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ASSESSMENT OF THE SOIL EROSION & WATER QUALITY STATE IN THE DOWNSTREAM PORTION OF SYRDARYA USING THE WATER QUALITY INDEX ARITHMETIC METHOD

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Abstract. The Syrdarya river basin, with its rich historical significance in agriculture, now faces with contemporary challenges that demand immediate attention. The main issues revolve around soil erosion and declining water quality downstream, both of which pose severe threats to the ecosystem and local communities. One pressing concern is the alarming lack of research in this region, leaving a critical knowledge gap in understanding and addressing these challenges effectively. The interplay between water quality and soil erosion is a fundamental aspect that cannot be overlooked. Salinity, primarily caused by elements such as SO_4^{2-} and Ca^{2+}, plays a pivotal role in the degradation of soil and exacerbation of erosion by impeding plant root access to water. Downstream areas, particularly those reliant on rice-based cropping fields that require extensive irrigation, bear the brunt of these issues. Erosion in these regions leads to a cascading effect on water quality. Saline soil, pesticides, and fertilizers eroded from fields ultimately find their way into the river, posing significant threats to both ecosystems and nearby communities. Furthermore, the escalating levels of soil erosion and degradation have substantially increased the demand for irrigation water. If the current rate of soil salinization and river pollution remains constant, it's a bleak forecast for the Kyzylorda region. In a matter of decades, the once-fertile lands may become unsuitable for agriculture, and the Syrdarya river's water may no longer be safe for drinking or other critical purposes. This study aims to shed light on the intricate relationship between water quality and soil erosion in the Syrdarya river basin. It utilizes the water quality index (WQI) methodology to assess the impact of soil erosion and potential pollutants on the river's water quality. By doing so, it underscores the urgent need for informed decision-making in the pursuit of sustainable resource management and environmental protection in this crucial region. Recognizing and addressing these challenges is not only essential for the present but also for safeguarding the future of the Syrdarya river basin and its inhabitants.

Key words: soil erosion, water quality, Agricultural practice, furrow irrigation, Kyzylorda, Syrdarya, WQI (water quality index), priority indicator of water quality index.

INTRODUCTION

The Syrdarya river basin, renowned for its historical role in agricultural production, confronts contemporary challenges centered on water quality and soil erosion downstream in the irrigated lands. Despite the pressing need to address the impact of agricultural and industrial pollutants in this region, research has been notably lacking. The interdependent relationship between water quality and soil erosion cannot be overstated [1]. The statistical analysis found that the irrigated lands in the Syrdarya river basin had the highest levels of salinity, with SO_4^{2-} being the main anion and Ca^{2+} as the main cation contributing to this [2]. Salinization will contribute to the erosion and degradation of soil which can be ascribed to the vegetation dynamics. Because the salts hinder the ability of plant roots to access water in the soil.

Both primary and secondary salinization are significant factors contributing to soil erosion in the Syrdarya region which are related to agricultural activities. Primary salinization occurred in the region as a result of the initial accumulation of salts in the soil due to factors like the use of saline water for irrigation. This process disrupted the soil's structure and reduced its ability to retain moisture, making it more vulnerable to erosion by wind and water.

Secondary salinization, on the other hand, has occurred because the salts that have accumulated in the soil over time are brought closer to the surface through capillary action or other mechanisms. This happens as a result of poor irrigation practices, such as excessive water application or inadequate drainage systems, which cause salts to rise and accumulate in the topsoil. Secondary salinization further exacerbated the soil's susceptibility to erosion.

The hydrochemistry and geochemistry of the Syrdarya River play a vital role in the region's economical situation, as they are significantly influenced by agricultural and industrial activities both upstream and downstream to the river. These activities have a profound impact on the lives and ecosystems of the local inhabitants. One notable example is the salinity of the soil, which results from ineffective irrigation practices.

Salt is a beneficial mineral for both human consumption and crop growth, as it is essential for the human body and plant development. However, when the salt content in the soil of the vicinity lands of a river exceeds the established standards, it initiates a series of negative consequences. First, it leads to soil erosion and infertility, degrading the quality of the land for agriculture. This, in turn, intensifies the water requirements of plants as they struggle to cope with the salt-affected soil. Additionally, the excess salt in the river pollutes the surface water as it is carried away by the flowing river. The Soil erosion in the downstream section of the Syrdarya adversely affected the river's water quality. This is primarily caused by the runoff of eroded saline soil from agricultural lands, coupled with the washing away of pesticides and fertilizers applied to fields, which ultimately find their way into the river. This process of sedimentation and pollution poses a significant threat to freshwater and marine habitats, as well as the well-being of local communities that rely on these ecosystems. In this study, we aimed to assess the impact soil erosion and other pollutants on the quality of Syrdarya. We employed the water quality index (WQI) methodology to identify pollution stemming from industrial and agricultural operations, encompassing both metallic and non-metallic chemical constituents, salinity, Ph levels, total dissolved solids (TDS), minerals, as well as pesticide residue contamination. The significance lies in the absence of recent water quality evaluations and the impact of soil erosion and agricultural practices.

Thus, it is crucial to effectively combat soil erosion to ensure the soil structure, its conservation, and subsequently preservation of water quality. Concerns related to water contamination, primarily stemming from agricultural practices, have been addressed in existing research, as highlighted by research studies [3].

Soviet initiatives aimed at boosting agricultural output resulted in significant water diversion, which has had adverse effects on the suitability of water for both irrigation and fisheries, as noted by [4].

Agricultural activities are identified as the primary source, accounting for 90% of water pollution in the basin, with industrial pollutants, though smaller in volume, posing heightened toxicity [5]. The discharge of agricultural irrigation water into the rivers was the major cause of the increases in minerals and salinity [6].

The discharge from irrigation runoff is a significant contributor to water contamination in various regions, as it has an impact on the suitability of water for subsequent purposes, including domestic, industrial, irrigation supply, fisheries, and occasionally recreational activities [7]. Eroded soil, which carries salinity and other mineral particles from fertilizers and pesticides in the soil, and soil itself, contributes to water pollution in the river.

When polluted water is released untreated or poorly treated into rivers, it becomes challenging to restore, making water quality a paramount issue. Furthermore, industrial activities, including hazardous chemical facilities and tailings management, pose significant threats to water quality [8].

Simultaneously, irrigated agriculture, which dominates the region, imposes stresses on soil structure. Water-intensive crops, such as rice, contribute to changes in soil structure and erosion. In Kyzylorda, the primary rice-growing region, furrow irrigation, which is essential for agricultural productivity, leads to soil erosion [9]. Erosion results in a decrease in topsoil depth, which contains vital nutrients like nitrogen, phosphorous, potassium, and magnesium, further impacting soil fertility and contaminating surface water bodies [10].

As per Figure 1, water contamination in the Syrdarya River has been a long-standing problem, and analysis of water samples has revealed a troubling pattern of increasing mineralization levels from 1960 to 2000. This rise in mineralization has been consistently observed in all four hydrographic representative sections of the river. Of particular concern is the region of Kyzylorda, which stands out with the highest average annual mineralization rate of 1.715 g/l, second only to the Kazalinsk hydrographic section along the Syrdarya River.

This data underscores the alarming trend of rising mineralization levels in the Syrdarya River, with Kyzylorda experiencing significant water quality challenges. The continuous increase in mineralization levels poses serious threats to the local ecosystem, agricultural practices, and the well-being of communities that rely on this water source. Urgent and comprehensive measures are needed to address this pressing issue of water contamination in the Syrdarya River, ensuring the preservation of both the environment and the livelihoods of those dependent on this vital waterway. [11]

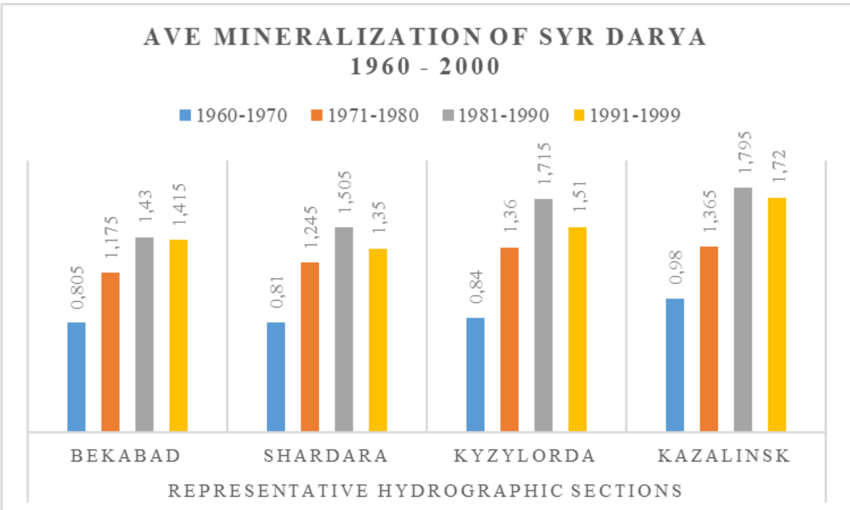

Figure 1 - Ave Mineralization of Syrdarya during 1960-2000 [11]

Figure 2 presented highlights a significant environmental concern in central and southern Kazakhstan that is the widespread problem of soil salinization. This issue is primarily driven by the distinctive arid and semi-arid climates prevalent in these regions, which contribute to the accumulation of salts in the soil. Agricultural activities in the area further intensify soil salinization.

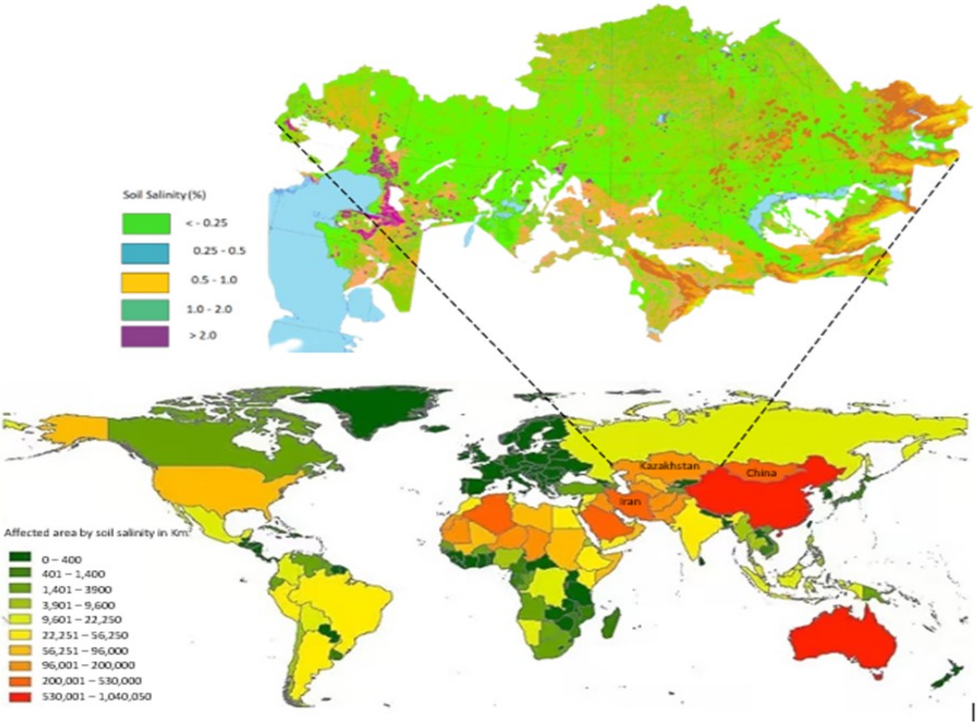

Figure 2 - Kazakhstan and global soil salinization during (1989 and 2020) [12][13]

Globally speaking, one-third of all irrigated land, encompassing more than 100 countries including across various climate zones, were affected by salinity. Central Asia, owing to its geographical location, is naturally characterized by high salinity. This includes one billion hectares of irrigated land with diverse levels of salt content, of which less than 80 million hectares can be attributed to human activities. The adverse impact of soil salinization is particularly significant in (semi-)arid regions, with detrimental consequences for their economic sectors.

According to United Nations data, approximately six million hectares of currently irrigated land are affected by salinity in different ways. Alarmingly, over 40% of the world's total agricultural land is degraded due to unsustainable land reclamation practices, which suggests that a substantial portion of irrigated land may become unsuitable for cultivation in the future [14].

Salinity is typically not evenly distributed and varies based on the geochemistry of a region. According to a global salinization map, one of the continents with the highest prevalence of salt-affected areas is Asia, with a particular focus on Kazakhstan, Iran, and China. In these arid and semi-arid climates, evaporation surpasses precipitation, leading to the accumulation of salt in the soil. The global map of soil salinization shows that soil salinity has almost doubled in Kazakhstan between 1980 and 2020 [12].

The quantity of water required for irrigation on farmed lands will increase due to soil salinity and degradation. Predictions indicated that most of the agricultural land in the Syrdarya river basin will become unsuitable for irrigation in the next few decades if the current trend of soil salinization and water pollution continues. In addition, the rivers will no longer be appropriate for supplying drinkable water due to the increasing levels of salt contamination. This type of river contamination has the potential to do irreversible damage to the ecology and the socioeconomic development of the Kyzylorda oblast.

A significant shift has occurred in Kazakhstan's water usage patterns over recent decades. While surface water sources were historically the predominant choice for water supply in most regions, the constraints associated with surface water availability and quality have led to a heightened utilization of groundwater resources.

In such a situation, the management of soil erosion and desalinization can be very helpful but quite costly. Also, the choice of strategies depends on the specific type of salinity and erosion conditions that need to be addressed. Nevertheless, in the southern part of Kazakhstan and the flood plain of the Syrdarya river basin soil salinity is caused by furrow irrigation in rice-based cropping fields [15]. Efficient water utilization can best manage and mitigate salinity irrigation issues in this region. Particularly drip irrigation serves as a prime illustration of effective water management to control soil salinity.

This literature review underscores the interdependence of water quality and soil erosion in the Syrdarya river basin, emphasizing the need for comprehensive research and integrated strategies to address these environmental challenges effectively.

MATERIALS AND METHODS

In this study, we adopted a secondary data collection approach to gather and analyze data. This approach allowed us to leverage previously collected information and focus on analyzing, interpreting, and drawing meaningful conclusions from the available data. For analyzing purpose, it was important to understand the extent of water pollution in the basin. Only a handful of studies have previously reported the level of water pollution in the river stemming from agricultural practice and soil erosion. For instance, in 2015, Daniel. D. Snow conducted a research study in which water samples were gathered from five remote locations to investigate how agricultural practices affected seasonal changes in water quality before and after crop growing seasons. These samples were obtained from downstream areas of the Syrdarya river in Kazakhstan. During all the sampling events in Syrdarya, it was observed that the water samples contained residues of lindane (γ-HCH) ranging from 0.014 to 0.24 g/L. These concentrations were among the highest reported globally for river systems. Considering that Lindane, a chemical compound used both as an agricultural insecticide and as a pharmaceutical remedy for lice and scabies, can pose significant risks when it contaminates sources such as drinking water and fisheries, it's important to be aware of its potential harm in these contexts. Syrdarya [16]. Hence, a literature review was an effective tool for data collection procedures.

UNECE report on water quality in the Amu-Darya and Syrdarya river basins detailed water quality indicators for the Syrdarya are outlined in table 1. The Maximum Allowable Concentrations (MAC) 1 and 2 are specified for fisheries and agriculture, while MAC 3 is designated for drinking purposes in open water bodies. These indicators formed the foundation for establishing standard values for each parameter in our analytical study. The subsequent tables and paragraphs provide a comprehensive overview of the parameters' indicators and mean concentration values [17].

These indicators will provide us with insights into the acceptable levels of salinity, PH, and other minerals in the Syrdarya's water for specific purposes such as agriculture, fisheries, and drinking. If these mineral levels surpass the established standards, it indicates potential issues with the neighboring soils too.

Table 1 - Water quality indicators for Syrdarya river [17]

№	Indicator	Unit	MAC1	MAC2	MAC3
1	Oxygen	mg/l	6	-	0.005
2	BOD	mgO^2/l	3	-	6
3	COD	mgO^2/l	15	-	-
4	Nitrite Nitrogen	mg/l	0.02	-	3
5	Salinity	mg/l	1000	-	up to 1000
6	Chlorides	mg/l	300	350	350
7	Sulphates	mg/l	100	-	500
8	Magnesium	mg/l	40	-	< 40
9	Sodium	mg/l	120	-	120
10	Total hardness	ml/l	7	7	7
11	Copper	µg/l	1	1	1
12	Zinc	µg/l	10	5	1
13	Chrome VI	µg/l	1	-	0.5
14	Phenol	mg/l	0.001	-	No more than 0.01
15	Oil products	mg/l	0.05	-	No more than 0.05
16	Fluoride	mg/l	0.75	1.5	1.5

The analysis of soil conditions in 2020 unveiled a notable degree of land degradation, affecting 43% of Kazakhstan's landmass to a significant extent. Additionally, desertification is on the rise within the irrigated soils of the Syrdarya river deltas. [18]. Though, it is the responsibility of soil to capture and retain water. However, degraded soil lacks the ability to hold water for extended periods, leading to excessive runoff that eventually flows into the river, resulting in river' water pollution. This is a recurring issue occurring in the Syrdarya river. Following in this research we will scrutinize that the current states exceed the standard level.

The region lacks adequate water quality data, making it challenging to assess the current status reliably. This is not surprising, given the limited understanding of the regulating processes, which in turn hinders the development of sustainable management strategies for predicting solute variations.

The latest research, which focuses on assessing the concentrations of dissolved and acid-leachable trace elements concerning applicable water quality standards in the Syrdarya, Aral Sea Basin, South Kazakhstan [19], also scrutinized the levels of metallic and non-metallic chemical compounds, along with other minerals and total dissolved solids. This analysis was conducted based on three distinct criteria: minimum, average, and maximum, as illustrated in table 2. The mean values were utilized in this research.

In the present study the approach is calculation of Water Quality Index WQI using the weighted arithmetic index method [20], which indicates the extent of water pollution or quality. This unique parameter will help us better understand the current state of the water quality of Syrdarya in terms of an index number, which represents the overall quality of water for any intended use. It is defined as a rating that reflects the composite influence of different water quality parameters taken into consideration for the calculation of an index (WQI). The indices are among the most effective ways to communicate information on water quality trends to the public or the policy makers and in water quality management. In the formulation of the WQI, the relative importance of various parameters depends on the intended water.

Table 2 - Major ions and TDS (in mg L−1) collected for Syrdarya waters in August 2021, [19]

Minerals	TDS	HCO_3^-	$CO^2{}_3^-$	CL^-	$SO^2{}_4$	Ca^{2+}	Mg^{2+}	Na^+	K^+
Metal/Non-metal ions	NA	NA	N	N	N	M	M	M	M
Average	1359	140	-	125	737	130	95	175	4.1
Maximum	1502	247	9	147	804	170	109	213	4.8
Minimum	1257	98	ND	113	661	116	89	158	2.4

Step 1: In the present study, the unit weight (Wn) values for each parameter were calculated by using the following formula taken from studies on water quality parameters of bore waters of Reddigudum Mandal [21].

$$W_n = \frac{k}{Sn} \quad (1)$$

Were,

$$K = \frac{1}{\frac{1}{s1}+\frac{1}{s2}+\frac{1}{s3}+....+\frac{1}{sn}} = \frac{1}{\Sigma\frac{1}{sn}} \quad (2)$$

Sn = Standard permissible value for the nth parameters

W_n = unit weight for nth parameter

k = proportionality constant

Step 2: Calculation of Sub index (Qn) value by using the formula:

$$Q_n = \frac{(Vn-Vo)}{(Sn-Vo)} \times 100 \quad (3)$$

Q_n = quality rating

n = water quality parameter

v_n = Mean concentration of observed value

v_S = Standard value

v_o = ideal value, in most cases Vo=0 except in certain parameters like Ph, dissolved oxygen, etc.

$$Q_{PH} = \frac{(VPH-7)}{(8.5-7)} \times 100 \quad (4)$$

Therefore,

$$Q_{PH} = \frac{(8.21-7)}{(8.5-7)} \times 100$$

$$Q_{PH} = \frac{(1.21)}{(1.5)} \times 100 = 0.8$$

Q_{PH} = 0.8

Step 3: Calculation of WQI, by combining step 1 and step 2:

$$WQI = \frac{\Sigma Wn\ Qn}{\Sigma Wn} \quad (5)$$

$$WQI = \frac{89.25}{1} = 89.25$$

Table 3 - Calculation of Water Quality Index [20]

Parameters	Standard (Sn)	1/Sn	Σ 1/ Sn	K = 1/ (Σ1/Sn)	Wi = K/Sn	IDEAL Value (V0)	Mean Con Value (Vn)	Vn/Sn	Qn= Vn/Sn *100	WnQn
PH	8.5	0.118	0.259	3.861	0.454	7	8.21	0.8	80.000	36.342
EC	300	0.003	0.259	3.861	0.013	0	318.4	1.0613	106.133	1.366
TDS	500	0.002	0.259	3.861	0.008	0	1359	2.718	271.800	2.099
Ca2+	75	0.013	0.259	3.861	0.051	0	130	1.7333	173.333	8.924
Mg2+	<40	0.025	0.259	3.861	0.097	0	95	2.375	237.500	22.926

Продолжение таблицы №3

Parameters	Standard (Sn)	1/Sn	Σ 1/Sn	K = 1/(Σ1/Sn)	Wi = K/Sn	IDEAL Value (V0)	Mean Con Value (Vn)	Vn/Sn	Qn= Vn/Sn *100	WnQn
CL-	250	0.004	0.259	3.861	0.015	0	125	0.5	50.000	0.772
Na+	120	0.008	0.259	3.861	0.032	0	175	1.4583	145.833	4.693
K+	12	0.083	0.259	3.861	0.322	0	4.1	0.3417	34.167	10.994
SO(4) 2-	500	0.002	0.259	3.861	0.008	0	737	1.474	147.400	1.138
Sum		0.259			1.000002					89.254

RESULTS AND DISCUSSION

Irrigation practices in the rice cropped areas, such as in Kyzylorda, caused soil erosion and diminish soil fertility due to salinity and alterations in soil structure, resulting in the contamination of the Syrdarya river by the irrigation runoff water.

A numerical analysis of the priority indicators of water quality in Syrdarya for fisheries, agriculture, and drinking water were provided by [13]. These indicators were evaluated based on the maximum acceptable concentration, as shown in table 1.

Our study determined that the median value for PH in Syrdarya was 8.21, the median value for electrical conductivity (EC) was 318.4 μS cm^{-1}, and the median value for total organic carbon (TOC) was 2.75 mg/l.

Table 1 and table 2, which are included in our study, serve as the foundation for calculating the WQI and provide a description of the current water quality status in Syrdarya. To estimate the WQI, we took the average values from nine different sites, focusing on the concentrations of minerals in the river, as presented in Table 2. The calculation of WQI and the respective formulas were provided at table 3.

In addition, we assessed the appropriateness of the (WQI) values, as indicated in table. 4, for human consumption, based on a study conducted on the pollution in the drinking water of Rairangpur, a small town in North Orissa predominantly inhabited by tribal communities [22]. The ratings for the WQI values are as follows:

Table 4 - Classification of Surface Water quality according to [22].

Classification of surface water quality according to WQI range		
Category	Water Quality	WQI
I	Excellent	0 -25
II	Good	26 - 50
III	Poor	51 - 75
IV	Very Poor	76 - 100
V	Unsuitable	Above 100

Our calculations and literature analysis revealed that the water quality, which results from eroded soil in the flood plain of Syrdarya, falls under Mishra & Patel's (2001) IV category, as indicated in table. 4, that is "Very Poor" and unfit for drinking purposes.

The results of this study emphasize the critical interplay between water quality and soil erosion in the Syrdarya river basin.

The combination of these factors poses severe challenges for both the environment and local communities, particularly in downstream regions heavily reliant on agriculture. It is evident that the impact of agricultural and industrial pollutants in this region, coupled with poor irrigation practices, has led to salinization and subsequent soil erosion.

The absence of adequate research and comprehensive data on water quality and soil conditions in the Syrdarya region highlights the urgent need for further investigation. This study utilized the WQI methodology to assess the impact of soil erosion and potential pollutants on the river's water quality. The calculated WQI of 89.25 underscores the substantial pollution and degradation of water quality in the Syrdarya, indicating that immediate measures are required to mitigate these issues.

Efforts to combat soil erosion, such as efficient water management practices like drip irrigation, are crucial for preserving soil structure and preventing further degradation. Furthermore, addressing salinity issues in soil and water sources is imperative to maintain the viability of agriculture in the region.

The consequences of failing to address these challenges are dire, with the potential for vast areas of the Syrdarya basin becoming unsuitable for irrigation and increasing risks to both the environment and human health. It is imperative for policymakers and stakeholders to recognize the urgency of this situation and prioritize informed decision-making to ensure the sustainable management of resources and protection of the Syrdarya river basin and its inhabitants. Additionally, further research and data collection efforts are essential to monitor changes in water quality and soil conditions over time and to guide effective mitigation strategies.

CONCLUSION

In conclusion, this research delves deep into the pressing environmental challenges plaguing the Syrdarya River Basin, with a specific focus on unraveling the complex interplay between soil erosion and water quality decline. The findings of this study cast a spotlight on the profound repercussions of this intricate relationship, reflecting throughout the entire region's water quality.

One of the pivotal discoveries of this investigation is the irrevocable degradation of water quality downstream in the Syrdarya River. This deterioration can be primarily attributed to agricultural practices and related erosion of soil. The erosive forces at play, coupled with the runoff of pesticides and fertilizers, have led to a distressing surge in pollution levels.

This alarming scenario poses an imminent threat not only to the delicate freshwater and marine ecosystems but also to the livelihoods of the local communities heavily reliant on these ecosystems for their sustenance.

To comprehensively gauge the extent of this environmental crisis, the study employed the WQI (WQI) methodology, taking into account some parameters including chemical constituents, PH level, Total Dissolved Solids (TDS), mineral content, and pesticide residues. This research assumes paramount importance given the dearth of recent evaluations regarding water quality, coupled with the mounting concerns regarding the loss of the most fertile layer of soil, and the declining water quality stemming from conventional irrigation practices, notably furrow irrigation which is commonly employed for cash crops such as rice.

Categorically, this study pinpoints agricultural activities as the primary culprit behind water pollution in the Syrdarya River Basin, contributing a staggering 90 % to the overall pollution burden. Although industrial pollutants are comparatively lower in quantity, they exhibit significantly higher toxicity levels, compounding the overall environmental challenge. The discharge of agricultural irrigation water into the river emerges as a pivotal factor exacerbating soil erosion and elevating salinity levels, thus further amplifying the water pollution crisis.

In the quest to enhance surface water quality in the region, the study underscores the effectiveness of adopting soil conservation measures. Techniques such as conservation tillage, no-till farming, establishing buffer strips, terracing, and various other management strategies can go a long way in mitigating soil erosion. Furthermore, the implementation of drip irrigation presents a promising avenue to curb soil erosion and minimize water loss, thus promoting sustainable agricultural practices.

In summation, this research offers invaluable insights that should serve as a guiding compass for decision-makers in the Syrdarya River Basin. It sounds like a clarion call for immediate action, emphasizing the imperative need to address the rampant soil erosion and institute stringent controls on agricultural and industrial pollutants. The preservation of the region's water quality and the fragile ecosystems it sustains hang in the balance, and concerted efforts must be taken to ensure their continued health and vitality.

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ТҮЙІН

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СУ САПАСЫ КӨРСЕТКІШ АРИФМЕТИКАЛЫҚ ӘДІСІМЕН СЫР-ДАРИЯНЫҢ ТӨМЕНГІ БӨЛІГІНДЕГІ ТОПЫРАҚ ЭРОЗИЯСЫ ЖӘНЕ СУ САПАСЫНЫҢ ЖАҒДАЙЫН БАҒАЛАУ

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Ауыл шаруашылығындағы өзінің бай тарихи маңызы бар Сырдария өзенінің бассейні қазір шұғыл түрде назар аударуды талап ететін заманауи мәселелермен бетпе-бет келіп отыр. Негізгі мәселелер топырақ эрозиясы мен төменгі ағыстағы су сапасының төмендеуіне байланысты, олардың екеуі де экожүйе мен жергілікті қауымдастықтарға үлкен қауіп төндіреді. Мазасыздандыратын мәселелердің бірі – осы аймақтағы зерттеулердің жеткіліксіздігі, бұл проблемаларды тиімді түсіну және шешуде маңызды білім алшақтығын қалдырады. Су сапасы мен топырақ эрозиясы арасындағы өзара

байланыс елеусіз қалдырмайтын негізгі аспект болып табылады. Тұздылық, ең алдымен, SO42− және Ca2+ сияқты элементтерден туындайды, топырақтың деградациясында және өсімдік тамырларының суға қол жеткізуіне кедергі жасау арқылы эрозияның күшеюінде шешуші рөл атқарады. Ағыстың төменгі жағындағы аудандар, әсіресе күріш егістіктеріне тәуелді, олар кең көлемді суаруды қажет етеді, бұл мәселелердің ең ауыртпалығын көтереді. Бұл аймақтардағы эрозия су сапасына каскадты әсер етеді. Егістіктерден эрозияға ұшыраған тұзды топырақ, пестицидтер мен тыңайтқыштар, сайып келгенде, өзенге түсіп, экожүйелер мен жақын маңдағы қауымдастықтарға айтарлықтай қауіп төндіреді. Сонымен қатар, топырақ эрозиясының және деградациясының күшеюі суармалы суға деген сұранысты айтарлықтай арттырды. Топырақтың тұздануы мен өзендердің ластануының қазіргі қарқыны тұрақты болып қалса, Қызылорда облысы үшін бұл көмескі болжам. Санаулы онжылдықтарда бір кездері құнарлы жерлер ауыл шаруашылығына жарамсыз болып, Сырдария өзенінің суы ішуге немесе басқа да маңызды мақсаттарға жарамсыз болуы мүмкін. Бұл зерттеу Сырдария өзені алабындағы су сапасы мен топырақ эрозиясы арасындағы күрделі байланыстарды ашуға бағытталған. Ол топырақ эрозиясының және өзен суының сапасына ықтимал ластаушы заттардың әсерін бағалау үшін Су сапасының индексі (WQI) әдістемесін пайдаланады.

Түйінді сөздер: топырақ эрозиясы, су сапасы, ауыл шаруашылығы практикасы, бороз-ды суару, Қызылорда, Сырдария, WQI (су сапасының индексі), су сапасының индексінің басым көрсеткіші.

РЕЗЮМЕ

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ОЦЕНКА ЭРОЗИИ ПОЧВЫ И СОСТОЯНИЯ КАЧЕСТВА ВОДЫ В НИЖНЕЙ ЧАСТИ СЫР-ДАРЬИ С ИСПОЛЬЗОВАНИЕМ МЕТОДА АРИФМЕТИЧЕСКОГО ИНДЕКСА КАЧЕСТВА ВОДЫ

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Бассейн реки Сырдарья, имеющий богатое историческое значение для сельского хозяйства, сегодня сталкивается с современными проблемами, требующими незамедлительного внимания. Основные проблемы связаны с эрозией почвы и ухудшением качества воды ниже по течению, оба из которых представляют серьезную угрозу для экосистемы и местных сообществ. Одной из насущных проблем является практическое отсутствие исследований в этом регионе, что приводит к серьезному пробелу в знаниях для понимания и эффективного решения этих проблем. Взаимосвязь между качеством воды и эрозией почвы является фундаментальным аспектом, который нельзя упускать из виду. Засоленность, вызванная в первую очередь такими элементами, как SO_4^{2-} и Ca^{2+}, играет ключевую роль в деградации почвы и усилении эрозии, затрудняя доступ корней растений к воде. Основная тяжесть этих проблем приходится на районы, расположенные ниже по течению, особенно те, где выращивают рис и требуют интенсивного орошения. Эрозия в этих регионах приводит к каскадному воздействию на качество воды. Засоленная почва, пестициды и удобрения, вымытые с полей, в конечном итоге попадают в реку, создавая серьезную угрозу как для экосистем, так и для близлежащих сообществ. Кроме того, растущий уровень эрозии и деградации почв существенно увеличил потребность в оросительной воде. Если нынешние темпы засоления почв и загрязнения рек останутся постоянными, это мрачный прогноз для Кызылординской области. Через несколько десятилетий некогда плодородные земли могут стать непригодными для сельского хозяйства, а вода реки Сырдарья перестанет быть безопасной для питья или других жизненно важных целей. Целью данного исследования является пролить свет на сложную взаимосвязь между качеством воды и эрозией почвы в бассейне реки Сырдарья. Он использует методологию индекса качества воды (WQI) для оценки воздействия эрозии почвы и потенциальных загрязнителей на качество воды в реке.

Ключевые слова: эрозия почв, качество воды, сельскохозяйственная практика, бороздовое орошение, Кызылорда, Сырдарья, WQI (индекс качества воды), приоритетный показатель индекса качества воды.

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