of peas for all terms and seeding rates, the variant with the joint introduction of ammophos and ammonium sulfate differed the most.

Key words: soil, peas, nitrate nitrogen, mobile phosphorus, mineral fertilizers, yield.

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ASSESSMENT OF INTERDEPENDENT CHANGES OF NEXUS FLUXES ON THE IMPACT OF CLIMATE CHANGE & LAND USE ON THE EXAMPLE OF THE DISTRICTS ALONG THE SYR DARYA

Abstract

This research investigates the interplay between socioeconomic and environmental indicators in the Kyzylorda district along the Syr Darya River. Through an analysis of the food, energy, and water (FEW) functions and their implications for sustainable development, this study offers valuable insights for policymakers and practitioners. Specifically, we examine the impact of climate change factors, such as precipitation and temperature, on the production and yield of three key crops: wheat, rice, and corn.

To conduct this study, we utilized daily temperature and precipitation data from the preceding years of 2021 and 2022, along with corresponding crop yield data for the same period. Our methodology draws upon established practices, including correlation analysis to assess the relationship between climatic factors and crop yield. Additionally, regression analysis enables us to develop predictive formulas to anticipate the effects of future climate changes on crop yield and agricultural practices in the region. Moreover, ANOVA employed to measure variations in daily temperature and precipitation during the certain period.

Keywords: *NEXUS fluxes, Climate change, Syr Darya, Kyzylorda, Socioeconomic-environmental systems (SES) indicators, Correlation analysis, Regression analysis, ANOVA, irrigation efficiency.*

Introduction and research purpose

This research will examine the interdependent dynamics of socioeconomic-environmental systems (SES) indicators in an example district of Syr Darya in Kyzylorda, with the aim of gaining a deeper understanding of the relationships among the elements of the biophysical matrix and socioeconomic variables. The study will use a structured methodology that incorporates various statistical analyses, including canonical correlation analysis, step-wise regression and correlation analysis, path coefficient analysis, ANOVA, ANCOVA, and MANOVA, econometric modeling. By analyzing both the causal and non-causal relationships among these variables, this research aims to contribute to the development of sustainable development policies and practices.

The aim of this research is to explore the interdependent dynamics of (SES) indicators, with a focus on understanding the causal and non-causal relationships among the elements of the biophysical matrix and socioeconomic variables. Through the analysis of these relationships, we aim to develop a more comprehensive understanding of the complex interactions between the socioeconomic and environmental factors that shape SES, and to identify potential pathways for sustainable development in these systems. Our target population includes researchers, policymakers, and practitioners working in the fields of environmental sustainability, social welfare, and economic development.

Literature review & Citation

The climate in Syr Darya river basin is predominantly hot and arid, except for the mountainous areas where it is cooler and more humid. The soils in the region are generally thin and infertile, but they can support certain crops with proper irrigation. However, water is not abundant in the region, which poses a challenge for agriculture. O. S. Savoskul, et. al, (2003) [1]. Therefore, it is crucial to research the factors that impacts crop growth to determine which crops are suitable to plant in the region. In addition, providing genetically modified seeds of high-demand crops to farmers could be an effective alternative solution.

Amongst the beneficiaries of the basin, "Kazakhstan is an important land-locked dryland Asian country owing to its large size and economy". [2] K. Venkatesh et. al, (2020). In Kazakhstan during 2021, the average temperature was 1.58 °C higher than global climatic norm for the period 1941 – 2020. Croplands in the Aral Sea basin (ASB) confront a significant challenge of water scarcity. They are highly susceptible to water stress, land degradation, and substantial anthropogenic disturbances. L. Jiang, et. al, (2020).[3] Water stress is one of the consequences of extreme water withdrawal from Syr Darya, which is exacerbated by rapid increases in temperature.

Furthermore, the increasing demand for food, bioenergy and other agricultural products, as well as the intensification of climate change, pose special challenges for Central Asia's agricultural sector in terms of implementing sustainable land management. C. Conrad, G. Schmidt, & M. Kussainova, (2023). [4]

To demonstrate, Kyzylorda, during 2021 was one of the warmest years since 1941, with average temperature anomalies ranging from 1.89 to 2.28 degrees Celsius. The Kyzylorda region in Kazakhstan holds significant importance due to its thriving economy. T. Alimbaev et.al, (2020). [5] Yet, farmers are struggling with climate change and its impact over the product yield and income.

Whilst the changing climate is a threat, another significant concern in the region relates to the utilization of centuries-old practices in irrigated agriculture. While drawing upon this wealth of experience, it becomes crucial to exercise extreme caution when reconstructing the irrigation and drainage-collector network. It is essential to consider the soil cover's structure and diligently uphold the principles of contouring irrigated agriculture to ensure its preservation. T. Alimbaev et.al, (2020). [5]

Beyond a shadow of doubt, water, food, and energy are essential for sustainable development. Agriculture uses most of the world freshwater, and energy production requires water. As the demand for these resources grows quickly, governments must manage them sustainably to meet the needs of people, nature, and the economy. By doing so, we can handle the current and future challenges. UN Water, (2020). [6]

In Kyzylorda, climate change will harm spring crop yields (e.g., wheat, barley) due to increased temperatures and precipitation. However, it expected to benefit winter varieties of wheat and barley, enabling multiple cropping, and increase rice yield. A. Islyami, et. al, (2020) [7].

Last year in Kyzylorda the cultivation of valuable crops like rice reduced and mostly switched with moisture saving vegetables due to irrigation water scarcity. (JJ-TV News (2022)) [8].

In all likelihood, this will challenge the farmers and will affect their income and market. This alteration and replacement in agriculture has lead us to explore the cause and effects, and research on climatic factors.

Certainly, alteration in intensity and timing of precipitation as well as rapid increase in temperature with uncertainties are important climatic factors already challenged the peasants for agriculture and food production. Climate change scenarios revealed that within a period of 7 decades (2090) the temperature will rise up to (4 – 7) degrees Celsius, and annual precipitation will increase 16%. Furthermore, predictions indicated that both temperature and precipitation are highly variable and can experience extreme fluctuations in crop production and its yield.

Although in this research, we mainly assess climatic factors impact over crop yield, though other variables also have significant impacts over the crop production and its growth; as a case in point soil salinity and soil structure. For instance, inoculation with Amycolatopsis strains in soil with WS significantly decreased grain and straw of wheat yield. M. Kussainova and R. Kızılkaya (2021). [9]

Again, from the beginning Central Asia's most important cotton-growing region is concentrated in the floodplain of the Syr Darya. The river flows for 2,200 kilometers, from the Tien Shan Mountains west and northwest to the Aral Sea—the dying waterbody at the low point of the basin. Water has withdrawn from the river for agriculture for many decades. Although the Syr Darya is the second largest river flowing into the Aral Sea, its discharge is not very large and it easily depleted. Control of the river vested in the Syr Darya Basin Water Organization, run by nations with territory in the watershed. Some of the organization's main efforts include accurate gauging of water use and repair of canals to reduce widespread water leakage. NASA Earth Observatory, 2010. [10]

In the region, agricultural water occupies a huge share in Central Asia (over 85%). Therefore, when we talk about the actual use of water, we mainly imply the water used for agriculture. Industrial water in Kazakhstan occupies about 35%, and Kazakhstan is the only country in Central Asia that uses a considerable amount of water for industrial purposes. However, the issue is not that much the water scarcity and accessibility for Kazakhstan, rather the release of water from upstream countries of CA, especially when we talk about Syr-Darya River. For example, Kyrgyzstan saves water in the summer, as Kyrgyz aim at increasing the capacity of water for hydropower. In turn, they release water in winter when there is a need for hydropower energy by inevitably creating overflowing problems in downstream countries like Kazakhstan. S. Xenarios, (2021). [11]

Despite the fact that all central Asian countries use water for irrigation and hydropower, in Kazakhstan the water mostly used firstly for industrial and for agricultural use. It is because Kazakhstan is rich in fossil fuels and hydropower generation is not a matter of concern.

The impact of changing climate over crop production in Kazakhstan is of high concern. Researchers predict the impact as much as 37% during 1 decade (by 2030) and 49% by after 3 decades (by 2050). In other words, the annual crop production of 20 million tons will decrease by 7 million. This could realize by an average increase in temperature of 1/7 to 1.9 degrees celsius during 2020-2040. These statistics should persuade scientists to conduct precise research to analyze the climatic factors changes over the crop yield and growth. K. Akhat (2020). [12]

Water delivery, crop yields (cotton, wheat and rice) and water productivity used as major indicators of performance for the irrigation system of the basin. H. Murray-Rust, et. al, (2003) [13]. In the year 2000, the main crops produced in the Syr Darya Basin were wheat, with a production of 3 million tons, along with potatoes, which yielded approximately 2 million tons, and vegetables, which produced 1.3 million tons. O. S. Savoskul, et. al, (2003). [1]

Table 1 - Crop type vs land productivity

Crop Type	Land Productivity (t/ha)
Cotton	2.89
Wheat	2.82
Rice	3.99

Kazakhstan is an important producer and exporter of high-quality wheat. Average annual production is about 13 million tons, but output is highly dependent on weather and in recent years has fluctuated between 10 and 17 million tons. Kazakhstan also produces around 2 million tons of barley, and a small amount of oats, corn, and rice. USDA report (2010). [14]

Research questions:

1. How the FEW functions correlated with one another, and what are the subsets of variables that are most strongly associated with one another?
2. Which variables have the greatest influence on the dependent variable, as determined by "step-wise" regression, Spearman correlation coefficients, and boosted regression trees?
3. How do changes in NPP affect herding practices, and what is the statistical importance of this relationship as determined by path coefficient analysis?
4. Which regulations are most meaningful based on the results of ANOVA, ANCOVA, and MANOVA, and how do these regulations relate to the independent variables in the study?

5. What are the causal relationships between household behaviors and the socioeconomic and biophysical drivers, as identified through econometric models?

6. To what extent the water of Syr Darya polluted, as measured by WQI, compare to primary and secondary data sources, and what are the implications of these findings for water quality assessment in the study area?

Methodology

This research will use a structured methodology to achieve the research goals. Firstly, data on the biophysical matrix and socioeconomic variables in the study area, as well as climatic factors and water quality information will collect. Secondly, the collected data will clean, validate, and process to ensure its accuracy and consistency. Thirdly, Pearson canonical correlation analysis will use to identify correlations and subsets of the FEW functions in the study area. The Pearson coefficient measures the strength and direction of the relationship between two variables, which usually ranges between (+1,-1). Fourthly, "step-wise" regression, Spearman correlation coefficients, and boosted regression trees will use to explore and select the variables with the greatest influence on the dependent variable. Fifthly, path coefficient analysis will use to quantify the statistical importance of causal variables in FEW measures, such as how changes in NPP affect herding practices or vice versa. Sixthly, ANOVA, ANCOVA, and MANOVA will use to identify potential regulations and their meaningfulness based on the independent variables in the study. Finally, econometric models will use to identify causal relationships between household behaviors and the socioeconomic and biophysical drivers.

Findings and discussion

With a total area of 402,760 km2, the Syr Darya is one of the two primary headwaters of the Aral Sea basin. The river is home to 20 million people of which 73 % are living in rural areas. The beneficiaries of the river are Kyrgyzstan, Uzbekistan, Kazakhstan, and Tajikistan. The geographic information system and application of geo-referencing and google earth used to map the river, Aral Sea, and trans-boundary countries:

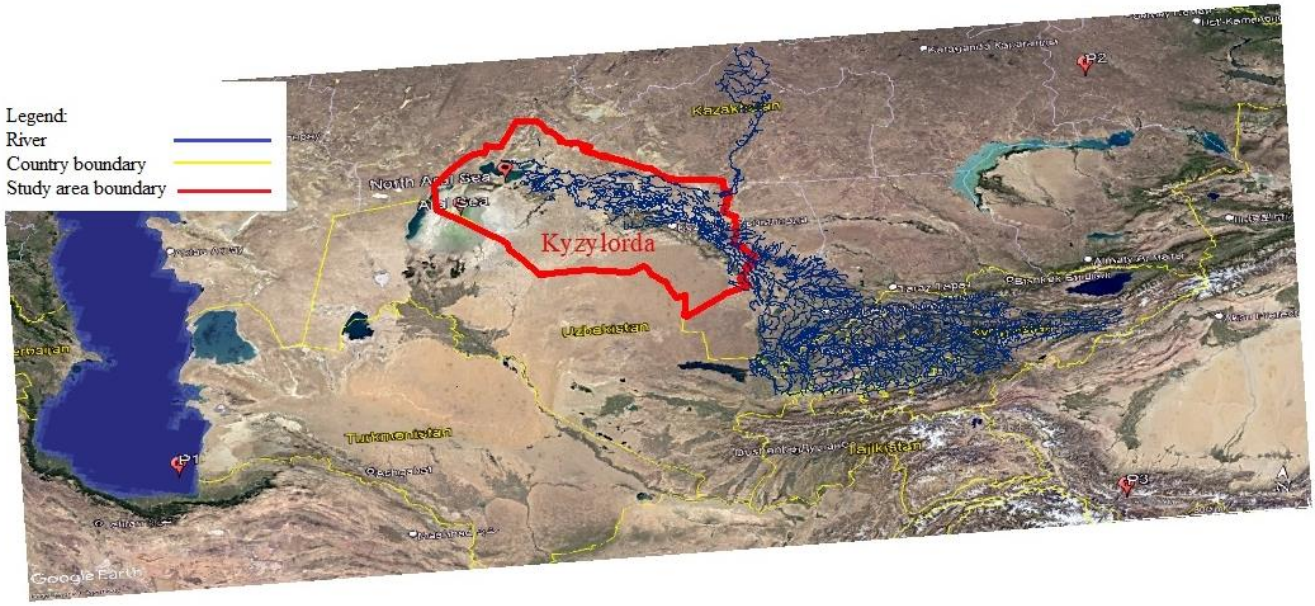

Figure 1 - Syr-darya & trans-boundary countries

Table 2 - Point coordinate

Point coordinate		
Point #	Latitude - N	Longitude – E
P1	37° 21' 44.75"	53° 24' 59.18"
P2	48° 35' 17.54"	78° 15' 44.06"
P3	36° 28' 44.86"	77° 4' 36.67"
P4	45° 13' 18.47"	46° 28' 21.72"

In this research, we specifically selected the Kyzylorda region as our study area, which locates in the shore of Syr Darya in Kazakhstan. The region's capital is Kyzylorda, with a population of 234,736. As indicated in figure 2, notable settlements within the region include Aral Sea basin and its proximity to Uzbekistan that further amplifies its strategic significance and agricultural potential.

Figure 2 - Study Area (Kyzylorda region)

Staple Crops

In this study, we examined the impact of climate variability on the yields of wheat, rice, and corn. Our objective was to understand how changing climate patterns influence the productivity of these staple food crops. By exploring the complex dynamics between climate factors and agricultural outcomes, we aim to inform decision-making and develop strategies for enhancing food security in a changing climate.

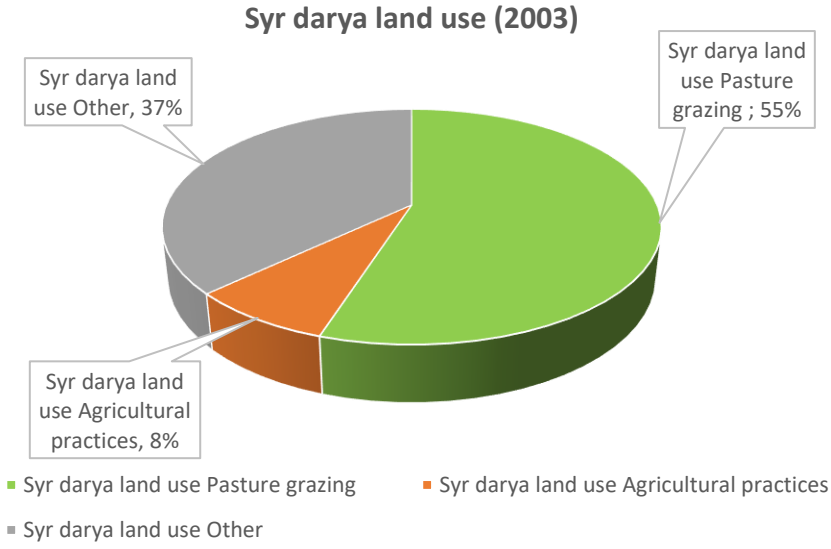

Figure 3 - Syr darya land use (2003)

Nexus in Syr Darya

The water resources of the Syr Darya River Basin are essential for both hydropower generation in upstream nations and agricultural production in both upstream and downstream countries.

However, there is a clear trade-off between these two important uses: the demand for energy in upstream countries is highest during the winter, while irrigated agriculture requires greater amounts of water during the summer.

O.S. Savoskul et al. (2003) [1] found that the majority of the land in the Syr Darya region utilized as pasture for grazing livestock, with less emphasis on agricultural practices. The Syr Darya Basin (shown in Fig. 1) is one of the two primary headwaters of the Aral Sea Basin in Central Asia.

Correlation Analysis for irrigation efficiency:

Rain-fed crop yields are typically 50% lower on a global scale compared to irrigated yields. [15]: S. Jaramillo, E. Graterol, and E. Pulver, (2020)

In Kazakhstan, irrigated agriculture is the biggest water consumption industry that accounts for 70% of all water consumed in the country. In most parts of Kazakhstan, traditional agricultural practices are used. Flooded irrigation advanced by gravity canals to convey the water to the fields is common for agriculture, particularly, in downstream parts of Syr Darya. Weak application of water-saving irrigation technologies by agricultural producers directly affects the irrigation efficiency and food security as well.

The amount of water consumption and irrigation efficiency indicated in the table below. If the peasant and small holders in Kazakhstan use water saving technologies e.g. drip irrigation the water consumption will decrease by an average rate of 25%. G. Rau, (2016) [16].

Table 3 - Irrigation efficiency in Kazakhstan

	Traditional agriculture practices		**Water saving agricultural practices**	
Agricultural crops (Ton)	**Specific Water Consumption (m^3/t)**	**Irrigation water efficiency US dollar per 1 m3 of water**	**Specific Water Consumption (m3/t)**	**Irrigation water efficiency US dollar per 1 m3 of water**
Rice	7500	0.06	5625	0.08
Cotton	5500	0.22	4125	0.29
Corn for grain	1500	0.10	1125	0.13
Sugar beet	600	0.25	450	0.33
Cereal	1400	0.11	1050	0.15
Vegetables	500	0.24	375	0.32
Melons	180	0.19	135	0.25
Orchards & vineyards	800	1.0	600	1.33
Perennial herbs	2500	0.07	1875	0.09

Correlation analysis for crop yield against temperature (Wheat, corn, & rice):

In this research, we followed a methodology that previously has proved successful in studying the impact of climatic factors on crop yield. As stated by Badri Kanal in 2016 [17], analyzing the minimum and maximum temperature and precipitation data from the preceding years is crucial to determine the optimal conditions for crop production.

To perform our correlation analysis, we used data from the two preceding years for daily temperature and rainfall and compared it with the crop yield of wheat, corn, and rice during the years 2021-2022. The correlation analysis of climatic factors over the wheat crop yield revealed a positive correlation coefficient of 0.31 between temperature and crop yield. This means that as the temperature increases, the wheat crop yield also increases. On the other hand, for corn and rice, we observed a negative correlation coefficient of -0.23 and -0.42, respectively. This indicates that as the temperature increases, the yield of corn and rice crops decrease.

Overall, the findings of our research suggest that the impact of temperature on crop yield varies among different crops. While wheat crop yield increases with increasing temperature, corn and rice crop yield decrease. These findings can be useful for farmers and policymakers in making decisions related to crop production and management in response to changes in climate.

Correlation analysis for crop yield against precipitation (Wheat, corn, & rice):

The results of the correlation analysis indicate that there is little to no correlation between crop yield and precipitation for both wheat and corn. However, in the case of rice yield, there appears to be a positive correlation with precipitation, suggesting that an increase in precipitation leads to an increase in crop yield. Specifically, the correlation coefficient for rice yield and precipitation is 0.45.

Regression analysis:

The regression analysis computed for the crops revealed that wheat, corn, and rice, have coefficient of determination of 0.16, 0.16, 0.4 respectively. This indicates that 16, 16, and 40 % of the variance in wheat, corn, and rice production can be, respectively explained by the climatic parameters of temperature and precipitation. (Table 4).

Table 4 - Regression analysis for crop yield vs climatic factors.

Crop Type	R value	R square (The coefficient of determination)	Regression coefficient	F	Standard Error
Wheat	0.402	0.162		0.871	2196.841
Corn	0.02496	0.158		0.842	378.339
Rice	0.16	0.4		3	105690.3

Multiple regression analysis, supported by the regression formula, is a valuable statistical tool for studying the relationship between multiple independent factors and a single dependent variable. When analyzing the impact of climatic factors on crop production, it helps quantify the relevance of temperature and precipitation changes on crop yield. By inputting temperature and precipitation values into the regression formula, accurate predictions of future crop yields generated.

For corn regression formula to predict the crop yield by knowing the temperature and precipitation value is:

$Y = 141 - 10 (X1) + 54 (X2)$

Where:

Y = crop yield (ton)

X1 = temperature independent value (°C)

X2 = precipitation independent value (mm)

For sample prediction, at a precipitation of 7mm and a temperature of 35 °C the crop yield will be 378 tons.

Based on the calculations, we can conclude that higher temperatures and more rainfall negatively affect the yields of spring crops like wheat and barley. On the other hand, climate change could have a positive effect on winter varieties of wheat and barley, allowing farmers to grow multiple crops in one season.

The formula for wheat yield as a dependent on X1 and X2 is $Y = 2341 + 58 (X1) - 107 (X2)$, and for rice is $Y = - 356356 – 3585 (X1) + 134573 (X2)$.

ANOVA analysis:

A one-way analysis of variance (ANOVA) conducted to assess the variability of the climatic factor of precipitation over the course of one year and its potential impact on crop yield. The analysis involved testing two hypotheses to determine if climatic factors significantly contribute to the variation observed in crop yield.

Table 5 - ANOVA Analysis result for climatic factor (precipitation)

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	67.38539	11	6.125944	2.144868	0.016959	1.815817
Within Groups	1008.201	353	2.856094			
Total	1075.587	364				

In this research, a one-way analysis of variance (ANOVA) was helpful to assess whether there is a significant difference in daily rainfall levels throughout 2021. The objective was to quantify the variability in rainfall and make determinations about its potential impact on crop growth and yield. In Table 5, the obtained p-value from ANOVA was found to be less than the predetermined significance level (alpha) $P<\alpha$. Consequently, it inferred that the null hypothesis is false, indicating that there is insufficient evidence to support the notion of significant variance in precipitation data. This suggests that precipitation may not have played a substantial role in influencing crop yield, supporting the alternative hypothesis.

Table 6 - ANOVA Analysis result for climatic factor (temperature)

ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	1.445504	1	1.445504	0.006596	0.936003	4.30095
Within Groups	4820.967	22	219.1349			
Total	4822.412	23				

In contrast, the analysis of average monthly temperature data for the years 2021 and 2022 using ANOVA indicated that temperature variance has a significant impact on crop yield. This conclusion drawn based on the observed substantial variance among the average monthly temperature values for the aforementioned years. It is important to note that the p-value obtained from the ANOVA analysis of temperature statistics exceeded the predetermined alpha value, leading to the rejection of the null hypothesis and providing support for the alternative hypothesis.

Conclusion

In conclusion, this research aims to assess the interdependent changes of NEXUS fluxes on the impact of climate change and land use in the districts along the Syr Darya. By analyzing the relationships among socioeconomic-environmental systems (SES) indicators, the study seeks to gain a deeper understanding of the complex interactions between the biophysical matrix and socioeconomic variables. The research methodology involves various statistical analyses, including correlation analysis, regression analysis, path coefficient analysis, ANOVA, ANCOVA, MANOVA, and econometric modeling.

The findings of the research highlight the importance of water, food, and energy for sustainable development. The study emphasizes the challenge of water scarcity in the region and the need to research factors that impacts crop growth to determine suitable crops for cultivation. It also discusses the trade-off between hydropower generation and agricultural production, particularly in the context of the Syr Darya Basin.

The research findings indicate that climate variability has an impact on the yields of staple crops such as wheat, rice, and corn. The analysis reveals correlations between crop yield and temperature, with wheat yield increasing and corn and rice yields decreasing as temperature rises. Additionally, the study highlights the importance of irrigation efficiency in Kazakhstan, with potential water savings through use of water-saving agricultural practices.

The regression analysis demonstrates the relationship between climatic factors (temperature and precipitation) and crop yield. The coefficient of determination indicates the percentage of variance in crop production that explained by these factors. Multiple regression analysis enables the prediction of future crop yields based on temperature and precipitation values.

Overall, this research contributes to the understanding of the interdependencies and dynamics of socioeconomic-environmental systems in the Syr Darya region. The findings can inform sustainable development policies and practices, particularly in the areas of water resource management, agricultural production, and climate change adaptation. The research outcomes are relevant to researchers, policymakers, and practitioners working in the fields of environmental sustainability, social welfare, and economic development in Central Asia.

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СЫРДАРИЯ БОЙЫНДАҒЫ АУДАНДАР МЫСАЛЫНДА КЛИМАТТЫҢ ӨЗГЕРУІ МЕН ЖЕРДІ ПАЙДАЛАНУДЫҢ ӘСЕР ЕТУІНЕ NEXUS АҒЫНДАРЫНЫҢ ӨЗАРА ТӘУЕЛДІ ӨЗГЕРІСТЕРІН БАҒАЛАУ

Аңдатпа

Бұл зерттеу Сырдария өзені бойындағы Қызылорда ауданындағы әлеуметтік-экономикалық және экологиялық көрсеткіштердің өзара байланысын зерттейді. Азық-түлік, энергия және су (FEW) функцияларын және олардың тұрақты даму үшін салдарын талдау арқылы бұл зерттеу саясаткерлер мен тәжірибешілер үшін құнды түсініктерді ұсынады. Атап айтқанда, біз жауын-шашын мен температура сияқты климаттың өзгеруі факторларының үш негізгі дақылдың: бидай, күріш және жүгері өнімі мен өніміне әсерін зерттейміз.

Бұл зерттеуді жүргізу үшін біз алдыңғы 2021 және 2022 жылдардағы тәуліктік температура мен жауын-шашын деректерін және сол кезеңдегі дақылдардың тиісті шығымдылығы деректерін қолдандық. Біздің әдістеме климаттық факторлар мен егін шығымдылығы арасындағы байланысты бағалау үшін корреляциялық талдауды қоса алғанда, қалыптасқан тәжірибелерге сүйенеді. Бұған қоса, регрессиялық талдау аймақтағы егін шығымдылығына және ауылшаруашылық тәжірибесіне болашақ климат өзгерістерінің әсерін болжай алатын болжамды формулаларды жасауға мүмкіндік береді. Сонымен қатар, ANOVA белгілі бір кезеңдегі тәуліктік температура мен жауын-шашынның өзгеруін өлшеу үшін пайдаланылды.

Кілт сөздер: NEXUS ағындары, Климаттың өзгеруі, Сырдария, Қызылорда, Әлеуметтік-экономикалық-экологиялық жүйелер (СЭС) көрсеткіштері, Корреляциялық талдау, Регрессиялық талдау, ANOVA, суару тиімділігі.

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ОЦЕНКА ВЗАИМОЗАВИСИМЫХ ИЗМЕНЕНИЙ ПОТОКОВ NEXUS НА ВЛИЯНИЕ ИЗМЕНЕНИЯ КЛИМАТА И ЗЕМЛЕПОЛЬЗОВАНИЯ НА ПРИМЕРЕ ТЕРРИТОРИЙ ВДОЛЬ СЫРДАРЬИ

Аннотация

В данном исследовании изучается взаимодействие между социально-экономическими и экологическими показателями в Кызылординском районе, расположенном вдоль реки Сырдарья. Благодаря анализу функций продовольствия, энергии и воды (FEW) и их значения для устойчивого развития, это исследование предлагает ценную информацию для политиков и практиков. В частности, мы изучаем влияние факторов изменения климата, таких как осадки и температура, на производство и урожайность трех ключевых культур: пшеницы, риса и кукурузы.

Для проведения этого исследования мы использовали данные о суточной температуре и осадках за предыдущие 2021 и 2022 годы, а также соответствующие данные об урожайности культур за тот же период. Наша методология основана на устоявшейся практике, включая корреляционный анализ для оценки взаимосвязи между климатическими факторами и урожайностью сельскохозяйственных культур. Кроме того, регрессионный анализ позволяет нам разрабатывать формулы прогнозирования, позволяющие предвидеть влияние будущих

изменений климата на урожайность сельскохозяйственных культур и методы ведения сельского хозяйства в регионе. Кроме того, ANOVA используется для измерения изменений дневной температуры и осадков в течение определенного периода.

Ключевые слова: Потоки NEXUS, Изменение климата, Сырдарья, Кызылорда, Показатели социально-экономических и экологических систем (СЭС), Корреляционный анализ, Регрессионный анализ, ANOVA, эффективность орошения.

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КОМПЛЕКСНАЯ ОЦЕНКА ГЕНЕТИЧЕСКИХ РЕСУРСОВ ГОРОХА НА ОСНОВЕ КЛАСТЕРНОГО АНАЛИЗА

Аннотация

Зернобобовые культуры богаты белком, в следствии чего являются важным компонентом растениеводческого биоразнообразия и продовольственной безопасности. Обеспечение населения страны продовольствием – главная задача аграрного производства. Целью настоящего исследования было изучение генетического разнообразия сортов гороха и определения степени генетического расхождения между коллекционными образцами. Изучено 37 генотипов гороха усатого морфотипа, различного эколого-географического происхождения. Исследования проводили на полях селекционного питомника Научно-производственном центре зернового хозяйства имени А.И. Бараева. Кластерный анализ — это процедура группировки объектов исследования по определённому набору данных. Наблюдения проводились по 12 количественным признакам, а именно: вегетационный период от всходов до цветения, сут.; от всходов до созревания, сут.; урожайность, г/м^2; число междоузлий, шт.; число продуктивных узлов, шт.; высота растения, см.; высота прикрепления нижнего боба, см.; число бобов на растении, шт.; число семян в бобе, шт.; число семян с растения, шт.; масса семян с растения, г.; масса 1000 семян, г., с помощью анализа основных компонентов и кластерного анализа для определения родства и генетического расхождения между особями. В результате кластерного анализа сгруппировали 37 образцов зародышевой плазмы гороха в два основных кластер и пять подгрупп, при этом минимальное количество образцов было обнаружено во втором кластере, в группе 3В (1 шт.), а максимальное количество было обнаружено в группе 1В (13 шт.). Полученные результаты показали, что среди двух кластеров отдельный генотип в группе 2С имеет наивысшее среднее значение практически по всем анализируемым признакам, кроме числа семян в бобе. Для селекционных программ образцы 2-го кластера, выделившихся по основным хозяйственно-ценным признакам представляют наибольший интерес и могут быть использованы в качестве родительских форм при гибридизации.

Ключевые слова: *генетические ресурсы, горох, вегетационный период, морфологические признаки, кластерный анализ, селекция, урожайность.*

Введение

Изменение климата представляет собой огромную проблему для повышения урожайность сельскохозяйственных культур. Из-за последствий изменения климата урожайность некоторых основных сельскохозяйственных культур уже стагнировала или даже