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Spatiotemporal Variations and Socio-Economic Influencing Factors of Soil Erosion at Different Spatial Scales in Key Agricultural Areas of the Qinghai—Tibet Plateau from 2000 to 2022: A Case Study of the Huangshui River Basin

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Abstract: Soil erosion is a significant global environmental issue, especially in important agricultural areas. This study focuses on the Huangshui River Basin in the Qinghai–Tibet Plateau from 2000 to 2022. The soil erosion intensity, spatiotemporal changes in soil erosion rate, and its socio-economic influencing factors at three spatial scales (basin, city, county) were analyzed. The results show that slight erosion is predominant across all scales, yet there are some localized areas with more severe erosion, like Guide County and Hualong County. At the three spatial scales, the change trend in the soil erosion rate has many peaks and valleys, and peaks and valleys occur in the same year. Influencing factors vary by scale. At the basin scale, there is no significant correlation with socio-economic factors; however, at the city and county scales, multiple factors show significant correlations, like population and GDP. Based on these findings, targeted soil erosion control measures are proposed considering socio-economic perspectives. This paper can provide a scientific basis for soil erosion and ecological environment control in Huangshui River Basin.

Keywords: soil erosion; socio-economic influencing factors; Huangshui River Basin; Qinghai–Tibet Plateau

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1. Introduction

Soil erosion remains one of the most critical environmental issues globally. It not only accelerates land degradation but also exacerbates water pollution and poses a threat to food security [1]. Severe soil erosion can even have adverse impacts on economic development and human life safety [2]. For this reason, soil erosion has received high attention from countries around the world. Researchers around the globe have conducted extensive research on many aspects, such as the causes, processes, monitoring technologies and methods, erosion hazards, and influencing factors of soil erosion, and have achieved fruitful results [3–5]. These results play a crucial role in the control and prevention of soil erosion.

The influencing factors of soil erosion mainly consist of two aspects, namely natural factors and socio-economic influencing factors [6]. Natural influencing factors include precipitation, soil, terrain, vegetation, etc. [6]. Socio-economic influencing factors encompass land use, industrialization, urbanization, engineering construction, agricultural activities, etc. [7]. In comparison with economic and social factors, current research focuses more on the impact of natural factors on soil erosion. However, with the acceleration of urbanization, the influence of economic, population, and land use structure and other socio-economic factors on erosion is gradually increasing [8–10]. Human activities and related land use changes have become the principal causes of accelerated global soil erosion.

As the population continues to grow, humans require more social living conditions, such as more cultivated land and houses. Consequently, in the process of social development, the primary and secondary industries expand rapidly, inflicting substantial damage on the ecological environment and further accelerating soil erosion [11,12]. For instance, in Ethiopia, the expansion of cultivated land has altered the land use structure, accelerated land degradation, and then promoted soil erosion, becoming the main driving force for accelerated soil erosion in agricultural activities [11]. Simultaneously, with the continuous development of urbanization, the government pays increasing attention to soil protection and has implemented a series of ecological projects to control soil erosion. For example, the policy of returning farmland to forests implemented on a large scale in China plays an extremely important role in controlling soil erosion in China [13,14]. However, due to differences in socio-economic conditions, the soil conservation effects in different regions vary, and the key socio-economic factors affecting soil erosion have not been well evaluated [15,16]. Therefore, the relationship between economic and social development and soil erosion is worthy of in-depth discussion.

The Qinghai–Tibet Plateau is an important ecological barrier in China and plays a pivotal role in maintaining climate stability, carbon budget balance, and water resource supply. It is called the "Asian water tower" and is the "regulator" of environmental changes in Asia and even the Northern Hemisphere. Under the background of global warming, the ecological environment of the Qinghai–Tibet Plateau is more sensitive and prominent in response to climate change. In the past few decades, the Qinghai–Tibet Plateau has experienced significant warming, glacier retreat, frequent floods, and intensified melt-soil erosion [17]. The Qinghai–Tibet Plateau is vast in territory, and there are significant differences in terrain, climate, vegetation, etc. in different regions, almost encompassing all types of soil erosion driving forces on land [18]. Many scholars have conducted research on different types of soil erosion on the Qinghai–Tibet Plateau and achieved remarkable results [3,18–20]. However, there are still many deficiencies in the research on the socio-economic influencing factors of soil erosion in this region. Among the relevant results, there are more quantitative analysis studies on the natural influencing factors of soil erosion. However, for socio-economic influencing factors, these studies only mention that they accelerate soil erosion in the discussion or analysis, without using quantitative analyses [3,20].

The Huangshui River Basin is one of the important agricultural regions on the Qinghai–Tibet Plateau (the other is the Yarlung Zangbo River Basin). Due to the arid and cold climate on the Qinghai–Tibet Plateau and fewer areas suitable for agricultural activities, the farming activities and urbanization process in this region are more rapid than in other regions; thus, soil erosion is also more serious [21]. This study takes the Huangshui River Basin as an example, uses the RUSLE model to analyze the spatiotemporal variations in soil erosion and its socio-economic influencing factors in this region from 2000 to 2022, and proposes scientific approaches for preventing and controlling soil erosion in this region.

2. Materials and Methods

2.1. Study Area

The Huangshui River Basin is located in the northeast of the Qinghai–Tibet Plateau (Figure 1) and is formed by the alluvial deposits of the Huangshui River and the Yellow River. The geomorphic types of the basin are divided into valley plains (<2200 m), low hilly areas (2200–2800 m), and semi-low hilly areas (>2800 m), with an average altitude of 3095.4 m. The annual precipitation is 166.4–646.5 mm. Precipitation is mainly concentrated from May to October. Rain and heat occur in the same period. It has obvious advantages in agricultural location and resources and belongs to a high-altitude semi-arid area [22]. The administrative divisions of this area are divided into five city-level administrative units: Haibei City, Xining City, Haidong City, Huangnan City, and Hainan City. These five city-level administrative units have 17 counties under their jurisdiction. They are Menyuan County belonging to Haibei City; Huangyuan County, Huangzhong County, Datong County, Chengbei District, Chengxi District, Chengzhong District, and Chengdong District belonging to Xining City; Huzhu County, Ping'an District, Ledu District, Minhe County, Hualong County, and Xunhua County belonging to Haidong City; Guide County belonging to Hainan City; and Jianzha County and Tongren County belonging to Huangnan City. The land area is about 35,621 km^2. Although the area of Huangshui River Basin is much smaller than that of Qinghai Province, it has three-quarters of the population and 80% of the population in Qinghai Province. It is the area with the longest development history and the highest development intensity in Qinghai Province [22]. Water resources in the region are mainly distributed from south to north in the main stream of the Yellow River and its tributary Huangshui River. Due to the broken rock mass along rivers and ditches, collapse, landslide and debris flow disasters easily occur after being eroded by heavy rain.

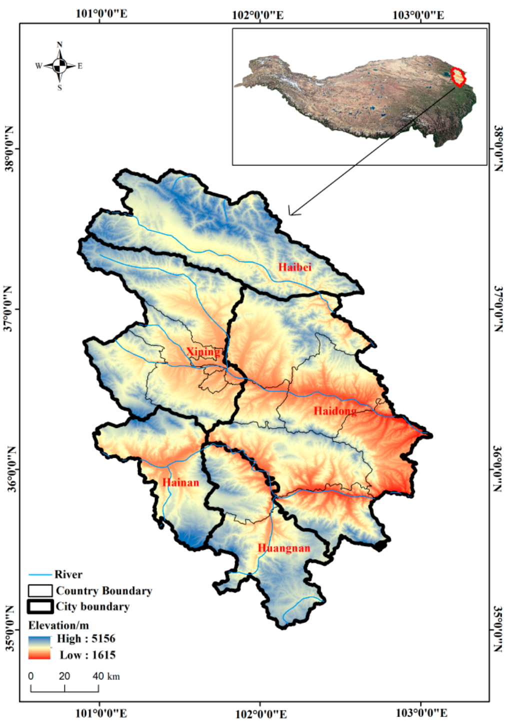


Figure 1. Study area [22].

2.2. Soil Erosion Estimation

The Revised Universal Soil Loss Equation (RUSLE) [23] is the most widely used soil erosion prediction model. The equation is expressed as follows:

$$A = R \times K \times L \times S \times C \times P \quad (1)$$

where A is the annual soil erosion rate ($t \cdot ha^{-1} \cdot yr^{-1}$); R is the rainfall erosivity factor ($MJ \cdot mm \cdot ha^{-1} \cdot h^{-1} \cdot yr^{-1}$) calculated by the method proposed by Zhang et al. [24], and this method has been widely validated in the Tibetan Plateau [24]; K is the soil erodibility factor ($t \cdot h \cdot MJ^{-1} \cdot mm^{-1}$) calculated by the formula (EPIC) proposed by Williams et al. [25]; L is the slope length factor, S is the slope steepness factor, and these are the LS factor, which is calculated using the LS tool [26] provided by the National Geographic Resource Science SubCenter (https://gre.geodata.cn (accessed on 5 April 2024)); C is the cover management factor, estimated using the formula proposed by Van der Knijff et al. [27]; and P is the support practice factor that is assigned values based on previous studies in QTP by land use types [3,28]. Specifically, 0.4 was assigned to cropland; 1 was assigned to forest, grassland, shrub, barren land, and snow/ice; and 0 was assigned to water, wetlands and impervious areas. Among them, L, S, C, and P are dimensionless factors.

The daily gridded precipitation dataset [29] was downloaded from the National Tibetan Plateau Third Pole Environment Data Center (https://data.tpdc.ac.cn (accessed on 1 April 2024)) at 0.1° resolution, and the paper related to this dataset was published in the *Earth System Science Data* [29]. Soil property raster data were obtained from the National Tibetan Plateau Third Pole Environment Data Center (https://data.tpdc.ac.cn) at 1 km resolution. DEM (ASTERGDEEM) data were obtained from Geospatial Datacloud (https://www.gscloud.cn/#page1/1 (accessed on 2 April 2024)) at 30 m resolution. Normalized Difference Vegetation Index (NDVI) data are derived from Landsat remote sensing images obtained through the Geospatial Datacloud, calculated after radiometric calibration and atmospheric correction, with a spatial resolution of 30 m, covering the time period from 2000 to 2022, and temporally focused on April to October. Land use data were downloaded from the Zenodo website, and the paper related to this dataset was published in the Earth System Science Data [30], with a resolution of 30 m. The above raster data are reclassified to a spatial resolution of 30 m.

2.3. Classification of Soil Erosion Intensity Grades

The soil erosion rates from 2000 to 2022 were calculated by RUSLE using a raster calculator in ArcGIS 10.2. Thus, the soil erosion rate of 2000–2022 were generated with raster data at a 1 km resolution. Then, soil erosion was classified into six grades according to the SL190-2007 "Standards for classification and gradation of soil erosion" published by Ministry of Water Resources of the People's Republic of China [31]. As shown in Table 1, these grades include light, moderate, intense, extremely intense, and severe erosion.

Table 1. Grading of soil erosion intensity [31].

Soil Erosion Intensity	Slight	Light	Moderate	Intense	Extremely Intense	Severe
Soil erosion rate ($t \cdot ha^{-1} \cdot yr^{-1}$)	0–5	5–25	25–50	50–80	80–150	>150

2.4. Influencing Factors of Soil Erosion

According to the related research of soil erosion and natural and socio-economic factors, combined with the characteristics of Huangshui River Basin, the socio-economic factors are included in the research scope of this paper, and the specific description and data sources are shown in Table 2.

Table 2. The details of socio-economic factors system.

Influencing Factor	Indicator (Unit)	Reference	Data Source
Socio-economic factors	Population: Total population (1×10^4 person), Population denstiy (person/km^2), Number of employees in agriculture (person); Economic: GDP(1×10^4 CNY), Value added of the primary industry (1×10^4 CNY), Value added of the secondary industry (1×10^4 CNY), GDP per capita (CNY/person), General budget expenditure of local finance (1×10^4 CNY) Land use: Cropland area (km^2), Forestland area (km^2), Grassland area(km^2), Impervious land area (km^2), Total grain output (t), Total oil seed yield (t), Total meat production (t).	Wang et al., 2022 [32]; Wang et al., 2017 [33]; Hua Li, 2013 [34].	China Statistical Yearbook (county-level), Xining Statistical Yearbook

2.5. Data Processing

The raster calculator in ArcGIS 10.2 was employed to compute soil erosion rates at the scale of the Huangshui River Basin. Subsequently, soil erosion rates were classified according to Table 1 within ArcGIS 10.2 to obtain the soil erosion intensity at three scales within the Huangshui River Basin, including basin, city and county. Administrative boundaries of cities and counties within the Huangshui River were then used to clip the soil erosion rates and soil erosion intensity, yielding data for different cities and counties in terms of soil erosion rates and soil erosion intensity. ArcGIS's zonal statistics function was utilized to acquire average annual soil erosion rates and soil erosion intensity data at the basin, city, and county scales from 2000 to 2022. The acquired data were organized in Excel and then subjected to correlation analysis (Spearman's correlation analysis) with various influencing factor indicators for the average soil erosion rates at the basin, city, and county scales in SPSS 24.

3. Results

3.1. The Distribution Characteristics of Soil Erosion Intensity Grades at Different Scales

Over the past two decades, at the scale of the Huangshui River Basin, slight erosion has been the most extensive, with the area affected by slight erosion reaching up to 95.32%. Light erosion accounts for 4.59% of the area, moderate erosion for 0.09%, and intense erosion approximately 0.00% (Figure 2a). At the city scale, slight erosion is dominant in all cities, with the area affected by slight erosion consistently over 90%, while other types of erosion have a smaller share. Xining City has the highest proportion of slight erosion among all cities (Figure 2b) at 98.63%, with light erosion covering only 1.37% of the area, and no areas of moderate or intense erosion. Hainan City ranks second in the proportion of slight erosion at 91.03%, with light erosion covering 4.58%, moderate erosion 0.30%, and intense erosion 0.06% of the area. Except for Xining City, other cities have a small proportion of slight erosion, all below 0.5%. Additionally, only Hainan Prefecture has areas of intense erosion, while other cities have no areas of intense erosion.

At the county scale (Figure 2c), similar to the urban scale, slight erosion is predominant in all counties, with proportions consistently over 90%. The distribution of slight erosion ranges from 91.10% in Guide County to 99.35% in Huangyuan County. Light erosion is present in all counties, with proportions ranging from 0.65% to 8.52%. Moderate erosion is only found in seven counties: Guide County, Hualong County, Huzhu County, Jianzha County, Menyuan County, Ping'an County, and Xunhua County. Intense erosion is only present in two counties, Guide County and Hualong County.

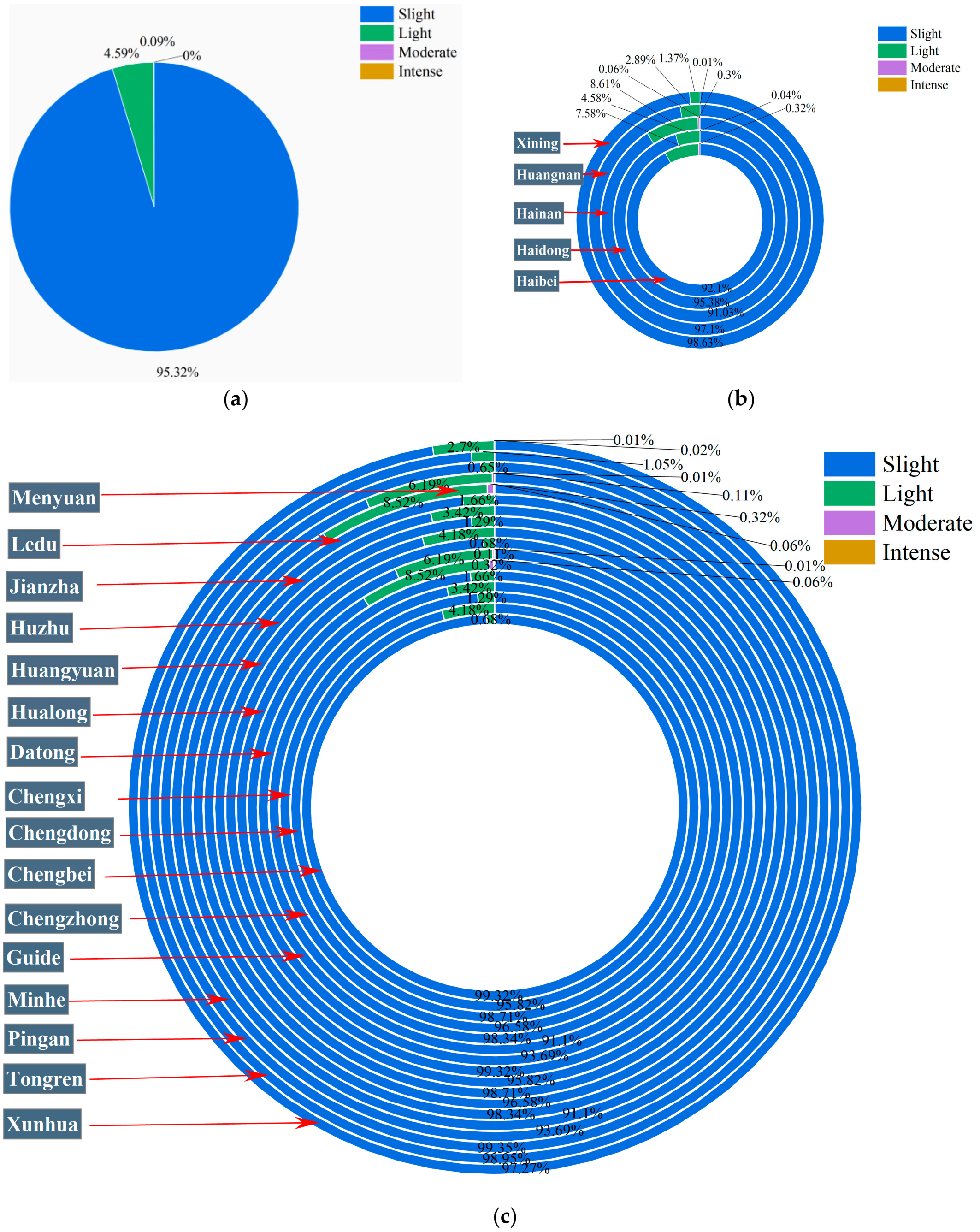
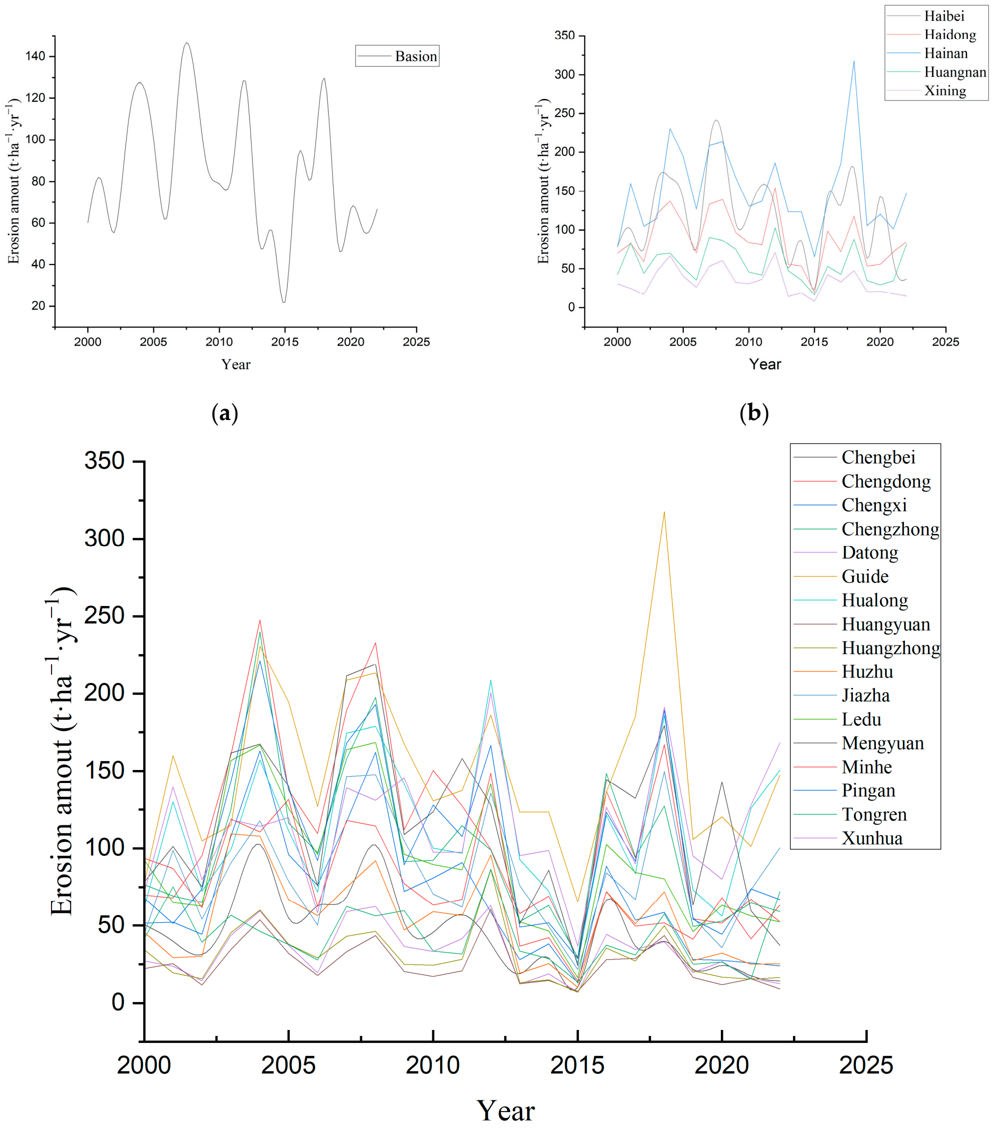


Figure 2. Proportion of different erosion intensities. (**a**–**c**) present the proportion of erosion intensity at the basin scale, city scale, and county scale, respectively. Note: The proportions in the figure represent the area of each erosion type as a percentage of the corresponding administrative jurisdiction area. (**a**) Proportion of erosion intensity at the basin scale; (**b**) Proportion of erosion intensity at the city scale; (**c**) Proportion of erosion intensity at the county scale.

3.2. Soil Erosion Rates at Different Scales from 2000–2022

At the basin scale, the soil erosion rate fluctuates over time, with multiple peaks and troughs (Figure 3a). The soil erosion rate is relatively high in the years 2004 (t·ha^{-1}·yr^{-1}), 2008 (136.85 t·ha^{-1}·yr^{-1}), 2012 (127.88 t·ha^{-1}·yr^{-1}), and 2018 (129.50 t·ha^{-1}·yr^{-1}), marking the peak positions. The soil erosion rate is lower in the years 2002 (55.48 t·ha^{-1}·yr^{-1}), 2006 (62.66 t·ha^{-1}·yr^{-1}), 2015 (22.19 t·ha^{-1}·yr^{-1}), and 2019 (50.79 t·ha^{-1}·yr^{-1}), marking the trough positions. The mean soil erosion rate is 83.27 t·ha^{-1}·yr^{-1} (Figure 4a), with a maximum value of 136.85 t·ha^{-1}·yr^{-1} in 2008 and a minimum value of 22.19 t·ha^{-1}·yr^{-1}

in 2015. The coefficient of variation is 0.38 (less than 0.1 is low; 0.1–1 is medium; greater than 1 is high), indicating a medium level of variation.



(**a**) (**b**) (**c**)

Figure 3. The soil erosion rate fluctuates over time. Here, (**a**–**c**) present the soil erosion rate fluctuates over time at the basin scale, city scale, and county scale, respectively. (**a**) The soil erosion rate fluctuates over time at the basin scale; (**b**) The soil erosion rate fluctuates over time at the city sale; (**c**) The soil erosion rate fluctuates over time at the county scale.

At the city scale, the soil erosion rate in each city fluctuates over time, similar to the basin scale, with multiple peaks and troughs (Figure 3b). Additionally, the years of peaks and troughs are the same as that noted at the basin scale, with higher rates in 2004, 2008, 2012, and 2018, and lower rates in 2002, 2006, 2015, and 2019. The mean soil erosion rate ranges from 33.79 t·ha^{-1}·yr^{-1} in Xining City to 116.01 t·ha^{-1}·yr^{-1} in Hainan City (Figure 4b). The maximum values range from 70.93 t·ha^{-1}·yr^{-1} in Xining City to 317.66 t·ha^{-1}·yr^{-1} in Hainan City, and the minimum values range from 8.02 t·ha^{-1}·yr^{-1} in Xining City to 65.40 t·ha^{-1}·yr^{-1} in Hainan City. The coefficient of variation ranges from 0.37 in Hainan to 0.52 in Xining, all indicating a medium level of variation.

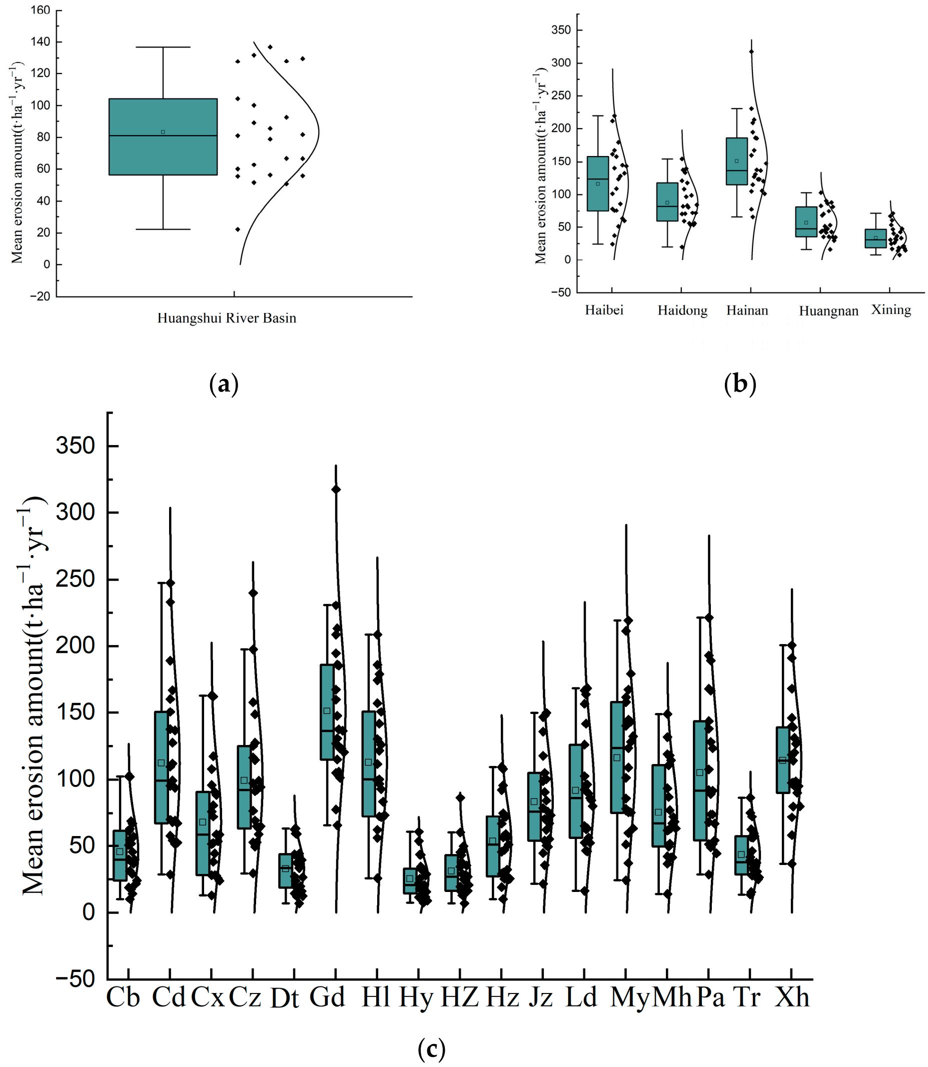


Figure 4. Mean soil erosion rate in 23 years (2000–2022). Here, (**a**–**c**) represent the mean soil erosion rate over 23 years at the basin scale, city scale, and county scale, respectively. Note: Cb, Cd, Cx, Cz, Dt, Gd, Hl, Hy, HZ, Hz, Jz, Ld, My, Mh, Pa, Tr, and Xh represent Chengbei, Chengdong, Chengxi, Chengzhong, Datong, Guide, Hualong, Huangyuan, Huangzhong, Huzhu, Jiazha, Ledu, Mengyuan, Minhe, Pingan, Tongren, and Xunhua, respectively. (**a**) Mean soil erosion rate over 23 years at the basin scale; (**b**) Mean soil erosion rate over 23 years at the city scale; (**c**) Mean soil erosion rate over 23 years at the basin scale.

At the county scale, the soil erosion rate in each county fluctuates over time, similar to the basin and urban scales, with multiple peaks and troughs (Figure 3c). Additionally, the years of peaks and troughs are the same as that noted at the basin scale, with higher rates in 2004, 2008, 2012, and 2018, and lower rates in 2002, 2006, 2015, and 2019. The mean soil erosion rate ranges from 25.28 t·ha^{-1}·yr^{-1} in Huangyuan County to 151.25 t·ha^{-1}·yr^{-1} in Guide County (Figure 4c). The maximum values range from 60.61 t·ha^{-1}·yr^{-1} in Huangyuan County to 317.66 t·ha^{-1}·yr^{-1} in Guide County, and the minimum values range from 6.97 t·ha^{-1}·yr^{-1} in Huangzhong County to 65.40 t·ha^{-1}·yr^{-1} in Guide County. The coefficient of variation ranges from 0.35 in Xunhua County to 0.52 in Huangzhong County, all indicating a medium level of variation.

3.3. Analysis of Influencing Factors of Soil Erosion Rates at Different Scales

At the basin scale, the mean soil erosion rate shows no significant correlation with all influencing factors (Table 3). At the urban scale, the mean soil erosion rate exhibits a significantly positive correlation with GDP, value added of the secondary industry, and impervious land area. It also shows a significant positive correlation with GDP per capita and a significantly negative correlation with grassland area. At the county scale, the mean soil erosion rate is significantly correlated with total population, population density, number of employees in agriculture, GDP, value added of the primary industry, value added of the secondary industry, GDP per capita, total grain output, total oil seed yield, total meat production, and cropland area. Conversely, it shows a significant negative correlation with general budget expenditure of local finance and a significant negative correlation with forestland area.

Table 3. The correlation analysis between the mean soil erosion rate and various influencing factor indicators.

Influencing Factor Indicators	Basin Scale	City Scale	County Scale
	Mean Soil Erosion Rate		
Total population	0.243	0.141	0.253 **
Population density	0.243	0.077	0.152 **
Number of employees in agriculture	−0.218	0.072	0.211 **
GDP	0.245	0.330 **	0.289 **
Value added of the primary industry	0.25	0.074	0.289 **
Value added of the secondary industry	0.223	0.277 **	0.268 **
GDP per capita	0.253	0.190 *	0.233 **
General budget expenditure of local finance	−0.272	−0.151	−0.317 **
Total grain output	0.251	0.031	0.151 **
Total oil seed yield	−0.218	−0.15	0.138 **
Total meat production	0.253	0.088	0.282 **
Cropland area	−0.129	0.088	0.140 **
forestland area	−0.326	−0.123	−0.119 *
Grassland area	−0.056	−0.312 **	0.08
Impervious land area	0.239	0.205 *	0.042

Notes: ** Spearman correlation coefficients are significant at $p < 0.01$. * Spearman correlation coefficients are significant at $p < 0.05$.

4. Discussion

4.1. Soil Erosion in the Temporal and Spatial Distribution of the Huangshui River Basin

The results presented in this study offer a comprehensive analysis of soil erosion patterns within the Huangshui River Basin. The findings indicate that the majority of the basin is characterized by slight erosion, which is consistent across different scales, including the basin, city, and county levels. This widespread yet mild form of erosion suggests that while soil degradation is prevalent, it is not severe, indicating a relatively stable environmental condition in the region from the soil erosion aspect. This may be related to the soil erosion control project, ecological environment control project, and the project of returning farmland to forest in the Huangshui River Basin in recent years [35]. The dominance of slight erosion, particularly in Xining City at an overwhelming 98.63%, implies that the urbanization and agricultural practices in this area have not led to significant soil degradation. This may be because Xining, as the capital city of Qinghai Province, has relatively perfect soil erosion control measures and ecological environment management [3]. However, the presence of light, moderate, and even intense erosion in certain areas, albeit minimal, suggests that there are localized hotspots where erosion is more pronounced and requires targeted interventions. This is also in line with the local actual situation. Under the conditions of heavy rain and heavy rainfall, the local area is prone to severe soil erosion [36].

The temporal analysis of soil erosion rates reveals a fluctuating pattern with multiple peaks and troughs over the two decades at three scales. It shows that there are many factors affecting soil erosion rate that do not follow a fixed trend. This is similar to the research results in other areas of the Qinghai–Tibet Plateau, and the soil erosion rate fluctuates on the time scale [3,28]. The mean soil erosion rate of 83.27 $t \cdot ha^{-1} \cdot yr^{-1}$ at the basin scale, with a medium level of variation as indicated by the coefficient of variation, suggests that while there is some variability in erosion rates, the overall trend is relatively stable. This stability is also reflected at the urban and county scales, with mean rates ranging from 33.79 to 16.01 $t \cdot ha^{-1} \cdot yr^{-1}$ and 25.28 to 151.25 $t \cdot ha^{-1} \cdot yr^{-1}$ respectively. At the same time, the direct soil erosion rates in different cities and counties are different, although their changing trends along time are similar (Figure 4). The variation in erosion rates across different administrative divisions could be attributed to differences in land use practices, topography, and the effectiveness of erosion control measures [16,24,32]. Overall, the soil erosion rate in the Huangshui River Basin is changeable, but there is no abnormality on the whole. It can be reflected that the soil erosion rate in this area is still in a relatively stable state under the background of climate, land use, economy, and population factors. Furthermore, it can be shown that the soil erosion control measures in this area are effective.

4.2. Analysis of Influencing Factors of Soil Erosion Rate

At the basin scale, the soil erosion rate is not significantly related to any socio-economic factors. This may be because on a large scale, soil erosion is still controlled by many natural factors, but its correlation with social economy is weak in the Huangshui River Basin. This is also consistent with the conclusion of the overall soil erosion research on the Qinghai–Tibet Plateau [3]. Although the influence of human activities on soil erosion is constantly strengthening, the contribution rate of human activities to soil erosion changes is 16.7–25.4% [3]. This discovery can also reflect that at the basin scale, human activities have not reached a decisive level for soil erosion in the Huangshui River Basin, but are relatively controllable. The lack of significant correlation with other factors at the basin scale could be attributed to the broader scale of analysis, which may mask the influence of local factors [37]. Additionally, the homogeneity of the basin in terms of land use and management practices could reduce the variability in other factors, leading to non-significant correlations.

At the city scale, the mean soil erosion rate shows a significantly positive correlation with GDP, value added of the second industry, average annual rainfall, and impervious land area. These correlations suggest that urbanization and industrialization are significant drivers of soil erosion in the region [38]. The expansion of urban areas and industrial zones leads to an increase in impervious surfaces, which reduces the soil's capacity to infiltrate water and increases runoff, thereby enhancing soil erosion. The positive correlation with GDP and the value added of the second industry indicates that economic development is closely linked to soil erosion [38]. This could be due to the increased demand for land for industrial and commercial purposes, leading to the conversion of natural landscapes into built-up areas, which are more prone to soil erosion [3]. The mean soil erosion rate shows a significant negative correlation with grassland area. It shows that at the city scale, with the increase in grassland area, the soil erosion rate decreases. The increase in grassland area usually means the increase in vegetation coverage, which plays an important role in reducing soil erosion [38,39]. Vegetation can enhance the anti-erosion ability of soil through its roots, and the plant canopy can reduce the direct impact of rain on the soil surface, thus reducing the risk of soil erosion [38].

At the county scale, the mean soil erosion rate is significantly correlated with a wide range of factors, including population-related indicators (total population, population density, and number of employees in agriculture), economic indicators (GDP, value added of the primary and second industries, and GDP per capita), and land use indicators (cropland area, total grain output, total oil seed yield, and total meat production). These correlations suggest that soil erosion is a complex issue influenced by multiple factors operating at the county scale. The significant positive correlation with population-related variables and agricultural outputs indicates that population pressure and agricultural activities are key drivers of soil erosion. As population density increases, the demand for agricultural land and resources also increases, leading to more intensive agricultural practices and potentially higher soil erosion rates [40]. Similarly, the expansion of agricultural activities to meet the demand for food and other agricultural products can lead to land degradation and increased soil erosion [41]. The soil erosion rate is positively correlated with total grain output, total oil seed yield, and total meat production, which shows that the output of grain, oil crops, and meat products will damage the surface of farmland or grassland, thus leading to the increase in soil erosion rate [42,43]. The significant negative correlation with the general budget expenditure of local finances and forestland area suggest that areas with higher investments in environmental protection and areas with more natural vegetation cover are less prone to soil erosion [3,44]. This highlights the importance of investments in environmental conservation and the role of natural vegetation in reducing soil erosion.

4.3. Soil Erosion Control Measures Based on Socio-Economic Perspective

Although the overall situation is good, there is still intense erosion in some areas, such as Guide County, Huzhu County and Hualong County, so we can put forward some targeted prevention measures from the county scale. The first measure includes reasonable control of industrial activities and urban expansion. Although the increase in industrial activities and cities will increase the GDP in the short term, it will also lead to an increase in the soil erosion rate. Industrial activities and urban expansion will destroy vegetation and soil on land surface, resulting in soil erosion [45]. Second, the government departments should increase the budget investment for soil erosion control. Although seeking economic development, increasing grain production, and increasing cultivated land is the pursuit of county development, it is difficult to change these factors in a short period of time. However, by increasing the budget for soil erosion control, the areas of afforestation, watershed control, and erosion gully control can be increased. Then, the soil erosion rate can be indirectly reduced [3,44]. Third, soil and water conservation agriculture and animal husbandry measures should be promoted. The ecological environment of the Huangshui River Basin is fragile, but the local area is also indispensable for agricultural development. Based on the results presented in this paper, it can be seen that the increase in agricultural activities will lead to an increase in the soil erosion rate. Therefore, we can introduce soil and water conservation agriculture and animal husbandry measures to ensure that soil erosion is reduced as much as possible while carrying out agriculture and animal husbandry activities. At present, such measures are very extensive, such as terrace construction [46], contour tillage [47], agroforestry [48], and rotational grazing [49]. What we need to pay attention to is that although we have put forward prevention and control measures for severe soil erosion in some areas, it does not mean that the widespread slight and light soil erosion does not need prevention and control. Although the soil erosion rate is relatively low, slight and light soil erosion is very extensive in the Huangshui River Basin, accounting for 95.32% and 4.59% of the area of Huangshui River Basin, respectively. After long-term development, slight and light soil erosion will also cause great damage to water and soil resources. Therefore, it is also necessary to control the slight and light erosion by formulating policies for afforestation and returning farmland to forests. Through the above measures, the soil erosion rate in Huangshui River Basin is close to zero or close to the natural rate. Although these measures are put forward according to the results of this research, these results also have good applicability and universality. These results can also be popularized and applied to other ecologically fragile areas. Finally, we need to pay attention to the fact that the Qinghai–Tibet Plateau is one of the regions with the most severe climate change on the Earth, and it faces many problems such as melting glaciers, rising temperatures, and increasing precipitation [50]. Therefore, these measures need to be implemented with the highest standards and quality possible to cope with the impact of future climate change on soil erosion. How to quantify the implementation standards of these measures under the influence of climate change will be the focus of our next research.

5. Conclusions

This study comprehensively analyzed soil erosion patterns in the Huangshui River Basin. The prevalence of slight erosion indicates a relatively stable environment, although localized hotspots require attention. Temporal fluctuations in erosion rates suggest the influence of multiple factors. At the basin scale, natural factors dominate. However, at city and county scales, socio-economic factors play a more significant role. This implies that soil erosion control should be scale-specific. The proposed control measures from a socio-economic perspective, such as the introduction of certain policies by the county government to control industrial activities, increases in the budget for erosion control, and the promotion of conservation agriculture and animal husbandry, are helpful to reduce soil erosion in this area. Of course, the implementation of these measures requires not only the formulation of county-level governments, but also the support of higher-level governments and the cooperation of relevant departments affected by policies. Overall, this research provides valuable insights for understanding and managing soil erosion in similar agricultural areas.

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