GeoJournal of Tourism and Geosites
ISSN 2065-1198, E-ISSN 2065-0817

Year XV, vol. 43, no. 3, 2022, p.866-871
DOI 10.30892/gtg.43304-898

ANALYSIS OF THE IMPACT OF SOIL EROSION IN THE EMBULATOVKA RIVER BASIN ON THE DEVELOPMENT OF RECREATIONAL CONDITIONS OF THE NATURAL RESOURCE STATE OF THE WEST KAZAKHSTAN REGION

Nurgul RAMAZANOVA*
L.N. Gumilyev Eurasian National University, Department of Physical and Economical Geography, Nur-Sultan, Kazakhstan, e-mail: nurgulram@gmail.com

Zhanar OZGELDINOVA
L.N. Gumilyev Eurasian National University, Department of Physical and Economical Geography, Nur-Sultan, Kazakhstan, e-mail: ozgeldinova@mail.ru

Tangal TURSYNOVA
L.N. Gumilyev Eurasian National University, Department of Physical and Economical Geography, Nur-Sultan, Kazakhstan, e-mail: tangaltt@mail.ru

Kalibek ASYLBEKOV
L.N. Gumilyev Eurasian National University, Department of Physical and Economical Geography, Nur-Sultan, Kazakhstan, e-mail: aslkalibek@mail.ru

Elvira TURYSPEKOVA
L.N. Gumilyev Eurasian National University, Department of Physical and Economical Geography, Nur-Sultan, Kazakhstan, e-mail: elvira.turyspekova@mail.ru

Sabina TOKSANBAEVA
L.N. Gumilyev Eurasian National University, Department of Physical and Economical Geography, Nur-Sultan, Kazakhstan, e-mail: sabina.toksanbaeva@mail.ru

Dauren ZHANABAYEV
L.N. Gumilyev Eurasian National University, Department of Physical and Economical Geography, Nur-Sultan, Kazakhstan, e-mail: zhanada@mail.ru

Citation: Ramazanova, N., Ozgeldinova, Z., Tursynova, T., Asylbekov, K., Turyspekova, E., Toksanbaeva, S., & Zhanabayev, D. (2022). ANALYSIS OF THE IMPACT OF SOIL EROSION IN THE EMBULATOVKA RIVER BASIN ON THE DEVELOPMENT OF RECREATIONAL CONDITIONS OF THE NATURAL RESOURCE STATE OF THE WEST KAZAKHSTAN REGION. *GeoJournal of Tourism and Geosites*, 43(3), 866–871. https://doi.org/10.30892/gtg.43304-898

Abstract: The article analyzes the impact of soil erosion in the Embulatovka River basin on the development of recreational conditions of the natural resource state of the West Kazakhstan region. The purpose of the work is to determine the process of washing out the soil of the river basin of the Embulatovka River for different types of agricultural land. The analysis of soil erosion in the Embulatovka River basin can serve as a basis for identifying and changing factors that negatively affect soil erosion, which will increase soil fertility and increase crop yields and the availability of livestock feed. The following data were used for the determination of the soil wash of the Embulatovka River basin: erosion potential of sediments, soil type, mechanical composition, steepness of slopes, vegetation, types of plowing. As a result of the study of the soil, an average washing of the soil in the Embulatovka River basin was determined for each landfill. After analyzing the map of the agricultural lands of the study area, we concluded that pastures occupy 27% of the land, arable land (38%), forest (8%), haymaking (4%), populated areas (0.50%), orchards (0, 50%), reservoir (0.50%), clean pastures (8%). If you pay attention to the average loss of soil, you can see the largest number of them fall on arable land-4,22 tons, the reservoir is 2,3 tons, the gardens- 0,22, haymaking-0,08, pasture-0,05. Analyzing the results of calculations, we can say that about 90% of the losses occur on the treated soil. The results obtained can be used as a basis for the development of soil conservation plans for specific sites in order to promote sustainable land management practices, since land resources are the basis for the placement of recreational facilities and are important in the recreational sector.

Key words: West Kazakhstan, natural resource state, river basin, soil, erosion, rusle, GIS

* * * * * *

INTRODUCTION

The most important component of the tourism industry is the traditional culture and way of life, as well as the national cuisine of the local population, which is directly related to the natural resource potential of the area. The natural resource state depends on the level of development of such areas of the national economy as agriculture, in particular crop production and

* Corresponding author

animal husbandry. Indicators of the level of crop yield and the availability of animal feed are soil fertility and conditions of cultivation, processing and application of anti-erosion measures. Water erosion of soil is one of the most serious, environmental and economic threats around the world. The aggravation of this problem is often associated with changes in land use (Amralin, 2003; Bayandin, 1963). The development of virgin and fallow lands in the north and north-western part of Kazakhstan has increased dramatically over the last century creating major environmental challenges especially related to surface water quality (Ageleuov, 1982; Isachenko, 1991). The relationship between different land uses and soil erosion has been studied by many researchers who concluded that various combinations of vegetative cover and agricultural practices have different effects on soil properties (Zhaksybaev and Usmanov, 1986; Chigarkin, 1980). Riparian forest buffers are a management tool that helps reduce streambank erosion in agriculturally dominated watersheds (Schultz et al., 2000). The importance of streambank erosion to watershed-scale sediment export is being increasingly recognized (Schultz et al., 2013; Tevfik and Unal, 2012). Improved management of riparian areas to decrease streambank erosion results in significant water quality improvement in streams (Schultz et al., 2012). The empirical Universal Soil Loss Equation (USLE) is one of the most widely used models for estimating annual soil loss (Wischemeyer and Smith, 1978; Mukayev et al., 2022).

For the West Kazakhstan region of Kazakhstan, agricultural production is a traditional industry where a large part of the population is involved, and the volume of products produced ensures the food balance with the shipment of part of the products for export. Currently, the situation in the agro-industrial complex of the region is characterized by an increase in production volumes, an increase in its efficiency, significant attraction of financial resources for the development of branches of the agro-industrial complex and improvement of the quality of life in rural areas (Toksanbaeva et al., 2022).

Developing a common method that can be use throughout Kazakhstan is a challenge because of the vastness of the territory with a wide variety of natural conditions that support the culture of a wide variety of crops that have different impacts on the soil (Mukayev et al., 2020). It can be concluded that the problem of soil erosion is a key problem for agriculture in the Republic of Kazakhstan, also has an impact on the recreational sector, since recreational land use is directly related to agriculture, and agriculture depends on soil fertility and erosion component (Ramazanova et al., 2020).

THE RESEARCH TERRITORY

The river Embulatovka is the right tributary of the Zhayik river in Western Kazakhstan (Figure 1). The watershed is located along the border with the Russian Federation in West Kazakhstan between the latitudes 51.794331 N and 50.643325 N and longitudes 52.354869 E and 51.058482 E (Figure 1), (Dzhanaleeva, 1999; Darbayeva, 1966). The main channel of the Zhayik River, the length of the watercourse is 82 km, the catchment area is 890 km ² (Chashina et al., 2020). The river is located on the territories of two states: the Russian Federation and the Republic of Kazakhstan (Ignatov and Telyatov, 1978; Palmer et al., 2013). Intensification of agriculture in combination with extensive livestock farming in the early 20th century led to numerous environmental impacts, namely, increased soil erosion (Ramazanov, 2000). The objective of this study was to compare eight different land uses on soil erosion. The land uses included arable land, pastures, forest, meadow, a garden, clean pastures, deposits and settlements (Darbayeva et al., 2012; Chibilev, 1983). According to statistics, agricultural lands of the West Kazakhstan region on 01.01.2020 amount to 6 984.8 thousand hectares, arable land – 541.8 thousand hectares, hayfields and pastures – 5 977.2 thousand hectares. The sown area of agricultural crops in the region as of 01.01.2020 is 522.6 thousand hectares (2.4% of the total sown area of agricultural crops of the Republic of Kazakhstan). Grain crops occupy 251.4 thousand hectares or 48.1%. Fodder crops – 182.7 thousand hectares or 35.0%. The main share of land potential is concentrated in grain production. The directions of the grain produced are sales, feed, seeds.

Figure 1. Study area location of the territory of the West Kazakhstan region

MATERIALS AND METHODS

To analyze the natural conditions of the river basin, a topographic and cartographic method based on geomorphological analysis of the shape and location of the horizontal lines, as well as mathematical, graph analytic and other methods was used. Also, the method of assessing soil flushing was used, designed to identify and take measures for the occurrence of risks, as well as for timely and effective response to any deviations.

Methods of decoding satellite images were used. That is, the processes of geo-informational mapping of basin territories, which consist of several stages and are carried out according to a methodology that includes primary data processing, analysis of cartographic materials and satellite images, the formation of a unified geodata database, as well as in-depth morphometric analysis based on a digital relief model (DEM).

The extent of erosion processes was estimated using the Wischmeier and Smith equation which is widely used around the world. The authors of this equation were Wischmeier and Smith, who in 1978 investigated erosion processes and created a guide to conservation planning in agriculture (Wischmeier and Smith, 1978):

$$A = R * K * L * S * C * P \qquad (1),$$

Where: A - loss of soil; R - precipitation; K is the coefficient of erosion; L is the coefficient of length; S is the slope coefficient; C is the coefficient of land use and P is the coefficient of anti-erosion measures.

Coefficient of soil erosion (K)

Values for the coefficient of soil erosion (K) were based on the soil map of Western Kazakhstan. Values for K in the equation were based on the structure, texture and organic matter content of the soils described on the map of the Embulatovka River basin. The mechanical map of the Embulatovka River basin was compiled on the basis of a soil map of the area with a scale of 1: 10 000.

Topographic factor. L is the coefficient of length; S is the slope coefficient.

For these calculations, we used the ArcGis10.5.1 program and the 2020 space image of the territories (DEM files), as well as a table for calculating the LS factor. The factors slope length (L) and steepness of the slope (S) show the effect of relief on soil erosion (Wischmeier and Smith, 1978) R is the precipitation factor.

The average annual precipitation in the study area is 94 mm, the data was taken from the meteorological station in Yanvartsevo, in the Zelenovsky district.

Land Use factor (C)

Factor C reflects the effect of vegetation on the rate of erosion (Renard et al., 1997), given that it reduces the erosive effects of precipitation. In this study the factor C factor was focused on presenting the variability in vegetation cover between the eight different types of land management that was evaluated. Soil cultivation methods were related with specific crops cultivated in the region. Values for C were produced in ArcGIS 10.5.1

Factor of anti-erosion measures (P)

The factor P was calculated from the ratio of average monthly and (or) average annual soil losses from individual land use measures (plowing, surface modeling, etc.) which depend on the type of cultivation of the land.

The block diagram of the study is shown below in Figure 2.

Investigation of the system of physical and geographical factors of formation and development of water erosion processes in the territory of the West Kazakhstan region on the basis of topographic-cartographic, mathematical and graph analytic methods

Determination of the research area using the method of decoding satellite images and geoinformation mapping of the basin territory:
- Primary data processing;
- Analysis of cartographic materials and satellite images;
- Formation of a single geodata database;
- In-depth morphometric analysis based on a digital terrain model

Determination of factors using the interpolation method

Determination of the degree of erosion processes based on the RUSLE loss equation

Figure 2. Block diagram of the study of soil erosion

RESULTS AND DISCUSSION

Of the 12 districts of the West Kazakhstan region, Baiterek district has the largest sown area - 224.6 thousand hectares or 43.0% of the total, Terekta district – 139.5 thousand hectares or 26.7%, Burlinsky district – 56.0 thousand hectares or 10.7%. There is a regional agrarian inequality. In total, these areas account for 80.4% of the cultivated area of the studied region. In the first half of 2020, in the created gross regional product of the Republic of Kazakhstan, the West Kazakhstan region structurally accounts for 4.3%. In agriculture, the indicator is 3.8% (in 2019, 3.2%, this is the 11th place among the regions of the Republic of Kazakhstan). This indicator is significantly lower in comparison with other regions of the republic. For example, the share of Almaty region in the gross regional product of the Republic of Kazakhstan agriculture is 16.3%, North Kazakhstan region 12.1% in 2019. The level of profitability of agricultural production in agricultural enterprises amounted to 43.8% in 2019, 35.5% in 2018. The growth rate compared to 2015 is 28.2%. The growth of the gross domestic product of agriculture of the West Kazakhstan region of the Republic of Kazakhstan on the forecast horizon is based on an increase in domestic demand, both consumer and investment. At the same time, there are a number of problems in the agriculture of the region that hinder the development of the industry. Among them in the crop production industry are: the use of extensive technologies, low efficiency of the use of irrigated land, which causes low crop yields; insufficient use of chemical plant protection products and mineral fertilizers leads to a large contamination of crops and a decrease in the natural fertility of the land. Increasing the efficiency of crop production industries is associated with the introduction of modern technologies into production with the use of protective equipment and fertilizers, the development of seed production through state support. Agriculture should be developed on the basis of new generation agricultural technologies that ensure high labor productivity and high quality of products. It is necessary to use the world experience, to introduce it into our agriculture faster. Thus influence of each type of land use on soil erosion for each factor in the RUSLE model was studied. A map of the eight categories of agricultural lands of the investigated territory was created using the method of digital processing of space images in the ArcGIS 10.5.1 program (Figure 3). After analyzing the map, we determined that pastures occupy (38%), arable land (27%), forests (8%), meadow (4%), settlements (0.5%), garden (0.5%), deposit (0.5%) of the landscape of the Embulatovka River basin in Kazakhstan (Figure 4).

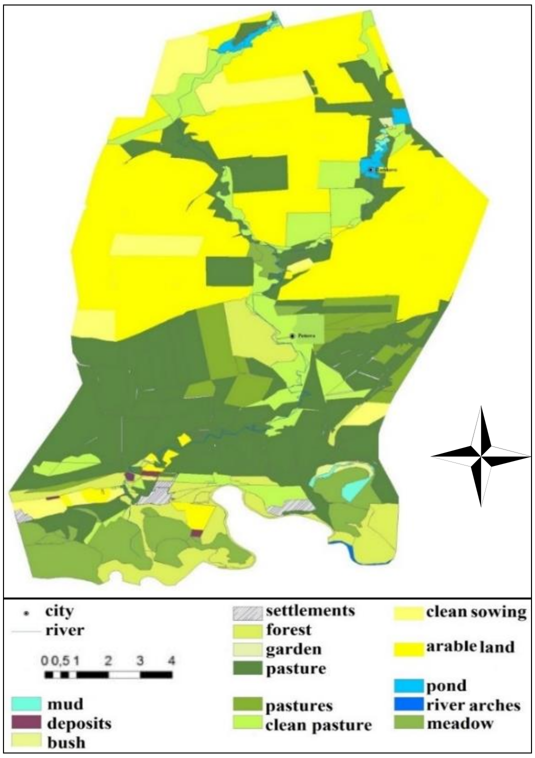

Figure 3. Map of agricultural land use in the Embulatovka river basin of the West Kazakhstan region (Source: Compiled by the authors, based on SRTM images from 2020)

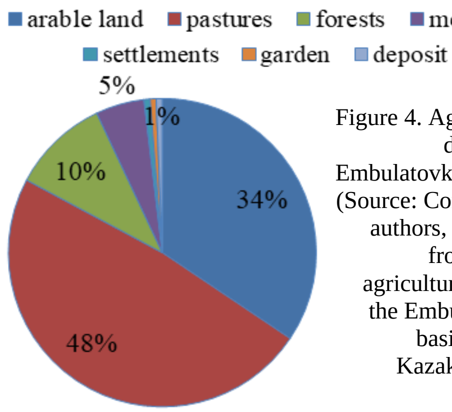

Figure 4. Agricultural use diagram of the Embulatovka River Basin (Source: Compiled by the authors, based on data from the map of agricultural land use in the Embulatovka river basin of the West Kazakhstan region)

Table 1. Characteristics of soil structure in the river basin of Embulatovka

Soil class	Mechanical composition of soil (%)	Factor of soil susceptibility to erosion (K)
Clay	10	0.26
Sand	14	0.02
Medium loam	13	0.28
Light loam	27	0.12
Heavy loam	36	0.37

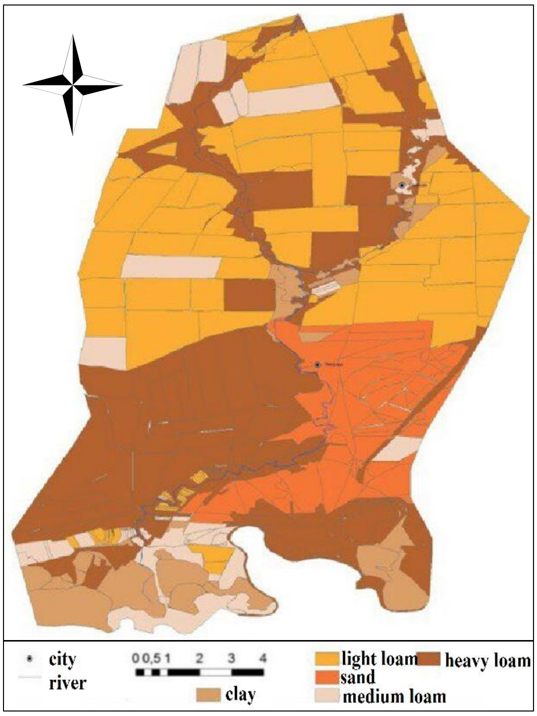

Figure 4. Mechanical composition of a soils of the Embulatovka River basin of the West Kazakhstan region (Source: Compiled by the authors, based on satellite images and data from the Atlas of the Republic of Kazakhstan from 2020)

Coefficient of soil erosion (K)

The soil erosion factor of the Embulatovka River Basin was found for the five prevailing soil structures in the area. The values were K=0.26 for clay, K=0.02 for sandy soils, K=0.28 for medium loam, K=0.12 for light loam, K=0.37 for heavy loam (Bigaliev and Zhamalbekov, 1995; Bronguleyev, 1961). In the basin of the river Embulatovka on heavily loamy soils occupying 36% of the territory, the K factor is 0.37; For medium loam which occupies 13% of the territory the K factor is 0.28; Sands occupy 14% of the territory and the factor K is 0.02; Clay occupies 10% of the territory and the factor K is 0.26; For 27% of the territory that is light loam K is 0.12 (Figure 3 - the mechanical composition of the soils of the Embulatovka River basin), (Table 1- Characteristics of soil structure in the river basin of Embulatovka), (Habtamu Sewnet Gelagey, Amare Sewnet Minale, 2016).

Topographic factor. L is the coefficient of length; S is the slope coefficient.

For these calculations, we used ArcGis10.5.1 and the 2020 space image of the territories (DEM files), as well as a table for calculating the LS factor. For each segment, calculations were made according to the previously calculated parameter LS table. The highest mean LS factor values occur next to the river, and are mainly associated to great slopes (Figure 5, Picture B). Through the prediction LS factor maps it was identified sensitive areas for some land uses, because it has been demonstrated that increases in this factor can produce higher overland flow velocities and correspondingly higher erosion.

Land Use Rate (C)

The surface is very heterogeneous due to land degradation (Dzhanaleeva, 2003). In the study area, we identified such types of land use as: pastures, arable land, hayfields, gardens, deposits. To subtract Factor C, we used Cs factors for crop species such as cereals, maize silage, beans and canola, cereals (spring and winter), horticulture, fruit trees, hay and pasture. Also, the factor - methods of soil treatment: dump, waste-free, mulching, special and zero processing (Elias Rodrigues et al., 2016). In the investigated territory, we identified such types of land use as: pastures, arable land, hayfields, gardens, deposits.

Factor of anti-erosion measures (P) The next factor is the factor of anti-erosion measures - P. Anti-erosion measures or support practices against soil erosion include a complex of organizational-economic, agrotechnical and hydraulic engineering practices to reduce the degree of erosion of soils. Only with the combination of these major measures is it possible to prevent wind and water erosion of soils. Several types of anti-erosion measures are being carried out in the Embulatovka River basin: up and down the slope, transverse slope, contour farming, strip of crops, contour.

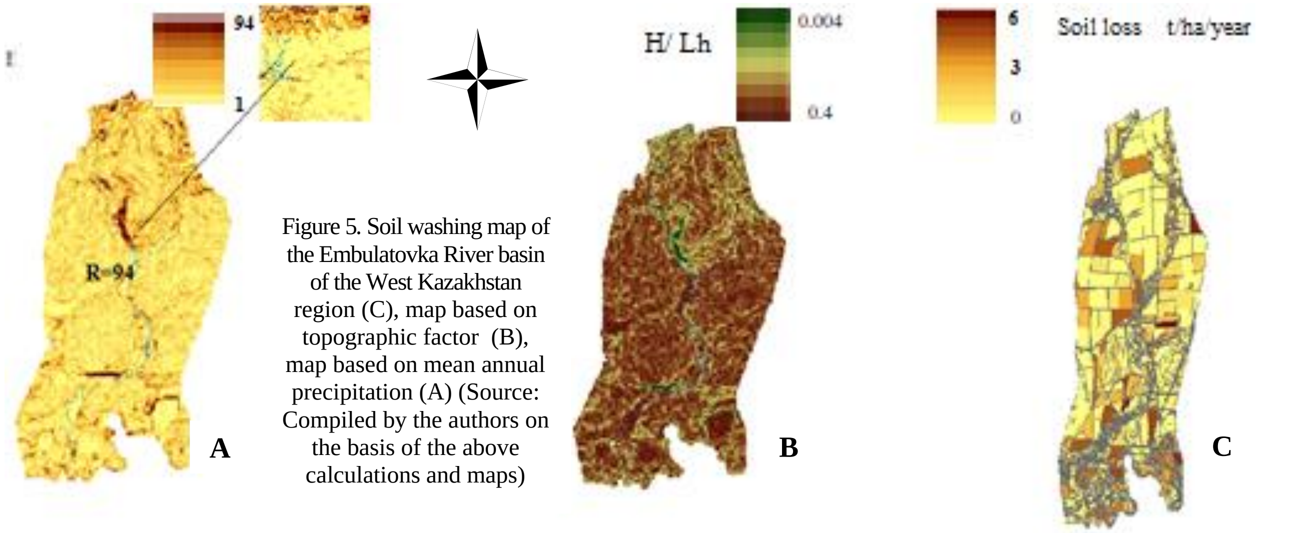

Figure 5. Soil washing map of the Embulatovka River basin of the West Kazakhstan region (C), map based on topographic factor (B), map based on mean annual precipitation (A) (Source: Compiled by the authors on the basis of the above calculations and maps)

Soil loss

Calculating the coefficients of all five factors, using the RUSLE formula, we obtained a soil erosion map for the agricultural land of the study site. The observed variability of soil erosion reflects the importance of studying different land use scenarios. There were significant differences in the erosion reaction of soils under different types of land use. The erosion index in the southern part of the basin is 0.004-0.4 tons / year. These lands are mainly used for pasture, are located on dark chestnut and flood-meadow soils, in texture mainly medium and heavy loam soils. The level of erosion in the southeastern part of the basin is the lowest, 0.004-0.1 t / ha per year, while in the southwestern part the erosion is relatively high, 0.1-0.4 t / ha in year. The lowest level of erosion is mainly in land that is used for pasture. The relatively high level of soil erosion in the northern part of the study region, is 0.5-5 tons / ha per year because it is mainly used as arable land, in texture loamy soil. Analyzing the results of calculations, we can see that a high level of soil erosion is most in the treated areas. In order to reduce the erosion rates of soils, we will make the following changes.

Change in the method of soil cultivation with " Disenchanting - 0.9" for "Zero processing-0.25".

Thus, the factor C (revised) =0.50 * 0.25=0.12 The adjusted annual volume of soil loss: A = R * K * LS * C * P = 94 * 0.12 * 1.6 * 0.12 * 0.75=1.6 t / ha per year. Thus, by changing the method of soil cultivation, the average annual soil loss for this field is 6 t/ha/year, instead of 1.6 t/ha/year. The next example is the change in factor C from row-crops to growing fruit trees, factor C changes from 0.40 to 0.10. Thus, the factor C (revised) = 0.10 * 0.25=0.025

The adjusted annual volume of soil losses is found by the equation of Wischmeier and Smith. The authors of this equation were Wischmeier and Smith (Wischmeier and Smith,1978):

$$A = R * K * LS * C * P \qquad A = 94 * 0.12 * 1.6 * 0.025 * 0.75 = 0.3 \text{ t / ha per year.}$$

So, thanks to the change in factor C, we significantly reduced the rate of soil washout for this site.

CONCLUSIONS

This article demonstrates the application of the empirical model of soil erosion as RUSLE integrated with GIS for assessing soil erosion in the Embulatovka River Basin. In addition, the impact of changes in land use patterns on soil erosion were studied. Soil erosion of the Embulatovka River basin on the development of recreational conditions of the natural resource state of the West Kazakhstan region is also analyzed. Analysis of soil erosion in the Embulatovka River basin can serve as a basis for identifying and changing factors that negatively affect soil erosion, which will increase soil fertility and increase crop yields and the availability of livestock feed. The following data were used to determine soil erosion in the Embulatovka River basin: erosion potential of sediments, soil type, mechanical composition, slope steepness, vegetation, types of plowing. The territory of the basin is occupied by pastures (38%), arable land (27%), forests (8%), haymaking (4%), populated areas (0.5%), orchards (0.5%). Areas most susceptible to loss of soil are located next to the river, and are mainly associated to great slopes. The lowest level of soil washout in the region, where the land is mainly used for pasture. A high level of soil erosion in the northern part of the study region, 0.5-5 tons / ha per year, because this is mainly land used as arable land.

It can be said that the application of the RUSLE model is an effective method for estimating soil losses in catchments populated by rural settlements, that is, the same model for soil loss can be used for other river basins. The results of this study will help to better understand the current situation and the relationship of soil loss. The analysis of soil erosion in the Embulatovka River basin can serve as a basis for identifying and changing factors that negatively affect soil erosion, which will increase soil fertility and increase crop yields and the availability of livestock feed. Consequently, the natural resource conditions of the region allow us to repeatedly increase the production and processing of agricultural products. In the West Kazakhstan region, grain and its processed products are the main export products of the crop industry. These results are useful for complementing erosion control strategies, as well as for creating and implementing conservation programs in this area of the environment. Agriculture by its mission, economic and social significance for Kazakhstan is more important than the branch of the national economy. About 80% of the entire territory is occupied by farmland. Almost half of the population lives in rural areas and a third of them are employed in the economy, with all their social, economic and everyday values. Meanwhile, rural areas, just like the production of this specific industry, are lagging behind the general pace of economic development and the well-being of urban residents today. Unfortunately, this gap is not shrinking, but is growing alarmingly. Therefore, the improvement of land cultivation methods is the key to a productive agricultural sector. This will completely solve the issues of food security and sustainable competitiveness of the agro-industrial sector of the national economy. Appreciations to effective land management, it is possible to achieve the goal of increasing yields and guaranteed to receive high incomes in a particular area, including recreational land use.

Acknowledgement

The research was funded by the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan (Grant No. AP09260232).

REFERENCES

Ageleuov, E.A. (1982). *Floodplain meadows of the Ural River,* Alma-Ata, Kazakhstan.

Amralin, A. (2003). *Northern, Western Kazakhstan and soil morphology,* Kazakh Agrarian University, Astana, Kazakhstan.

Bayandin, N. (1963). *Soil scientists,* Publishing house of the State Agricultural Literature, Almaty, Kazakhstan.

Bigaliev, A.B., & Zhamalbekov, E.O. (1995). *Soil of Kazakhstan and its ecology,* Reader, Almaty, Kazakhstan.

Bronguleyev, V. (1961). Structure history of the formation of the Middle Paleozoic structural floor of the Central Karatau. *Moscow: Gostoptehizdat,* 282.

Chashina, B., Ramazanova, N., Atasoy, E., Berdenov, Z., & Ilieș, D.C. (2020). Natural recreation potential of the West Kazakhstan region of the Republic of Kazakhstan. *GeoJournal of Tourism and Geosites,* 32(4), 1355–1361. https://doi.org/10.30892/gtg.32424-580

Chibilev, A.A. (1983). *Earth book of the steppe region,* YUKI, Chelyabinsk, Russia.

Chigarkin, A.A. (1980). *Natural Monuments of Kazakhstan,* Alma-Ata, Kazakhstan.

Darbayeva, T.E. (1966). *Ecological path for studying the vegetation of the Cretaceous outcrops of the ecosystems of the West Kazakhstan region,* Samara, Russia.

Darbayeva, T., Ramazanova, N., Chashina, B., Berdenov, Z.G., Mendybayev, E., Wendt, J., & Atasoy, E. (2020). Modeling soil erosion in the Chagan river basin of the west Kazakhstan with using RUSLE and GIS tools. *Journal of Environmental Biology,* 41, 396-404. https://doi.org/10.22438/jeb/41/2/(SI)/JEB-18

Dzhanaleeva, G.M. (1999). *Anthropogenic Landscape Studies.* Alma-ata, KazGu, 55 .

Dzhanaleeva, G.M. (2003). *Methodological bases of the use of the geosystem-basin approach to the study of arid territories,* KazNU, Almaty, Kazakhstan.

Elias, R., Vitor, M.B., & Elo, I. (2016). *Modeling soil erosion using RUSLE and GIS in a watershed occupied by rural settlement in the Brazilian Cerrado.*

Isachenko, A. (1991). Landscape studies and physical and geographical zoning. *Higher School,* 366.

Mukayev, Z., Ozgeldinova, Z., Dasturbayev, S., Ramazanova, N., Zhanguzhina, A., & Bektemirova, A. (2022). Landscape and recreational potential of the mountainous territories of the Turkestan region of the Republic of Kazakhstan. *GeoJournal of Tourism and Geosites,* 41(2), 362–367. https://doi.org/10.30892/gtg.41204-838

Mukayev, T.Z., Ozgeldinova, O.Z., Janaleyeva, M.K., Ramazanova, Y.N., & Zhanguzhina, A.A. (2020). Assessment of the tourist recreation capacity of lake Alakol basin. *GeoJournal of Tourism and Geosites,* 30(2spl), 875–879. https://doi.org/10.30892/gtg.302spl13-517

Palmer, J.A., Schilling, K.E., Isenhart, T.M., Schultz, R.C., & Tomer, M.D. (2013). *Streambank erosion rates and loads within a single watershed: Bridging the gap between temporal and spatial scales.*

Ramazanov, S.K. (2000). *Ecological state of steppe landscapes of Northern Caspian region,* Orenburg, Russia.

Ramazanova, N.E. (2012). *Hydrochemical state of small rivers in the West Kazakhstan region (using the example of the Bykovka River basin),* PGU, Pavlodar, Kazakhstan.

Ramazanova, N., Toksanbaeva, S., Berdenov, Z., Ozgeldinova, Z., Tursynova, T., & Zhakupov, A. (2020). Analysis of the current state of recreational resources of the Nura River basin, the Republic of Kazakhstan. *GeoJournal of Tourism and Geosites,* 31(3), 1043–1048. https://doi.org/10.30892/gtg.31316-539

Renard, K.G., Foster, G., Weesies, G.A., Mccool, D.K., & Yoder, D.C. (1997). Predicting soil erosion by water: a guide to conservation planning with the Revised Universal Soil Loss Equation (RUSLE). *Agricultural Handbook No 703. United States Department of Agriculture,* Washington, USA.

Schultz, R.C., Colletti, J.P., Isenhart, T.M., Marquez, C.O., Simpkins, W.W., & Ball, C.J. (2000). Riparian forest buffer practices. *North American Agroforestry: An integrated science and practices. American Society of Agronomy,* Madison, WI.

Tevfik, E., & Unal, Y. (2012). *Soil Erosion Risk Assessment in the Sincanlı Sub-Watershed of the Akarçay Basin.Using the Universal Soil Loss Equation (USLE).* Ekoloji, Afyonkarahisar, Turkey.

Toksanbaeva, S.T., Ramazanova, N.E., & Tusupbekov, Z.A. (2022). Current state and prospects for the development of agricultural land in the Nura River basin. *IOP Conference Series: Earth and Environmental Science, 954(1), 012087.* https://doi.org/10.1088/1755-1315/954/1/012087

Wischmeyer, W.H., & Smith, D.D. (1978). *Predicting rainfall erosion losses: A guide to conservation.* Agricultural Handbook No. 537. Planning, Science and Education Administration. United States Department of Agriculture, Washington, USA.

Zhaksybaev, K.Z., & Usmanov, A.A. (1986). *Mechanization of soil cultivation: reference book,* Almaty, Kazakhstan.

Article history: Received: 07.02.2022 Revised: 28.05.2022 Accepted: 04.07.2022 Available online: 21.07.2022