Suspended sediment runoff and soil washout intensity in the Chirchiq-Ohangaron rivers basin

Fazliddin Khikmatov[1], Oyjamol Kholtojiyeva[2], Bekzod Khikmatov[3], Komiljon Rakhmonov[4]

[1.]Department of Surface hydrology and meteorology, National University of Uzbekistan,
Email: hikmatov_f@mail.ru
[2.]Department of Surface hydrology and meteorology, National University of Uzbekistan,
Email: oyjamolxoltojiyeva@gmail.com
[3.]Institute of Civil Protection of the Ministry of Emergency Situations of the Republic of Uzbekistan, Email: fvvfmi@umail.uz
[4.]Department of Surface hydrology and meteorology, National University of Uzbekistan, Email: komiljons@mail.ru

Abstract. This article addresses the study of suspended sediment flow and the assessment of soil washout intensity from the mountain river basins of the Chirchiq–Ohangaron region. Data on suspended sediment runoff from rivers were used as the primary source material. The study also evaluates the contributions of seasonal atmospheric precipitation and air temperature to the formation of suspended sediment runoff in mountain rivers. Calculation nomograms are proposed for the quantitative assessment of suspended sediment runoff, developed on the basis of normalized regression equations that describe the relationship between suspended sediment runoff and hydrometeorological factors. The quantitative indicators of hydrological variables characterizing the intensity of soil washout from river basins have been refined through testing of the calculation nomograms. Furthermore, the long-term average values of suspended sediment runoff have been determined, including sediment volume norms, flushing modulus, erosion meter and other related parameters.
[Fazliddin Khikmatov, Oyjamol Kholtojiyeva, Bekzod Khikmatov, Komiljon Rakhmonov. **Suspended sediment runoff and soil washout intensity in the Chirchiq-Ohangaron rivers basin.** *World Rural Observation* 2026;18(2):9-17]. ISSN: 1944-6543 (Print); ISSN: 1944-6551 (Online). http://www.sciencepub.net/rural. 02. doi:10.7537/marswro180226.02

Keywords: river; water flow; suspended sediment; sediment load; flushing modulus; flushing layer; erosion meter.

Introduction

As a result of global climate change occurring on a global scale, there is an increase in the area of arid territories and an increase in the intensity of soil erosion. As stated in studies carried out by foreign experts, "... with population growth, the potential of agricultural production simultaneously decreases, this is facilitated by a decrease in soil fertility as a result of water erosion and inefficient use of agro-climatic resources, primarily the reason for this is the incorrect specialization of territories by agricultural sectors[1]. This situation indicates the need to study the mechanism of the formation of suspended sediment runoff in mountain rivers and improve methods for assessing the intensity of soil washout from the surface of river basins.

Priority attention in the world is given to research in this area, in particular, water erosion and the study of the features of the formation of suspended river runoff, and the improvement of methods for their assessment. Therefore, today the improvement of methods for assessing the intensity of soil washout from the surface of mountain river catchments and, on this basis, the design of irrigation systems, hydraulic structures and other utilities, their construction and efficient operation, in the future the phased development of land-water and water-energy resources of mountain territories of arid countries, as well as the development of long-term plans for their optimal use are pressing issues.

The republic is implementing several activities aimed at developing agricultural production, rational use of the country's land and water resources, effective use of water and hydropower resources of small rivers and watercourses, construction of small reservoirs, and significant positive results have been achieved. The Action Strategy for five priority areas of development of the Republic of Uzbekistan identifies as important the tasks of "improving the reclamation conditions of irrigated lands, introducing modern technologies for saving water and water resources in the field of agricultural production"[2]. In this regard, in particular, scientific research aimed at studying the hydrological regime and the flow of suspended sediment of mountain rivers, and improving methods for calculating their

[1] An Introduction to Water Erosion Control, December 2017.
[2] Decree of the President of the Republic of Uzbekistan No. PF-4947 of February 7, 2017 "On the Action Strategy for the further development of the Republic of Uzbekistan"

hydrological characteristics, are of great importance.

The study of the hydrological regime of the suspended flows of mountain rivers is of great scientific and practical importance. The scientific significance of the issue is that the results of the study of the flow of river discharges allow us determine the laws of the water erosion process in their basins and to reconstruct the terrain of mountainous regions based on them. The practical importance of research in this direction is also very great. In particular, the flow of suspended effluents largely affects the formation of riverbeds, the speed at which reservoirs are filled with turbid effluents and the mode of operation of hydro-technical facilities. Taking into account the presence of Ohangaron, Tuyabogiz and Chorbog reservoirs built to improve the water supply of the irrigated lands of the Tashkent region in the studied Chirchiq-Ohangaron basin, the importance of the issue under consideration in the case is more clearly visible.

It is also known that the question of the methodology for mapping sediment runoff - an indicator of the intensity of washout from the surface of mountain river basins, was widely raised by her in the 60s of the last century in connection with the creation of a series of complex atlases of Azerbaijan, Armenia, Georgia, Tajikistan and Uzbekistan [*Sheglova*, 1984]. During these years, M. Huang [*Huang*, et al., 2021], M. Hotono and K.Yashemura [*Hotono, Yashemura,* 2020] studied in detail the compatibility of maps of river turbidity and the intensity of soil loss from the surface of mountain river basins with other maps of natural elements. Furthermore, A.N.Vazhnov and S.G. Musoyan pointed out that when constructing soil washout maps, it is advisable to consider their altitudinal zones separately, using the results of actual observations of suspended sediment runoff [*Vazhnov, Musoyan,* 1975].

Along with the above, the research of V.L. Shults, O.P. Sheglova , K.R. Rakhmonov, H.N. Magdiev, S. Abdullayev, M. Juliev etc., is devoted to the analysis and mapping of the genesis of the formation of suspended sediments - a product of the process of soil and soil washing from river basins. However, the studies of these scientists did not pay sufficient attention to the issues of assessing and mapping the intensity of water erosion in the basins of mountain rivers of Uzbekistan based on the values of the erosion modulus.

Research materials and methods

Research objectives: to investigate the process of formation of suspended sediment runoff in rivers depending on hydrological and meteorological factors; determination of average long-term values, that is, norms of hydrological indicators - flow rates and volumes of suspended sediment runoff, washout module, washout layer and others, characterizing the intensity of soil washout from the surface of river basins; improvement of existing methods for quantitative assessment of the intensity of soil washout from river basins, taking into account the influence of meteorological factors on them; identification of features of the distribution of the intensity of soil washout from river basins in altitudinal zones; mapping the intensity of soil washout from river basins, taking into account the peculiarities of their changes according to altitudinal zones.

The object of the study is the mountain rivers of the Chirchiq-Ohangaron basin and the flow of suspended sediment from these rivers.

The subject of the study is to identify the features of the process of soil washout from the surface of mountain river basins and the formation of suspended sediment runoff, as well as the improvement of methods for quantitative assessment of hydrological quantities characterizing these processes.

Research methods. The work used special methods of hydrological calculations and forecasts, hydrological analogy, geographical generalization, statistical mathematics, in particular, an objective method of leveling and normalizing correlations and others.

The main goal of the research work is to statistically evaluate the relationship between the suspended flows of mountain rivers in the Chirchiq-Ohangaron basin and the meteorological factors affecting their formation. To achieve this goal, the following tasks were defined and found their solution in the work: 1) selection of hydrological stations that monitor the natural water regime of the rivers of the Chirchiq-Ohangaron basin, collecting, primary processing, generalization of the data on the measured water and suspended effluents; 2) selection of representative meteorological observation points, collection of atmospheric precipitation and air temperature data measured at them, their primary processing, creation of a database; 3) statistical assessment of pairwise and polynomial correlations between the flow rates of rivers and climatic factors.

The Chirchiq-Ohangaron basin stands out from other river basins of Uzbekistan due to its well-studied natural conditions, including the geological structure of the land surface, relief, orography, soil and climatic conditions, plant life, hydrography, etc. The Chirchiq-Ohangaron basin, which was selected as a research object, is bounded by Kurama and Chotkal mountain ranges in the south and east, Talas Olatovi in the north, and Ugom and their branches in the northwest, as described by V.L. Shults [*Shults*, 1965]. In the southwest, the border of the basin can be passed through the Syrdarya basin. It is known that the main part of the basin is located in the Tashkent region of Uzbekistan, and the rest is located on the borders of the republics of Kazakhstan and Kyrgyzstan. Chirchiq and Ohangaron rivers are relatively large right tributaries of Syrdarya, which consist of two independent basins.

The mountains in the valleys of Chirchiq and Ohangaron are composed of rocks of the Paleozoic, Mesozoic and Cenozoic eras. In the mountains, granite, Paleozoic limestone, sandstone and alluvial rocks, and in the foothills and river valleys, gravel, sand and clay layers of the Paleogene, Neogene and Anthropogenic geological periods are widespread, and they are prone to washing. This situation is especially typical for the Ugom, Navolisoy, Aksokotasoy, Mazarsoy, Shovvasoy, Okchasoy, Dukantsoy basins.

The relief of the Chirchiq-Ohangaron basin has a rather complex appearance. The topography of the basin can be conditionally divided into two parts, i.e. mountainous and plain. The height of some peaks in the mountainous part of the basin, including Chimyon, is greater than 3000 meters and even 4000 meters in Qizilnura.

Since the western side of the Chirchiq-Akhangaron basin is open to humid air currents coming from this direction, the catchment areas of both basins are very rich in water. The catchment area of the basin is bounded by the Talas Alatov Range and its southwestern branches, which are relatively high in the east. The saturation conditions and hydrological regime of the rivers in the basin depend mainly on these and the above-mentioned mountain ranges and the general shape, heights and orientations of their branches (Figure 1).

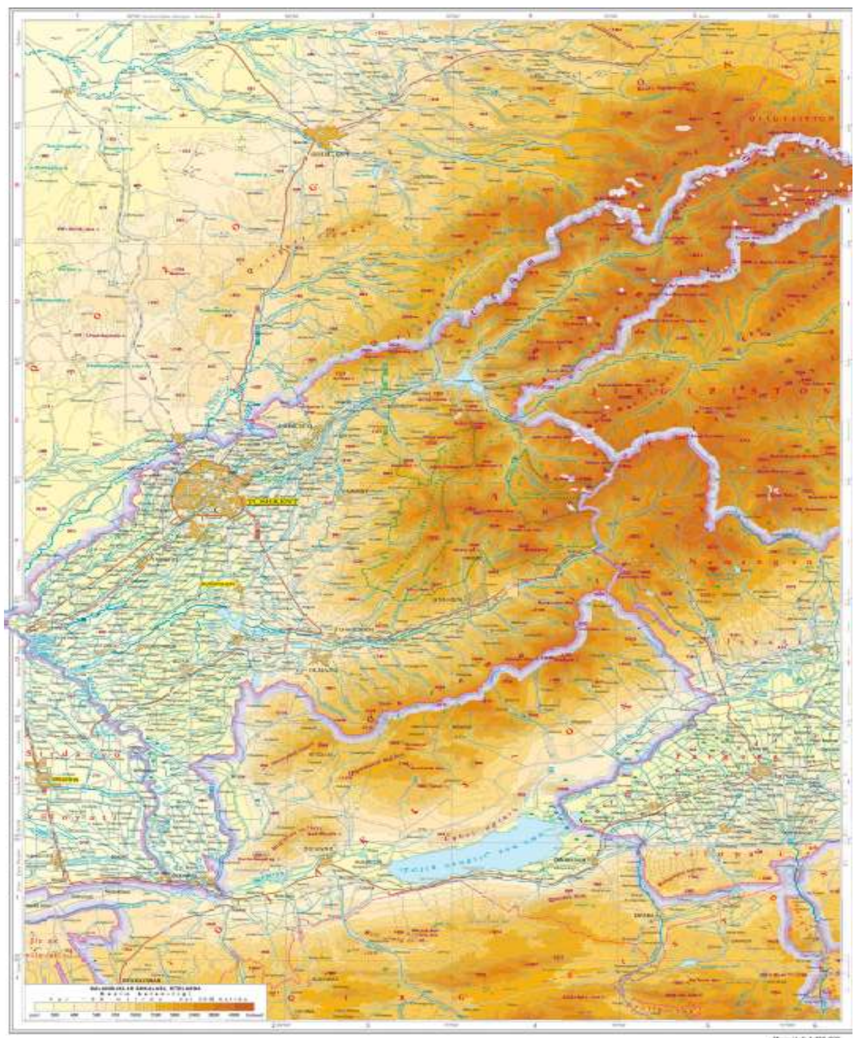

Fig. 1. Natural map of the Chirchiq-Ohangaron basin.

The highest values of the number of hydrological stations in the basin studied in the study fall on the years 1961-1965. During these observation periods, 51 hydrological monitoring stations operated in the Chirchiq-Ohangaron basin. However, in recent years, especially from 1981-1990, the number of hydrological stations in the basin, the type of observations at them, and, accordingly, the volume of work performed, began to decrease. In general, continuous hydrological monitoring in the basin continued. It should be noted that in the Chirchiq-Ohangaron basin, in addition to rivers, hydrological posts have been established on 8 canals, including Bozsuv, Karasuv, Khafiz Polvonov, Tashkent, Hamdam, and Parkent, and continuous monitoring has been established there. All of them are under the control of the Ministry of Water Resources of the Republic of Uzbekistan. Also, in hydrological studies, it is more convenient to combine these two river basins into one basin based on the experiences of V. L. Shults [*Shults*, 1965], A. R. Rasulov [*Rasulov*, 1991] and others (Table 1).

Table 1. Basic hydrological indicators of rivers

№	Rivers	Water catchment area, F, km^2	The average height of the basin $H_{mean.}$, м	Years of observation	
				Water flow	Suspended sediment flow
1	Chotqol	6580	2660	1965-2020	1965-2020
2	Piskom	2540	2740	1965-2020	1965-2020
3	Oygaing	1010	3010	1950-2015	1934-1992
4	Chiralma	103	2700	1934-2015	1934-1992
5	Maydontol	471	3130	1934-2015	1934-1992
6	Ugom	869	2030	1950-2020	1950-2020
7	Ohangaron	1110	1169	1971-2020	1971-2020
8	Qizilcha	51,6	2340	1951-2020	1967-1992
9	Nishboshsoy	141	2050	1951-2020	1962-1992
10	Jiblansoy	19	1960	1981-2020	1981-2020
11	Dukantsoy	201	2210	1971-2020	1973-1992
12	Qorabogsoy	166	1031	1949-2020	1962-2020
13	Shaugazsoy	65,8	1660	1951-2020	1962-1992
14	Abjazsoy	70,5	1590	1978-2020	1980-2020

Research result and discussion

Atmospheric precipitation is unevenly distributed in the Chirchiq-Ohangaron basin, as in all mountainous regions of Central Asia. This situation is reflected in the distribution of rainfall over the area of the basin and seasonally and monthly throughout the year. The least precipitation falls on the southwestern part of the basin. The annual rainfall in these areas is 250-300 mm. The amount of precipitation increases towards the northeast side of the basin. An average of 850 mm of rain was recorded at the Piskom meteorological station. In the highlands of the Piskom Valley, the annual rainfall is 1800 mm and more (Table 2). Precipitation is also unevenly distributed over the seasons. 40-45% of annual precipitation falls in spring, 5-10% in summer, 20-25% in autumn, and 30-35% in winter. March is characterized by a large amount of precipitation. For this purpose, using the example of the Chirchiq-Ohangaron rivers basin, based on the materials of meteorological observation points carried out in their basins, changes in precipitation and air temperature with the altitude of the area are considered (Figures 2 and 3).

Table 2. Variation of atmospheric precipitation and air temperature with height observed at meteorological observation points located in the basin

№	Meteorological station	Year of observation	Altitude	Average precipitation	Average air temperature
1	Dalverzin	1928	289	324	14,9
2	Bekobod	1910	300	326	14,6
3	Kokorol	1933	340	353	13,7
4	Yangiyol	1926	344	333	14,3
5	Toytepa	1937	388	397	14,3
6	Oqqorgon	1966	399	340	14,7
7	Tuyabuguz	1963	404	396	14,8
8	Bo'zsuv	1923	473	414	15
9	Tashkent	1867	477	419	14,2
10	Olmaliq	1978	507	463	15
11	Chorbog	1926	832	772	13,6
12	Angren	1909	942	598	13,2
13	Piskom	1932	1258	871	9,46
14	Boshqizilsoy	1959	1277	804	11,1
15	Soqoq	1961	1351	855	11,4
16	Chimyon	1983	1670	944	8,7
17	Dukant	1958	2001	922	7,9
18	Qizilcha	-	2075	1005	5,9

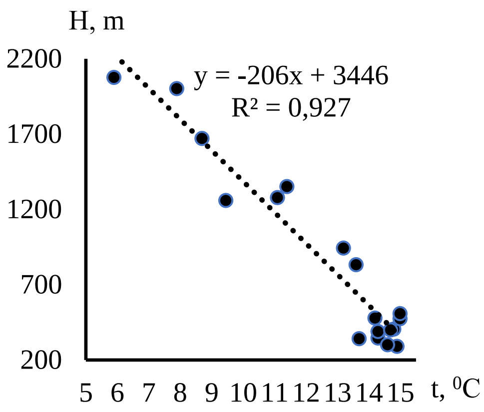

Fig.2. Changes in air temperature with height in the Chirchiq-Ohangaron basin

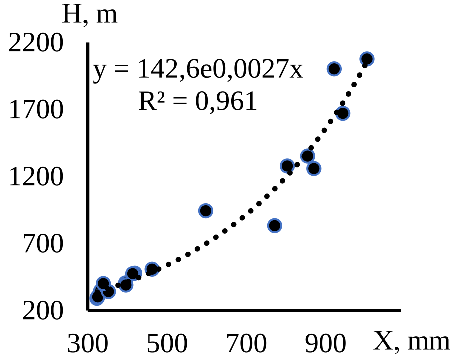

Fig.3. Changes in atmospheric precipitation with altitude in the Chirchiq-Ohangaron basin

The connections between suspended sediment runoff and water flow rates are considered using the example of all river basins selected as the object of study. Based on observation data at hydrological posts of the rivers under study, paired correlation coefficients were calculated, characterizing the closeness of the relationship between the average annual flow of suspended sediment and water flows, and an analysis of the results obtained was carried out. For example, calculated for the Chatkal River based on observation data at the hydrological station at the mouth of the Khudaidadsay River, the value of the pair correlation coefficient, expressing the closeness of the relationship of the type R=f(Q), is equal to 0,876 and its error was ±0,022 (Fig. 4).
Based on the graphs, regression equations representing the dependence of water and suspended solids consumption of rivers were obtained and their accuracy was evaluated (Table 3). Based on these equations, discontinuities in the flow data of the mountain rivers in the Chirchiq-Ohangaron basin were restored and brought to a single meaning.

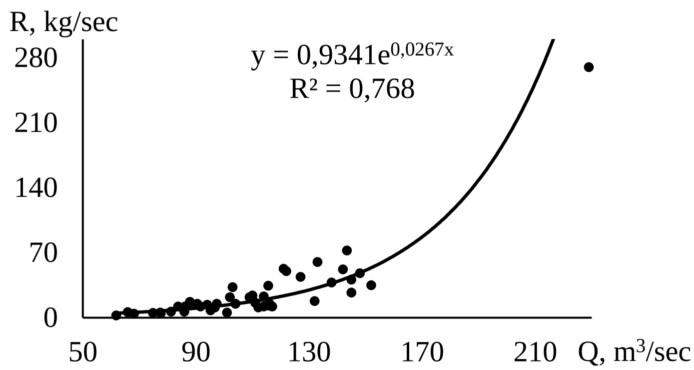

Fig.4. Relationship between suspended sediment runoff (R) and water flow (Q), Chotqol-Khudaydadsay

Table 3.

Regression equations for the relationships between water flows and suspended sediments of rivers

№.	Rivers	Regression equations	$r \pm \sigma_r$
1	Chotqol	R aver = $0,934 \cdot e^{0,027 \cdot Q}$	0,876 ± 0,017
2	Piskom	R aver = $0,203 \cdot e^{0,048 \cdot Q}$	0,811 ± 0,033
3	Oygaing	R aver = $0,0257 \cdot e^{0,1512 \cdot Q}$	0,864 ± 0,044
4	Chiralma	R aver = $0,0017 \cdot e^{1,3214 \cdot Q}$	0,900 ± 0,031
5	Maydontol	R aver = $0,042 \cdot e^{0,19 \cdot Q}$	0,766 ± 0,072
6	Ugom	R aver = $0,421 \cdot e^{0,111 \cdot Q}$	0,787 ± 0,032
7	Ohangaron	R aver = $0,133e^{0,145 \cdot Q}$	0,817 ± 0,035
8	Qizilcha	R aver = $0,005e^{2,67 \cdot Q}$	0,778 ± 0,058
9	Nishboshsoy	R aver = $0,015e^{0,443 \cdot Q}$	0,787 ± 0,057
10	Jiblansoy	R aver = $0,0039e^{3,7693 \cdot Q}$	0,898 ± 0,026
11	Dukantsoy	R aver = $0,013e^{0,792 \cdot Q}$	0,874 ± 0,039
12	Qorabogsoy	R aver = $0,021e^{0,465 \cdot Q}$	0,516 ± 0,070
13	Shaugazsoy	R aver = $0,0011e^{3,88 \cdot Q}$	0,804 ± 0,049
14	Abjazsoy	R aver = $0,006e^{2,233 \cdot Q}$	0,643 ± 0,075

Note: $r \pm \sigma_r$ – correlation coefficient and its error.

Based on the regression equations of these graphs, the discontinuities in the pending effluent expenditure data were restored. As a result, the average annual discharges of all rivers were brought to an unambiguous series. Regression equations representing the dependence of water and suspended solids consumption of rivers of the Chirchiq-Ohangaron basin were created and their accuracy was evaluated. Almost 60% of the regression equations had values greater than 0,800. 30% of the shares were above 0,700. In the Chiralma River (0,900), this value was the largest. Only in some rivers, i.e. Karabogsoy (0,516) and Abjazsoy (0,643), these values were relatively smaller.

The intensity of erosion processes arising from the meltwater of eternal snow and glaciers in the highlands is mainly determined by the magnitude of positive air temperatures. When choosing the calculation period for air temperature, we took into account intra-annual changes in the flow of suspended sediment on the rivers of learned basins. As a result, their average values observed at meteorological stations during the warm half of the year, that is, the months April-September, were used as an index of the air temperature regime.

Calculations were performed using the objective method of alignment and normalization of correlations proposed by G.A. Alekseev.

Paired correlation coefficients were calculated between the discharge of suspended sediment in the mountain rivers of the Chirchiq-Ohangaron basin and climatic factors, that is, precipitation in the winter (X_w) and summer (X_s) seasons and average summer air temperature (t_s). The calculated values of pair correlation coefficients (r_{01}, r_{02}, r_{03}, r_{12}, r_{13} and r_{23}) were analyzed and the limits of their changes were assessed (Table 4).

Table 4. Pair correlation coefficients of relationships between suspended sediment flow and meteorological factors

№.	Rivers	Pair correlation coefficients		
		r_{01}	r_{02}	r_{03}
1	Chotqol	0,514/0,801	0,501/0,478	-0,331/-0,397
2	Piskom	0,835/0,498	0,466/0,457	-0,233/-0,461
3	Oygaing	0,685/0,345	0,325/0,409	-0,285/-0,250
4	Chiralma	0,857/0,300	0,501/0,266	-0,218/-0,190
5	Maydontol	0,787/0,104	0,456/0,399	-0,268/-0,111
6	Ugom	0,596/0,633	0,289/0,495	-0,382/-0,385
7	Ohangaron	0,781/0,456	0,538/0,497	-0,252/-0,585
8	Qizilcha	0,477/0,758	0,550/0,521	-0,201/-0,639
9	Nishboshsoy	0,430/0,539	0,607/0,368	-0,388/-0,699
10	Jiblansoy	0,601/0,433	0,377/0,464	-0,422/-0,331
11	Dukantsoy	0,668/0,504	0,512/0,621	-0,003/-0,292
12	Qorabogsoy	0,696/0,086	0,446/0,224	-0,385/0,235
13	Shaugazsoy	0,484/0,639	0,696/0,480	-0,457/-0,469
14	Abjazsoy	0,614/0,133	0,479/0,359	-0,351/-0,073

Note: *r_{01}, r_{02}, r_{03} are paired correlation coefficients characterizing the relationship between suspended sediment flow rates and, accordingly, winter and summer precipitation and summer air temperature.*

In all studied river basins, pairwise correlation coefficients between suspended sediment runoff and winter and summer precipitation were obtained with positive values, which vary, respectively. On rivers of the snow-rain type of feeding, the connection between the runoff of suspended sediment and summer precipitation turned out to be closer, but on rivers of the snow-type feeding type, the opposite turned out to be the case, that is, the connection with winter precipitation turned out to be closer.

In the work, regression coefficients (α_{01}, α_{02}, α_{03}) were calculated for all river basins studied. Based on these values and the values of paired correlation coefficients, the total correlation coefficients (r_0) were calculated, allowing one to evaluate the accuracy of the equations of normalized values (Table 5).

Table 5. Values of regression coefficients and full correlation coefficients

№	Rivers	α_{01}	α_{02}	α_{03}	$r_0 \pm \sigma_{r0}$
1	Chotqol	0,739/0,432	0,099/0,363	-0,152/-0,109	0,830±0,065/0,669±0,106
2	Piskom	0,766/0,410	0,185/0,410	0,008/-0,244	0,853±0,067/0,710±0,095
3	Oygaing	0,699/0,224	0,058/0,325	0,083/-0,003	0,722±0,092/0,459±0,168
4	Chiralma	0,779/0,276	0,287/0,256	0,177/0,042	0,922±0,029/0,399±0,179
5	Maydontol	0,724/0,095	0,162/0,562	0,023/0,275	0,806±0,067/0,514±0,157
6	Ugom	0,599/0,557	0,240/0,352	-0,394/-0,081	0,759±0,081/0,747±0,085
7	Ohangaron	0,707/0,229	0,298/0,220	0,140/0,373	0,864±0,049/0,657±0,109
8	Qizilcha	0,293/0,571	0,488/0,199	0,131/-0,236	0,829±0,060/0,659±0,109
9	Nishboshsoy	0,172/0,248	0,489/0,045	-0,061/-0,595	0,752±0,084/0,628±0,116
10	Jiblansoy	0,491/0,329	0,082/0,210	-0,203/-0,081	0,642±0,113/0,496±0,145
11	Dukantsoy	0,553/0,351	0,380/0,578	0,154/0,151	0,762±0,081/0,752±0,084
12	Qorabogsoy	0,615/0,158	0,064/0,468	-0,166/0,551	0,722±0,092/0,499±0,144
13	Shaugazsoy	0,181/0,522	0,555/0,280	-0,093/0,045	0,699±0,098/0,718±0,093

14	Abjazsoy	0,491/0,064	0,250/0,440	0,064/0,191	0,667±0,107/0,425±0,158

Note: α_{01}, α_{02} and α_{03} – regression coefficients; $r_0 \pm \sigma_{r0}$ – total correlation coefficient and its error; the numerator of the fraction belongs to FBCP and the denominator belongs to CCP.

The contributions of summer and winter precipitation to the formation of suspended sediment runoff, according to the sources of river feeding, differ from each other. For example, for the rivers of the Chirchiq basin, the contributions of winter precipitation, according to the increase in the average height of the river basins, also increase. If, for the relatively low-lying basins of the Ugam river, the contribution of winter precipitation is 50-55%, then for the Pskom river and its tributaries, the average height of the basins of which is relatively higher, the contribution of winter precipitation is 65-75%. Contributions of summer precipitation on these rivers, on the contrary, decrease.

Depending on the purpose of the work, measured values of suspended solids discharge in rivers of selected basins based on the following hydrological indicators of the rate of water erosion in them rated:

1. Average long-term values of suspended solids of rivers belonging to each basin based on their average monthly and annual amounts (R, kg/sec);
2. Average long-term values of suspended solids expressed in units of weight (W_{RV}, tons) and volume (W_{RG}, m^3);
3. Indicator of the intensity of soil erosion from river basins - values of the erosion modulus (M_R, t/km^2 ·year);
4. Average long-term values of the layer of soil and soil washed out of river basins (h_c, mm);
5. Indicator of the intensity of water erosion, expressed in years, which is the average amount of water required to wash out one meter of soil and soil from river basins - erosion meter values (h_e, year).

In works for the rivers of the Chirchiq-Ohangaron basin, based on observed data on the flow of suspended sediment and extreme values of water flow, indicators of erosion activity were assessed using special calculation formulas. Analysis of the results obtained made it possible to clarify changes in the indicators of erosion activity in river basins and on this basis it became possible to determine the foci of water erosion where intensive erosion of soils occurs (Table 6).

Table 6. Indicators of the intensity of soil loss in river basins

No.	River basin	N	Values	Sediment runoff		M_R, ton/km^2·y	h_c, mm	h_e, y
				W_{RG}, 10^3 т	W_{RV}, 10^3 м^3			
1	Chirchiq	13	Max	23,02	15,3	406	0,271	3690
			Min	0,568	0,379	24,4	0,016	62500
2	Ohangaron	12	Max	200	133	159	0,106	9434
			Min	0,631	0,421	4,93	0,003	333333

Note: *N – number of hydrological posts; W_{RG} – sediment runoff, in weight units; W_{RV} – sediment yield, in volumetric quantities; M_R – flush duct; h_c – washout layer; h_e – erosion meter.*

Conclusions:

1. Data from hydrological stations where water consumption is continuously monitored in all mountain rivers with natural water regime in the Chirchiq-Ohangaron basin were collected. The interruptions in them were restored, and the lines of suspended discharges were brought to a single meaning;
2. The dependence of river suspended discharge flow on meteorological factors was statistically evaluated. Calculations were made based on the method of objective equalization and normalization of correlation links proposed by G.A. Alekseev;
3. Normalized regression equations were obtained, which allow the estimation of suspended flows of rivers. Complete correlation coefficients representing the accuracy of these equations and their errors were calculated. The values of full correlation coefficients varied in the range of 0,642÷0,922 in FBCP, and in the range of 0,399÷0,752 in CCP. The equations are recommended for use in hydrological calculations to estimate the amount of suspended solids in rivers.
4. Quantitative characteristics of flushing from the surface of river basins in the altitudinal zones of river basins were calculated using the method of genetic analysis developed by O.P. Sheglova. To map the loss of soils from the surface of river basins, the calculations also took into account hydrometeorological factors that shape the processes of water erosion. The values of washout modules determined for different altitudinal zones made it

possible to compile updated maps of soil washout from the surface of river basins.

5. It is recommended that the results of this study be used to solve practical problems related to the design, construction and operation of hydraulic and water management facilities, as well as to develop action plans to combat water erosion in river basins. In the future, the water erosion in the river basins to the above maps speed indicator - analysis of the flow of suspended solids according to their genesis on the basis of which there are possibilities for further clarification.

Corresponding author: Oyjamol Kholtojiyeva, Department of Surface hydrology and meteorology National University of Uzbekistan Tashkent, 100066, Uzbekistan

REFERENCES

1. Alekseev G.A. Objective methods for leveling and normalizing correlations. – L.: Gidrometeoizdat, 1971. – 363 s. (in Russian)
2. Aytbaev D.P. Evaluation of erosive detail in the stock of suspended particles in the Chirchiq-Ohangaron Basin. Autoref. diss. ... condidate. geogr. science – Tashkent, 2006. – 26 s. (in Russian)
3. Coleman N.L. Effects of suspended sediment on the open channel velocity distzibution // Water Resour. Res. - 1986. - Vol. 22. - № 10. - P. 1377-1384.
4. Ellison W.D. Raindrop energy and soil erosion // The Empire Journal of Experimetal agriculture. - 1952. - Vol. 20. - N 78. - P. 81-97.
5. Holeman J.N. The sediment yield of major of the world. Water resoures research // American Geophisical Union. - 1968. - Vol. 4. - P. 737-747.
6. Hatono M., Yoshimura K. Development of a global sediment dynamics model. Progress in Earth and Planetary Science, 2020. 7, 59. https://doi.org/10.1186/s40645-020-00368-6
7. Huang C., et al. Soil erosion modeling using ML in Loess Plateau. Remote Sensing, 2021. 13(2), 251.
8. Jansen M.L., Painter R.B. Predicting Sediment yield from climate and topography // J.Hudrol. - 1974. - Vol. 21. - № 4. - P. 371-380.
9. Juliev M., et al. Modeling of soil erosion using the RUSLE model for the Ugam Chatkal National Park. Journal of Geology, Geography and Geoecology, 2024. 33(1), 1173.
10. Ivanov Y.N. Suspended sediment runoff of rivers in the Syrdarya basin. – Tr. SANIGMI. – 1967. – Vip. 36(51). – 309 s (in Russian)
11. Kabanova K.S. Genetic analysis of the suspended sediment flow regime of rivers in Central Asia // Uchen. zap. LGU. Ser. geograficheskaya. – 1952. – № 152. – Vip. 8. – S. 107-158. (in Russian)
12. Karaushev A.V. Theory and methods for calculating river sediments. – L.: Gidrometeoizdat, 1977. – 272 s. (in Russian)
13. Liu W., Wan S., Huang F., Luo X., Fu M., Experimental study of subsurface erosion in granitic under the conditions of different soil column angles and flow discharges. Bulletin of Engineering Geology and the Environment, 2019. 78, 5877–5888. https://doi.org/10.1007/s10064-019-01519-w
14. Lopatin G.V. On water erosion and sediment runoff in the mountainous region of Central Asia // Voprosi geografii. – 1949. – N 15. – S. 193-204. (in Russian)
15. Parajul P.B., Risal A. Evaluation of climate change on streamflow, sediment, and nutrient load at watershed scale. Climate 2021, 9, 165.
16. Rasulov A.R. Formation of suspended sediment runoff and washout from the urface of the river basin. Ugom. Autoref. diss. ... condidate. geogr. science – Tashkent, 1972. – 28 s. (in Russian)
17. Shamov G.I. River sediment. – L.: Gidrometeoizdat, 1959. – 378 s. (in Russian)
18. Sheglova O.P. Genetic analysis and mapping of suspended sediment flow in rivers of Central Asia. – L.: Gidrometeoizdat, 1984. – 127 s. (in Russian)
19. Shults V.L. Rivers of Central Asia. Ch. 1,2. – L.: Gidrometeoizdat, 1965. – 691 s. (in Russian)
20. Vazhnov A.N., Musoyan S.G. Altitudinal features of suspended sediment runoff (on the example of Armenian rivers). Bulletin of Moscow State University, 1975, No.2
21. Wang J., et al. Sediment transport under climate variability. Journal of Hydrology, 2020. 587, 124958.
22. Xikmatov F.X. Water erosion and suspended sediment runoff in mountain rivers of Central Asia. – Tashkent: "Science and technology", 2011. – 248 p. (in Russian)