH=0.0243*QB+50.896          |
| B. Iyus-M. Syya  | Balakhta             | 1939-1951          | QB=0.4824*QB+7.4866         |
|              | Kopyevo              | 2010-2016          | QB=0.4389*QB+5.7849          |
| Baturino     | Sergeevo             | 1957-1970          | QB=1.0972*QC+126.41          |
|              | Tegulde              | 1932-1957          | QB=2.0674*QT+186.9           |
| Sergeevo     | Zyryanskoe           | 1931-2016          | QC=1.1032*QH+33.517          |
| Krasny zavod | Balakhta             | 1939-1951          | QB=1.7499*QB+8.5876         |
| Balakhta     | Krasny zavod         | 1992-2013          | QB=1.7499*Q+8.5876          |
| Kopyevo      | Balakhta             | 1939-1961          | QB=0.8815*Q+8.5689           |

### Table 5. Restoring maximum flow.

| Point        | Analogue point       | Observation period | Equation                     |
|--------------|----------------------|--------------------|------------------------------|
| Borsuk       | Zyryanskoe           | 1931-2016          | QB=0.3386*Q3-262.85          |
| Kazanka      | Nazarovo             | 1956-2013          | QB=1.0327*QH+96.191          |
| Ershovo      | Nazarovo             | 1956-1978          | QE=1.0741*QH+20.931          |
| Sergeevo     | Zyryanskoe           | 1931-2016          | QC=1.1082*Q3-25.404          |
| Podsoesnoe   | Kopyevo              | 1961-1995          | QPI=0.7007*QB+156.8          |
| Ch. Iyus-Sarala | Balakhta             | 1939-1958          | QH=0.7266*QB+25.848          |
| Baturino     | Sergeevo             | 1957-1970          | QB=1.0581*QC+444.75          |
Kopyevo Balakhta 1939-2000 QК=0.7273*QБ+97.177
Balakhta Kopyevo 1992-2012 QБ=0.7273*QК+97.177

Table 6. Restoring the minimum winter runoff.

| Point          | Analogue point       | Observation period | Equation         |
|----------------|----------------------|--------------------|------------------|
| Borsuk         | Zyryanskoe           | 1931-2016          | QB=0.2711*QЗ-15.104 |
| Sergeevo       | Teguldet             | 1932-2016          | QC=1.582*QT+49.892 |
| Ershovo        | Sergeevo             | 1958-1980          | QE=0.1649*QC+3.0182 |
| Kopyevo        | Krasny zavod         | 1952-1961          | QK=1.5532*QК+7.97 |

6. Findings
Analysis of the original recovered data and the ability to build dependencies.

6.1. Analysis of the average annual flow of the Chulym river before and after recovery.
Based on the initial and reconstructed series of mean annual water discharge, the mean runoff modules for a long-term period were determined and correlated with the catchment area and river length.

6.1.1. Analysis of the dependence of the mean annual flow modulus on the catchment area and river length according to the initial data before restoration.

Table 7. Average annual flow of the Chulym river (m$^3$/s).

| Hydrological posts                  | Year | v. Kopyevo | settlement Balakhta | v. Krasny zavod | v. Teguldet | v. Zyryanskoe | v. Sergeevo | settlement Baturino | B. Iyus-M. Syya | Ch. Iyus-Sarala | v. Podkosev | Nazarov n.b. | v. Ershovo | v. Kazanka | v. Legostaevo | v. Borsuk |
|-------------------------------------|------|------------|---------------------|-----------------|-------------|---------------|-------------|---------------------|-----------------|---------------|-------------|-------------|------------|-----------|-------------|------------|
| F km$^2$                            | 9990 | 14700      | 33800               | 55300           | 92500       | 1099013100   | 0           | 0                   | 3520            | 3100          | 1730        | 24600      | 5270       | 3200      | 1280        | 16800      |
| L from source, km                   | 11   | 194        | 619                 | 1201            | 1426        | 1519          | 1663        | -124                | -52             | 299           | 419         | 517        | 529        | 125        | 295        |
| M medium, l/s$^*$km before restoration | 9.51 | 6.80       | 5.47                | 5.29            | 6.15        | 5.89          | 6.00        | 12.50               | 16.19           | 6.85          | 4.82        | 5.98       | 5.42       | 7.17       | 7.31       |
| M medium, l/s$^*$km after restoration| 9.65 | 9.26       | 5.45                | 5.29            | 6.15        | 6.05          | 6.24        | 12.41               | 16.2            | 7.28          | 5.35        | 5.54       | 5.3        | 7.17       | 7.3        |

Analysis results:
1. The Chyorny Iyus is deeper than the White Iyus.
2. There are no observations in the upper reaches of the river. Chyorny Iyus in the area of the largest flow modules (over 171 l/s km$^2$).
3. The measured characteristics of the annual runoff on the river Chulym near Nazarovo are more objective than the characteristics of the runoff near the village of Ershovo, since between Ershovo and Kazanka flows into the more full-flowing (in specific section) river Uryup and the weighted average runoff module should increase in this section. According to the observations, an inverse relationship can be traced.
4. There is no need to organize monitoring of the runoff in the extended section of the Krasny Zavod - Teguldet since the runoff characteristics change little here.

5. Since on the site from Teguldet to the village Zyryanskiy river flows into the Kiya, then the relationship between the annual flow module and the catchment area may not be linear, but stepwise. In this regard, it is recommended to organize monitoring of the runoff above the mouth of the river Kiya.

6. There is no need to organize runoff observations in the area downstream from the village Baturino to the mouth.

6.1.2. Analysis of the dependence of the mean annual flow modulus on the catchment area and river length according to the initial data after restoration. Analysis results:

1. After recovery, the runoff module in B. Iyus - M. Syya decreased (12.50-12.41); in Ch. Iyus-Sarala it slightly increased (16.19-16.2).

2. There are no observations in the upper reaches of the Iyus-Sarala rivers in the area of the highest flow modulus (over 17 l / s * km²).

3. At the Kopyovo-Balakhta section, a change in the runoff modulus (l / s * km²) is visible, at Balakhta it has become much higher, the average annual runoff has become approximately the same in this section (9.65 -9.26).

4. Before restoration, the village of Borsuk had an obvious deviation due to lack of observational data, now the module (l / s * km²) is approximately the same.

5. Between the village of Ershovo and the village of Kazanka, the more full-flowing Uryup river flows into and the weighted average runoff module should increase in this section, but the data is inverse.

6. On the section from the village of Teguldet to the village of Zyryanskoe the river Kiya flows into, then the module connection may not be linear, but stepwise.

Similar analyses were carried out for the maximum and minimum flows of the Chulym River.

The obtained dependences are primarily necessary for calculating the hydrological characteristics in the river sections that are not illuminated by direct observations. However, they also allow for a cumulative assessment of the variability of runoff characteristics along the Chulym river and the detail of its accounting if it is possible to calculate and predict hydrological characteristics.

7. Conclusion

On the basis of long-term observations of the Chulym river flow on the territory of the Republic of Khakassia, Krasnoyarsk Territory and Tomsk Region and analysis of the factors of flow formation, for the first time, a regional calculated dependence of the characteristics of the annual and maximum flow on the catchment area and the length of the river has been developed. The runoff modulus increases from the mouth to the source, and the greatest change in runoff characteristics is observed when the river leaves the mountains to the plain.

The dependence allows to determine the characteristics of the flow along the entire river bed. To calculate the characteristics of the winter low-water season, the approach is implemented with a large error and cannot be applied.

The revealed features of the distribution of runoff characteristics along the Chulym channel made it possible to formulate a number of proposals for the reorganization of the observational network.

Based on the analysis of the results obtained, the following proposals can be made for reorganizing the network of hydrometric observations:

1. Organize additional runoff observations on the Cherny-Iyus river above the section of the Sarala settlement, in the area of the highest runoff modules for the Chulym basin;

2. Due to the fact that from village Teguldet to the village Zyryansky, the Kiya river flows into the Chulym, and the relationship between the annual and maximum runoff modulus from the catchment area may not be linear, but a stepwise one, it is recommended to organize monitoring of the runoff immediately above the mouth of the Kiya.
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