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CONTENTS

Yield and Profitability of Sweetpotato (*Ipomoea batatas* (L.) Lam) NSIC Sp36) as Affected by the Levels of Solophos and Muriate of Potash Fertilizers

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Abstract

Application of fertilizer on sweetpotato can boost the growth and yield of sweetpotato. This study was conducted to: (1) evaluate the growth and yield response of sweetpotato to the different levels of P and K fertilizers; (2) determine the appropriate levels of P and K fertilizers that will give the optimum yield for sweetpotato; and (3) determine the profitability of sweetpotato production per hectare using solophos and muriate of potash. Application of different levels of solophos and muriate of potash significantly increased the fresh herbage weight, length of the main vines, and leaf area index. NSIC Sp36 applied with fertilizer regardless of the levels showed a significantly longer length of main vines (T_2-T_6) than the plants not applied with fertilizer (T_1). On the other hand, plants applied with 45-55-55 kg ha^{-1} N, P_2O_5, K_2O (T_6) had the highest LAI but were significantly comparable to plants applied with 45-45-20 kg ha^{-1} N, P_2O_5, K_2O (T_4). However, applying different solophos and muriate of potash did not significantly influence the yield and yield component and harvest index of NSIC Sp36 variety. The highest net return of PhP274,039.24 ha^{-1} was realized when sweetpotato was applied with 45-20-45 N, P_2O_5, K_2O kg ha^{-1}.

Keywords*:* Muriate of potash, Profitability, Solophos, Sweetpotato, Yield

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INTRODUCTION

Sweetpotato (*Ipomoea batatas* (L.) Lam) is one of the most common and essential agronomic crops in the Philippines. It is a perennial crop that is widely grown as an annual crop used as animal feed and for manufacturing of industrial food products. It provides livelihood and food security, especially among vulnerable subsistent people living in a fragile upland environment. It is suitable as substitutionary food for rice and corn in times of scarcity and plays a supplementary role to cassava and maize as a source of seasonal food and cash crops. Sweetpotato is also used as a good cover crop to minimize soil erosion. Also, it is a climate resilience crop that is ideal for unfavorable conditions, just like in the Philippines (Relente and Asio, 2020). Farmers have found that sweetpotato is a niche in the global market, and it surpasses other primary foods. Also, it is a perfect substitution as a staple food and an immediate source of human income.

Furthermore, sweetpotato plays an essential role as an energy and phytochemical source in human nutrition and animal feed. Aside from that, this crop has essential medicinal value, and its various parts are used in traditional medicine in different countries (Mohanraj and Sivasanker, 2014). Sweetpotato has many uses, not only grown as a substitute crop for corn and rice but also as a potential source of raw materials for industrial purposes. Therefore, this crop has the potential to contribute significantly to food security as well as farmer`s income.

On the other hand, the soil rarely contains all the nutrients the plant needs because of socio-economic and demographic pressure through continuous cultivation in the agricultural sector of arable land. The yield of sweetpotato is known to be limited due to poor soil fertility and cultural management (Law-Ogbomo et al., 2019). One of the problems in sweetpotato is low yield and uniformity of storage root (SR) size, ranging from a few vast SRs to many small ones with no commercial value (Ratilla et al., 2018). However, farmers in my locality provided a small and marginal portion of their production area for sweetpotato. As a result, they did not apply fertilizers to sweetpotato, thus, resulting in low yield and income. This problem occurs because they don't know the effect or the response of sweetpotato to fertilizer. Therefore, it is essential to inform the farmers that sweetpotato needs a recommended fertilizer rate to obtain optimum yield.

Other common reasons for the low yield of sweetpotato in the locality of Cabulisan, Inopacan, Leyte are poor cultural management practices like selecting the certified NSIC recommended varieties and fertilizer management. Thus, researchers would find ways to improve the productivity and income of sweetpotato farmers through proper cultural management of sweetpotato such as the correct selection of variety and amount of fertilizer application. The fertilizer as nutrients for the crop is an essential component in crop production. The macro elements like Phosphorous (P) and Potassium (K) influences crop growth and development. Phosphorus is involved in several key plant functions, including photosynthesis, energy transfer, and transformation of sugar and starches. It affects tuber quality since it functions in cell division and synthesis and storage of starch in the tubers (Fernanes et al., 2014). It is one of the most critical nutrients for sweetpotato production. Potassium is also essential in sweetpotato for it improves nutrient value and enhances taste, color, and texture. It also promotes disease resistance and optimizes yield and quality. Phosphorus fertilizer determines the number of tubers produced, the size, and the time at which maximum yield will be obtained (Belachew, 2016). In sweetpotato cultural management, K fertilizer application has been identified as affecting tuber bulking. Potassium ions promote starch synthesis in tuberous roots. It influences tuber quality and significantly increases the rate of photosynthesis (Cruz et al., 2016). Potassium application causes a reduction in excessive vegetative growth following high nitrogen application. The use of K has also been associated with reduced disease resistance. (Jackson et al., 1990) reported reduced stem rot incidence (*Erwinia carotovora*) with K fertilizers treatments (Muoneke and Ukpe, 2010).

This study focuses on the application of different levels of phosphorus and potassium fertilizers in sweetpotato production. It is a big challenge for the researcher to promote the use of fertilizer as a critical factor in the growth and yield of sweetpotato and to determine the profitability of this fertilizer management to sweetpotato production per hectare.

MATERIALS AND METHODS

An area of 351.125 m^2 was used in this study. The area was plowed and harrowed using a four-wheeled tractor to incorporate the weeds, pulverize, and level the soil to provide better crop root development. After harrowing, furrows were immediately made at 0.75 m apart. Ten (10) soil samples were randomly collected at a depth of 0-20 cm using auger at the different spots in the experimental area. All the collected soil samples were mixed or composited, air-dried, pulverized, and sieved using a 2 mm wire mesh sieve. The soil sample was submitted for analysis at the Central Analytical Services (CASL) PhilRootcrops, Visayas State University, Baybay City, Leyte, for the determination of pH level (1:2.5 soil water ratio; ISRIC 1995), organic matter (%) (Modified Walkley Black Method, PCARR, 1980), total nitrogen (%) (Modified Ljedahl Method, PCARR 1980), available phosphorus (Modified Olsen Method, Olsen, and Sommer, 1982) and exchangeable potassium (Ammonium Acetate Method, PCARR, 1980). After harvest, three (3) soil samples were collected from every treatment plot from the harvestable area for final analysis.

The field experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Each treatment plot measured 4 m x 3.75 m. A 1.0 m alleyway was provided between replications and 0.5m alleyway between treatment plots to facilitate farm management and data gathering. The different treatments were designated as follows: T_1= No Fertilizer (Control), T_2= 45-45-45 kg ha^{-1} N, P_2O_5, K_2O (RR-Positive Control), T_3= 45-20-45 kg ha^{-1} N, P_2O_5, K_2O, T_4= 45-45-20 kg ha^{-1} N, P_2O_5, K_2O, T_5= 45-35-35 kg ha^{-1} N, P_2O_5, K_2O, T_6= 45-55-55 kg ha^{-1} N, P_2O_5, K_2O

The cuttings of sweetpotato NSIC Sp36 variety were procured from the experimental area of the Department of Agronomy Visayas State University, Visca Baybay City, Leyte. Apical cuttings 25-30cm long were taken from the healthy and matured vines. A total of one thousand four hundred forty cuttings were used in this study. It was planted in a slanting position for better development of the roots in every plot. One cutting was planted per hill at 0.75m between rows and 0.25m between hills. Urea (45-0-0), solophos (0-18 -0), and muriate of potash (0-0-60) fertilizer were used in this study. One-time fertilizer application was made in every treatment. It was done through band application seven days after planting.

Watering was done using water cans to maintain the growth and development of the plants. However, watering the plant only lasted two weeks due to occasional rainfall. Two weeks after planting, hand weeding and hilling up was done. Leaf miner (*Bedellia somnulentella*) infestation was observed but only minimal. Thus, no control measures were taken. The infected leaves turn brown, and later there are numerous holes. Sweetpotato weevil was observed during harvesting as indicated by undesirable odor, marks, and tiny holes in fleshy roots, but only caused minimal damage. Damage caused by sweetpotato weevil has not reached a threshold level. Thus, no control measures were employed on sweetpotato plants. On the other hand, the storage roots of sweetpotato were harvested 105 days after planting by manually digging the soil with a sharp bolo after cutting the vines. Freshly harvested roots, and fresh herbage, were collected and clean by washing the roots with water.

Data Gathered

For the agronomic characteristics; a) Length (cm) of main vines, b) Number of lateral vines, c) Leaf Area Index (LAI). LAI was gathered 60 days after planting by measuring the fully open leaves of sweetpotato. This was computed using this formula:

$$\text{LAI} = \frac{\text{Total leaf area (TLA)}}{\text{Area of the Quadrat (2500 cm}^2\text{)}} \quad (1)$$

$$\text{TLA} = \sum (\text{L x W x CF}) \quad (2)$$

Where: L=length, W=width, CF=Correction factor of 0.49 (Cajefe, 2003).

a) Fresh herbage weight (t ha^{-1}). The weight of fresh herbage was converted to tons per hectare using this formula:

$$\text{Herbage weight (t ha}^{-1}\text{)} = \frac{\text{Plot yield (kg)}}{\text{HA (7.875 m}^2\text{)}} \times \frac{10{,}000\ \text{m}^2\ \text{ha}^{-1}}{1{,}000\ \text{kg t}^{-1}} \quad (3)$$

Likewise, for the yield and yield components, a) Number of marketable and non-marketable roots per hectare. This was determined by counting the roots from marketable and non-marketable roots from the harvestable area per plot and was converted to per hectare basis, using the formula:

$$\frac{\text{No. of roots ha}^{-1}}{\text{HA (7.875 m}^{2)}} = \frac{\text{No. roots ha}^{-1}}{10{,}000\ \text{m}^2} \quad (4)$$

The considerable marketable storage roots had at least 2.5cm in diameter (broadest part) and 6.5cm in length (proximal to distal end) (Relente and Asio, 2020). The root damage by pests and disease are included in the number of non-marketable.

b) Weight (t ha^{-1}) of marketable and non-marketable roots. This was obtained by weighing the roots separately from marketable and non-marketable taken from the harvestable area in each treatment plot.

Then, the weight was converted to tons per hectare using this formula:

$$\text{Root yield (t ha}^{-1}\text{)} = \frac{\text{Plot yield (kg)}}{\text{HA (7.875 m}^{2)}} \times \frac{10{,}000\ \text{m}^2\ \text{ha}^{-1}}{1{,}000\ \text{kg t}^{-1}} \quad (5)$$

c) Total root yield (t ha^{-1}). This was obtained by adding the weight of both marketable and non-marketable roots in tons per hectare.

Parameters Gathered:

1. Harvest Index (HI)

This is the ratio between the weight (kg) of the roots as the economic yield and the total weight (kg) of the vegetative parts, including the total fresh weight of roots as the biological yield from the three (3) sample plants. A high harvest index means that the crop has efficiently converted the photosynthates into the production of economic yield than biological yield. In contrast, a low harvest index indicates that the photosynthates were utilized in the vegetative parts. Thus, low production of economic yield and high production of biological yield. Harvest Index (HI) was computed using the formula:

$$\text{HI} = \frac{\text{Fresh weight of herbage (kg)}}{\text{Fresh weight of herbage (kg)} + \text{Fresh weight of root (kg)}} \quad (6)$$

2. Cost and Return Analysis

The production cost was determined by recording all the expenses incurred in growing sweetpotato including the cost of the land preparation, fertilizer application, planting, hand weeding, harvesting, cleaning and sorting, sweetpotato cuttings and fertilizers. Gross income was determined by multiplying the marketable yield of each plot by the current price of sweetpotato per kilogram. Then, all the expenses were summed up to determine the total cost of production per hectare. The income was computed using this formula.

$$\text{Net Return (PhP)} = \text{Gross Income (PhP)} - \text{Total Expenses (PhP)} \quad (7)$$

3. Meteorological Data

Data on the total weekly rainfall (mm) and average daily temperatures (minimum and maximum, ^{o}C) and relative humidity (%) throughout the study were obtained from the PAGASA Station, VSU, Visca, Baybay, City, Leyte.

Statistical Tool

Statistical Tool for Agricultural Research (STAR version 2.0) software was used to analyze all the data gathered. Significant differences between means were compared using Honestly Significant Difference (HSD) test at 5% significance level.

RESULTS AND DISCUSSION

Soil Chemical Analysis

Results of the initial and final soil analysis are presented in Table 1. The initial analysis shows that the experimental area had a pH of 5.98, 1.007 % organic matter, 0.127 % total N, 27.76 mg kg^{-1} available phosphorus, and 0.75 me $100g^{-1}$ soil exchangeable potassium. These indicated that the soil is moderately acidic, with shallow organic matter, low in nitrogen but high in available phosphorus, and exchangeable potassium (Landon, 1991).

Table 1. Soil chemical properties before and after harvest of sweetpotato (*Ipomoea batatas* (L.) Lam) NSIC Sp36) as affected by the levels of solophos and muriate of potash

Treatment	Soil pH (1:2.5)	Organic matter (%)	Total N (%)	Available P (mg kg^{-1})	Exchangeable K (me $100g^{-1}$)
A. Initial analysis					
	5.98	1.01	0.13	27.76	0.75
B. Final analysis					
T_1	6.28	1.41	0.10	21.52	0.81
T_2	6.27	1.43	0.10	20.58	0.84
T_3	6.17	1.40	0.12	19.88	0.76
T_4	6.42	1.35	0.12	18.74	0.82
T_5	6.08	1.37	0.11	21.48	0.77
T_6	5.95	1.35	0.13	39.66	0.77
Mean	6.20	1.39	0.11	23.64	0.80

Legend:
T_1= No Fertilizer (Control)
T_2= 45-45-45 kg ha^{-1} N, P_2O_5 K_2O
T_3= 45-20-45 kg ha^{-1} N, P_2O_5 K_2O
T_4= 45-45-20 kg ha^{-1} N, P_2O_5 K_2O
T_5= 45-35-35 kg ha^{-1} N, P_2O_5 K_2O
T_6= 45-55-55 kg ha^{-1} N, P_2O_5 K_2O

The final analysis, on the other hand, showed a relative increase in soil pH, organic matter, and exchangeable K over the initial analyses, but a relative decrease in available P and total N was observed. The increase of exchangeable K may be due to increasing organic matter since organic matter decreases potassium fixation and increases potassium release (Bader et al., 2021). However, the relative decrease in available P and total N was due to plant uptakes and leaching.

Agronomic Characteristics

The agronomic characteristics of sweetpotato NSIC Sp36 as affected by the solophos and muriate of potash levels are presented in Table 2. The result revealed that the agronomic parameters differed significantly except for the number of lateral vines. Results revealed that sweetpotato applied with inorganic fertilizer, regardless of the levels, showed a significantly longer length of main vines (T_2-T_6) compared to the plants not applied with fertilizer (T_1). On the other hand, plants applied with 45-55-55 kg ha^{-1} N, P_2O_5 K_2O (T_6) had a higher LAI than the plants not applied with fertilizer but were significantly comparable to plants applied with 45-45-20 kg ha^{-1} N, P_2O_5 K_2O (T_3), 45-20-45 (T_4) kg ha^{-1} N, P_2O_5 K_2O and 45-35-35 kg ha^{-1} N, P_2O_5 K_2O (T_5). The least LAI was noted in the plants not applied with fertilizer (T_1) but significantly similar to plants applied with recommended inorganic fertilizer (T_2). Related studies found that increasing the application of fertilizer, especially phosphorus, to sweetpotato significantly increased the length of the vines and plant leaf area (Prasad and Roa, 1986; El-Gamal and Abdel-Nasser, 1996; El-Morsy et al., 2002; Hassan et al., 2005).

Table 2. Agronomic characteristics of sweetpotato (*Ipomoea batatas* (L.) Lam) NSIC Sp36) as affected by the levels of solophos and muriate of potash fertilizer

Treatment	Length of main vines (cm)	No. of Lateral Vines	Leaf Area Index	Fresh Herbage Weight (t ha^{-1})
T_1	201.16 b	3.80	0.59 b	16.27 b
T_2	252.86 ab	5.00	1.32 ab	32.38 ab
T_3	244.10 ab	4.97	2.17 a	40.83 a
T_4	264.29 a	5.27	1.70 a	37.78 a
T_5	256.48 a	5.03	1.68 a	33.73 ab
T_6	283.63 a	5.03	2.22 a	34.78 a
Mean	250.42	4.85	1.61	32.63
Pr > F	*	ns	*	*
CV (%)	7.67	22.76	22.34	19.32

Treatments means within the same column and without a letter are not significantly different at 5% level based on Tukey's HSD test.

Legend:
T_1= No Fertilizer (Control)
T_2= 45-45-45 kg ha^{-1} N, P_2O_5 K_2O
T_3= 45-20-45 kg ha^{-1} N, P_2O_5 K_2O
T_4= 45-45-20 kg ha^{-1} N, P_2O_5 K_2O
T_5= 45-35-35 kg ha^{-1} N, P_2O_5 K_2O
T_6= 45-55-55 kg ha^{-1} N, P_2O_5 K_2O

Likewise, plants applied with inorganic fertilizer (T_2- T_6) show a significantly higher fresh herbage weight than the control plants. The higher herbage weight could be attributed to the length of the main vines, indicating more lateral vines and a larger size of leaf area. On the other hand, plants not applied with fertilizer (T_1) (16.27 t ha^{-1}) have the lowest herbage weight recorded than the other treatments applied with fertilizer regardless of the amounts. According to Kareem (2013), the longer the length of main vines, the more leaf produced that could be contributed to the weight of the herbage yield. Likewise, Beltran and Cagasan (2021) reported that sweetpotato applied with inorganic fertilizer, regardless of the levels, produced more lateral vines and consequently resulted in heavier plant herbage weight. The result implies that fertilizer can significantly affect the length of main vines, leaf area, and fresh herbage weight of sweetpotato than the unfertilized plants.

Yield and Yield Components and Harvest Index

Yield components and harvest index of sweetpotato NSIC Sp36 are presented in Table 3. Results revealed that the number of marketable and non-marketable roots, weight of marketable and non-marketable roots and harvest index did not vary significantly except on the total root yield (t ha^{-1}). Results revealed that no significant difference interms of yield on the treatments applied with fertilizer than the plants not applied with fertilizer as the control.

This can be attributed to the effects of fertilizer to provide nutrients to sweetpotato that improves the yield of the crop. Likewise, other parameters responded positively to solophos and muriate of potash application. Still, they were significantly comparable to the unfertilized sweetpotato plants (control) and the same goes for the total root yield (tha^{-1}).

Table 3. Yield components and harvest index of sweetpotato (*Ipomoea batatas* (L.) Lam) NSIC Sp36) as affected by the levels of solophos and muriate of potash fertilizer

Treatment	No. of root (ha^{-1})		Wt. of root ($t\ ha^{-1}$)		Total Root Yield ($t\ ha^{-1}$)	Harvest Index
	Marketable	Non-marketable	Marketable	Non-marketable		
T_1	100317	80000	7.54	1.63	8.17b	0.37
T_2	113438	108360	10.74	2.62	13.36a	0.47
T_3	139259	113962	13.47	2.64	16.23a	0.41
T_4	109206	94815	11.10	2.48	13.58a	0.36
T_5	116825	11174	10.80	2.64	13.44a	0.31
T_6	128254	79153	11.89	1.97	13.86a	0.34
Mean	117883	98006	10.92	2.33	13.27	0.38
Pr>F	ns	ns	ns	ns	*	ns
CV (%)	23.83	17.28	25.37	21.82	20.87	16.09

Treatments means within the same column and without a letter are not significantly different at 5% level based on Tukey's HSD test

Legend:
T_1= No Fertilizer (Control)
T_2= 45-45-45 kg ha^{-1} N, P_2O_5 K_2O
T_3= 45-20-45 kg ha^{-1} N, P_2O_5 K_2O
T_4= 45-45-20 kg ha^{-1} N, P_2O_5 K_2O
T_5= 45-35-35 kg ha^{-1} N, P_2O_5 K_2O
T_6= 45-55-55 kg ha^{-1} N, P_2O_5 K_2O

The result obtained was not statistically significant. This might be due to the inherent nutrients in the soil from the experimental area where the initial soil chemical analysis resulted in low total N (0.13 %) but high available P (27.76 mg kg^{-1}) and exchangeable K (0.75 me $100g^{-1}$) that might be enough nutrients needed by sweetpotato NSIC Sp36 for the growth and root yield development. Likewise, the soil pH of the experimental area was considered favorable for sweetpotato production. The initial soil chemical analysis was moderately acidic (5.98 1:2.5), and the final analysis increased slightly acidic except for T_6. Bradenberger et al. (2022) stated that the optimum soil pH for a high yield of quality sweetpotato is 5.8 to 6.0. Also, continuous rainfall during the entire duration of the study might cause the fertilizer not to be efficiently utilized by the sweetpotato plants. According to Kuo et al. (2020), excessive rainfall results in leaching and surface runoff of fertilizer containing N, P, and K from the soil.

Cost and Return Analysis

The cost and return analysis of sweetpotato (*Ipomoea batatas* (L.) Lam) NSIC Sp36) as affected by the levels of solophos and muriate of potash is presented in Table 4. The data revealed that all treatments obtained a higher net income, including the control plants not applied with fertilizer.

Table 4. Cost and return analysis of sweetpotato (*Ipomoea batatas* (L.) Lam) NSIC Sp36) as affected by the levels of solophos and muriate of potash fertilizer

Treatment	Root Yield (t ha^{-1})	Gross Income (PhP)	Cost of Production (PhP)	Net Return (PhP)
T_1	7.54	188,500	52,133.00	136,367.00
T_2	10.74	260,500	64,933.00	195,567.00
T_3	13.47	336,750	62,710.76	274,039.24
T_4	11.10	330,500	63,266.20	267,233.80
T_5	10.80	270,500	63,377.24	207,122.76
T_6	11.89	297,750	66,487.86	231,262.14

*Calculation of gross income is based on the current price of sweetpotato at PhP25 kg^{-1}

Legend:
T_1= No Fertilizer (Control)
T_2= 45-45-45 kg ha^{-1} N, P_2O_5 K_2O
T_3= 45-20-45 kg ha^{-1} N, P_2O_5 K_2O
T_4= 45-45-20 kg ha^{-1} N, P_2O_5 K_2O
T_5= 45-35-35 kg ha^{-1} N, P_2O_5 K_2O
T_6= 45-55-55 kg ha^{-1} N, P_2O_5 K_2O

However, when sweetpotato variety NSIC Sp36 was applied with 45-20-45 kg ha^{-1} N, P_2O_5 K_2O (T_3) it gave a higher net return of PhP274,039.24 followed by sweetpotato applied with 45-45-20 kg ha^{-1} P_2O_5 K_2O (T_4) at PhP267,233.80 and 45-55-55 kg ha^{-1} P_2O_5 K_2O (T_6) at PhP231,262.14. The difference in the net income could be due to the variation in yield and the cost of fertilizer the solophos and muriate of potash. According to the study of Beltran and Cagasan (2021), when the sweetpotato variety NSIC Sp36 was applied with the recommended inorganic fertilizer at 45-45-45 $kgha^{-1}$ N, P_2O_5 K_2O, it produces more tubers and consequently obtained a favorable high net return.

CONCLUSION AND RECOMMENDATION

Application of P and K fertilizers at different levels did not show a significant difference on the agronomic and yield components as well as on the harvest index of sweetpotato plants. However, it showed a significantly longer length of main vines, leaf area index and fresh herbage weight (t ha^{-1}) than the control plants not applied with fertilizers. Likewise, the application of P and K fertilizers at any level did not cause to vary the root yield (tha^{-1}) of sweetpotato (variety NSIC Sp36) but significantly higher yield than the control plant not applied with fertilizer. Thus, application P and K at any level can be used for sweetpotato production.

On the other hand, sweetpotato variety NSIC Sp36 applied with 45-20-45 kg ha^{-1} N, P_2O_5 , K_2O gave the highest profit of PhP274,039.24 followed by sweetpotato applied with 45-45-20 kg ha^{-1} N, P_2O_5 K_2O at PhP267,233.80. It is farther conclude that the general recommendation of 45-45-45 kg ha^{-1} N, P_2O_5, K_2O is still applicable in sweetpotato production. It is recommended that a study be conducted under a hilly land area with low available P and low exchangeable K soils.

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Nutrition Value and Phytochemical Determination of Oyster Mushroom *(Pleurotus spp.)*

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Abstract

Oyster mushrooms, the common name for the species *pleurotus ostreatus*, are one of the most common types of an edible cultivated mushroom in the world that are necessary for a body health. The data obtained, from this research clearly show that cultivated *Pleurotus* spp. on Zea mays waste gave high level phytochemical compounds, carbohydrates, soluble proteins and amino acids indicating that Zea mays have been given mushroom more quality and more rich from these compounds than the other two wastes tested. It was observed that during this study, ethanolic extract from mycelia and fresh fruiting bodies have higher phytochemical contents than filtrate from liquid medium for all five *Pleurotus* spp. cultivated on the three agro- wastes.

Keywords: Bioactive compounds, Antioxidants, Flavonoids, Phenolic Compounds

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INTRODUCTION

The genus *Pleurotus* is commonly known as oyster mushroom. However, *Pleurotus* species can be grown in wild range of temperate and tropical areas as the wild mushroom. Nonetheless, *Pleurotus* species can be grown in wild range of temperate and tropical regions as the wild mushroom. It belongs to the family Tricholomataceae, order Agaricales, and class Basidiomycetes. There are 40 known species in this genus *P. ostreatus* and *P. sajor caju* are two species that have been extensively grown (Ahmed et al., 2009).

Furthermore, a large number of species in the *Pleurotus* genus have been used as sources of substances, including low-molecular-weight compounds (terpenoids, fatty acid esters, and polyphenols) and high-molecular-weight bioactive compounds (polysaccharides, peptides, and proteins) found in the fruiting bodies and mycelium that have anti-oxidative, anti-inflammatory, anti-neoplastic, anti-diabetic, anti-inflammatory, antibacterial, and immune-stimulatory qualities (Sarma et al., 2018; Golak-Siwulska et al., 2018).

Chemical composition of the fresh and dried mushroom *Pleurotus ostreatus* and their bioactive secondary metabolic products were studied by Mohamed and Farghaly 2014 they noticed the selenium content in *P. ostreatus* samples was measured by using ACAL –APR - 51-00 test methods and showed that the fresh sample had 58.24 mg/kg while the dry sample had 100.31 mg/kg. The ethanolic extracts of the *P. ostreatus* exhibit antioxidant activity by scavenging hydroxyl and superoxide radical and lipid peroxidation and inhibit the reducing power on ferric ions (Jayakumar et al., 2009).

Oyster mushrooms (*Pleurotus* spp.) are wood-inhabiting white-rot Basidio-mycetes with important biotechnological and environmental applications (Singh et al., 2012; Singh et al., 2013). They are highly adaptable to grow and fruit on a wide variety of forest and agro-industrial lignocellulosic substrates, because of their ability to synthesize the relevant hydrolytic and oxidative enzymes that convert the individual component of the substrate (cellulose, hemicellulose and lignin) into low-molecular weight compounds, which can be assimilated for fungi nutrition (Elisashvili et al., 2008).

Recently, mushrooms have been recognized as sources of antioxidants as they contain phenolic compounds and secondary metabolites that have a preventive effect against chronic diseases (Lbarmaic et al. 2009). Additionally, mushrooms are known to have therapeutic benefits; they are low in calories for diabetic and heart patients, lowering the blood cholesterol level, warding against cancer and also contain appreciable quantities of crude fibers on the total dietary fiber (TDF). Nowadays, mushrooms mainly are being considered as functional food because are a good source of proteins, amino acids (such as arginine, glutamine, and glutamic acid), vitamins (especially riboflavin (B2), niacin (B3) and folates (B9), minerals, fat lowering, sugars and sodium contents (Da Silva et al., 2012; Khan and Tania, 2012).The purpose of this study was focus in determination phytochemical compounds, carbohydrates, soluble proteins, amino acids, lipids, flavonoids and phenolic compounds of *Pleurotus* spp. which cultivated on the three agro-wastes (Zea mays, Sorghum bicolor Horse and Sorghum bicolor Giza 15).

MATERIALS and METHODS

Screening of some phytochemical compounds

Preparation of extracts

The dried samples were weighed and ground into powder prior to extraction. Then it was subjected with solvents, maintained at room temperature for 24 hours, sequentially. For the preparation of the extract, 1g dried powdered oyster mushroom was extracted successively with 50 ml ethanol (95%) in conical flask and then the contents were placed on a shaker for 24 hours at room temperature. The residual solvents were removed by evaporation at 40- 50 ºC for 30 minutes. The extracts were stored at 4^{o}C in sterile capped bottle for phytochemical, detection (Oseni et al., 2012).

Qualitative determination of phytochemicals

Detection of alkaloids

About 50 mg of solvent free extract was stirred with 3ml of dilute hydrochloric acid and then filtrate was tested carefully with various alkaloids reagents as fallow; 1 ml of filtrate, few drops of Wagner's reagent are added by the side of the test tube, the color changes were observed. A reddish brown precipitates confirm the test a positive (Wagner, 1993; Evans, 1997).

Detection of carbohydrates

One ml of extract was in addition to 1ml of Barfoed's reagent and heated on a boiling water bath for 2 minutes the color changes was noted and recorded. A red precipitate indicated presence of sugar. It is based on the reduction of copper acetate to copper oxide (Cu2O), which forms a brick-red precipitate (Barfoed, 1873).

Detection of Glycosides; Borntrager's test

First, 50 mg of the extract were hydrolyzed in hydrochloric acid conc. for 2 hr. Three ml of chloroform was added to 2 ml of oyster mushroom, extract and shaked, chloroform layer was separated, ammonia solution (10%) was added. The formation of pink color indicated the presence of glycosides (Evans, 1997).

Detection of phenols, Lead acetate test

The extract (50 mg) was dissolved in 5ml distilled water and 3 ml of 10% lead acetate solution was added, a bulky white precipitate indicated the presence of phenols (Lingaraoet al., 2012).

Detection of Tannins

The extract (50 mg) was dissolved in 3 ml of distilled water and few drops of neutral 5% ferric chloride solution were added, a dark green color indicated the presence of tannins (Mace Gorbach, 1963).

Detection of flavonoids

An aqueous solution of the extract was treated with sodium hydroxide solution the yellow flourescnce indicated the presence of flavonoid (Bello et al., 2011).

Detection of proteins

The extract (100 ml) in 10 ml distilled water, and filtered through filter paper. The filtrate (2ml) was treated with one drop of 2% copper sulphate solution and then added 1ml of ethanol (95%), followed by excess of potassium hydroxide pellets. The pink color appears in ethanol layer indicated presence of proteins (Gahan, 1984).

Detection of amino acids

Two drops of ninhydrin solution (10 mg of ninhydrin in 200 ml of acetone) was in addition to 2ml of aqueous filtrate, a characteristic of purple color indicate of amino acids (Yasuma and Ichikawa, 1953).

Detection of terpenoids

2 ml of chloroform and concentrated sulphuric acid was added carefully to 0.5 ml of extract, formation of red brown color indicates the presence of terpenoids (Salkowski, 1904).

Quantitative determination of phytochemicals

Extraction (supernatant)

By the use of 1g of dry sample of mycelia or mushrooms were boiled in 10 ml distilled water for 1 hr. and then centrifuged. The supernatant was used as extract for carbohydrates, amino acids and proteins detection.

Quantification of carbohydrate

The anthrone-sulphuric acid method (Fales, 1951; Schlegel, 1956) was used for the determination of carbohydrates.
Anthrone- sulphuric acid reagent preparation; Anthrone 0.2 g, 30 ml distilled water, 8 ml absolute ethyl alcohol, and 100 ml concentrated H2SO4 (D=1.84) were respectively mixed in a conical flask under continuous cooling in an ice bath. This reagent should be always freshly prepared anthrone reagent. This was prepared by dissolving 0.2 g of anthrone in 100 ml of H2SO4, made by adding 500 ml of conc. acid to 200 ml of water. The reagent was permitted to stand for 30-40 min. with occasional shaking until it was perfectly clear (Trevelyan et al., 1950).

Quantification of free amino acids

Free amino acids were identified according to the method of (Moore and Stein, 1948). However, in this method traces of proline and hydroxyl proline were encountered.
Reagent preparation

This method makes up of the following reagents.
Ninhydrin reagent: 0.25 g ninhydrin dissolved in 100 ml ethanol.
Citrate buffer: 10.5 gm citric acid in 100 ml NaOH (2N) added drop wise to adjust pH 5.
Stannus Chloride reagent: 0.01g Stannus Chloride + 10 ml citrate buffer + 10 ml ninhydrin reagent.

Diluent solvent: Prepared by mixing equal volumes of distilled water and ethanol.

Estimation procedures

In clean empty test tube, add one ml of stannus chloride reagent to 0.5 ml of the extract. Boiling the test tubes in water bath for 20 min. and then cooling. Add 4 ml of diluent solvent and mixed rapidly. The extinction of violet color was recorded spectrophotometerically (Plant physiology laboratory) at wave length 570 nm against blank containing all the above reagents and distilled water instead of the extract of plant sample.
A calibration curve was constructed using glycine and the data were expressed as mg amino acid (glycine)/g D.W.

Determination of total lipids

Total lipids contents were determined by the sulfophovanilin method (SPV) (Drevon and Schmitt, 1964)

Reagents;
a- concentrated sulphoric acid (36N)
b- phoshovanilin reagents (phoshoric acid, vanilin and ethanol)
Procedure
About 0.1 ml from extract was transferred to dry glass tube and 3ml conc H2SO4 was added and left in boiling water bath for 10 minutes after hydrolysis, 1.5 ml phoshovanilin reagent was added to 0.05 ml of hydrolyast, mixed well and incubated at 37°C for 10 minutes. The absorbance of characteristic pale pink color was measured at 530 nm.

Antioxidative properties of the broth medium, mycelia and fresh fruiting bodies:

Preparation of the ethanolic extract

Ten 10 g of fresh fruiting bodies and 10 g of mycelia were washed with tap water, rinsed with distilled water, drained, and chopped. Each of the samples was blended with 100 ml absolute ethanol using a homogenizer for 10 minutes and then filtration of the homogenate was carried out. The supernatants were freeze-dried and stored at -20º C until which used as extract.

Determination of free phenolic content

Free phenolic were determined according to Kofalvi and Nassuth (1995). 100 µl of the ethanol extract was diluted to 1 ml water and mixed with 0.5 ml 2 N Folin-Ciocalteu's reagent and 1.5 ml of 20% Na_2CO_3. After 20 min at room temperature, absorbance of samples was measured at 765 nm spectrophotometer. Phenolic concentration in the extract was determined from standard curve prepared with gallic acid and the data expressed as mg/g FW.

Determination of the total flavonoids

Total flavonoids were determined using spectrophotometric method as previously described by Zou et al. (2004). One milliliter of sample extract was combined with 0.3ml of 5% sodium nitrite ($NaNO_2$). The resulting solution was vortex mixed and permitted to stand at room temperature for 6 min. To this, 0.3 ml of 10% $AlCl_3$was added. After 5 min, 2 ml of Na OH (1N) was added and shaken to react. This was diluted by topping up to 5 ml mark. Each experiment was made in triplicates. Absorbance was measured at 510 nm. Quercetin was used as standard curve and flavonoids content were expressed as (mg/ml).

Determination of ascorbic acid

The ascorbic acid was determined according to Mushroom tissues (0.2 g) were ground with liquid nitrogen and suspended in 2 ml of 5% trichloroacetic acid (TCA). The homogenate was centrifuged at 10,000 rpm for 15 min. at 4 °C. Add 0.2 ml of tissue homogenate to 0.8 ml of 10% TCA. After vigorous shaking the tubes were stored in an ice bath for 5 min. and centrifuged at 3000 rpm for another 5 min. 0.5 ml of the extract was diluted to 2.0 ml using bi-distilled water, and 0.2 ml of diluted Folin's reagent (diluted 10-folds with bi-distilled water) was in addition to the extract, the tubes were vigorously shaken. After 10 min. the absorbance of the blue color developed was measured spectrophotometer at 760 nm. A standard curve was established by different concentrations of ascorbic acid (Jagota and Dani, 1982).

Statistical analysis

The data were statistically analyzed following the Randomized Complete Block Design (RCBD) with the arrangement of three replications and means were compared following Duncan's Multiple Range Test (DMRT) test at a 5% level of probability for interpretation of results (Gomez and Gomez, 1984).

RESULTS and DISCUSSION

The results in table (1) reveal that the highest carbohydrates content (24.6 ±0.05 mg/g) was obtained from filtrate on liquid medium cultivated with *P. ostreatus* on Zea mays while the lowest content (21.2 ±0.01mg/g) was obtained from *P. columbinus* on sorghum bicolor Giza 15. While, the highest carbohydrates content (35.5±0.02 mg/g) was estimated from ethanolic extract of mycelia on liquid medium of *P. floridanus* cultivated on Zea mays. On the other hand, the highest carbohydrates content (34.9±0.02mg/g) from ethanolic extract of fresh fruiting bodies was obtained from *P. sajor-caju* cultivated on Zea mays. These results are agreeing with (Egwin et al., 2011; Okwulehie et al., 2008).

On the other hand, the results in the current study were higher as compared to previous studies (Anjana et al., 2016). They recorded that, carbohydrate content in the *Pleurotus ostreatus* was 7.594 ± 0.59 mg/ml. On contrast, Alam et al. (2008) showed that the carbohydrate content of *P. florida*, *P. ostreatus*, and *P. sajor caju* were found to be 42.83, 37.8 and 39.82 g/100g respectively. Also, Dundar et al., 2008 reported that carbohydrate content of *P. eryngii*, *P. ostreatus* and *P. sajor-caju* were 39.85, 37.87 and 37.72 g/100g respectively. Similarly, the results of (Vishwakarma et al., 2017).

All, these results of carbohydrate content were higher than the results in the current study. However, it was observed that during this study, ethanolic extract from mycelia and fresh fruiting bodies have higher carbohydrate contents than filtrate from liquid medium for all five *Pleurotus* spp. cultivated on the three agro-wastes. Although, Okwulehie et al. (2008) reported high crude protein and carbohydrate contents in *P. ostreatus* cultivated on different substrates.

Table 1. Determination of total carbohydrates of filtrate from liquid medium, ethanolic extract from mycelia cultivated on liquid medium and ethanolic extracte from fruiting bodies

Type of mushroom / Type of waste		Filtrate from liquid medium (mg/g)	Ethanolic extracted from mycelia (mg/g)	Ethanolic extracted from fresh fruiting bodies (mg/g)
P. ostreatus	**Zea Mays**	**24.6 ±0.05**	33.7 ±0.05	31.7 ±0.03
	Sorghum bicolor Horse	22.7 ±0.06	32.5 ±0.06	32.6 ±0.01
	Sorghum bicolor Giza 15	23.6 ±0.08	30.2 ±0.03	32.4 ±0.04
P. columbinus	**Zea Mays**	**21.4 ±0.02**	28.4 ±0.04	33.8 ±0.05
	Sorghum bicolor Horse	22.6 ±0.03	33.2 ±0.02	34.3±0.03
	Sorghum bicolor Giza 15	21.2 ±0.01	29.3 ±0.03	31.3 ±0.02
P. pulmonarius	**Zea Mays**	22.5 ±0.05	28.7 ±0.02	32.8 ±0.01
	Sorghum bicolor Horse	23.8 ±0.04	29.3 ±0.01	33.4 ±0.01
	Sorghum bicolor Giza 15	24.9 ±0.03	28.9 ±0.04	31.4 ±0.03
P. sajor-caju	**Zea Mays**	21.9 ±0.01	29.7 ±0.03	34.9±0.02
	Sorghum bicolor Horse	21.8 ±0.02	32.6 ±0.02	**33.9 ±0.04**
	Sorghum bicolor Giza 15	22.6 ±0.03	32.5 ±0.01	29.5 ±0.03
P. floridanus	**Zea Mays**	23.3 ±0.04	35.5 ±0.02	32.5 ±0.04
	Sorghum bicolor Horse	23.7±0.03	34.9 ±0.03	31.7±0.05
	Sorghum bicolor Giza 15	**24.4 ±0.02**	**35.3±0.05**	33.2 ±0.02

Soluble protein

The results obtained in table (2) indicate that the highest amount of soluble protein determined from filtrate on liquid medium was found to be (18.8±0.05mg/g) of *P. ostreatus* cultivated on Zea mays. While, the highest amount of soluble protein obtained from dried mycelium cultivated on liquid medium was found to be (25.4 ±0.04mg/g) from *P. columbinus* cultivated on Zea mays. But, in case of dried fruiting bodies, the highest amount (28.8 ±0.02 mg/g) of soluble protein was obtained from *P. sajor-caju* cultivated on Zea mays. The lowest amount of soluble protein content was found to be (14.2 ±0.02 mg/g) obtained from filtrate on liquid medium for *P. floridanus* cultivated on sorghum bicolor Giza15. Li et al. (2017) reported protein levels of 27.4–34.8% from *P. sajorcaju* fruit bodies grown on wheat straw supplemented with raw/detoxified mahua cake (Gupta et al., 2013), the values obtained in Jin et al. (2018) are comparable to the reported values of 20.5–26.1% protein from *P. ostreatus* cultivated on cotton seed hull mixed with perilla stalk. According to Koutrotsios et al. (2014) the crude protein content was highly variable (14.64–31.36%) for *P. ostreatus*, which was produced on nine cultivation substrates. Gupta et al. (2013) reported that the protein content of mushrooms varies with the type of substrate, as a result of the differences in nutrient supply.

Table 2. Determination of soluble protein from filtrate on liquid medium, dried mycelium and dried fruiting bodies (mg/g)

Type of mushroom / Type of waste		Filtrate from liquid medium (mg/g)	Ethanolic extracted from mycelia (mg/g)	Dried fruiting bodies. mg/g)
P. ostreatus	**Z M**	**18.8 ±0.05**	24.3 ±0.05	28.6 ±0.03
	S H	17.9 ±0.06	27.1 ±0.06	26.5 ±0.01
	S G	16.9 ±0.08	25.2 ±0.03	27.4 ±0.04
P. columbinus	**ZM**	**18.4 ±0.02**	25.4 ±0.04	25.8 ±0.05
	S H	19.3 ±0.03	24.2 ±0.02	27.3±0.03
	S G	18.6 ±0.01	25.3 ±0.03	25.3 ±0.02
P. pulmonarius	**Z M**	17.5 ±0.05	22.7 ±0.02	26.8 ±0.01
	S H	16.8 ±0.04	21.3 ±0.01	27.4 ±0.01
	S G	17.9 ±0.03	24.9 ±0.04	28.1 ±0.03
P. sajor-caju	**Z M**	18.9 ±0.01	25.7 ±0.03	28.8±0.02
	S H	17.8 ±0.02	24.6 ±0.02	**27.9 ±0.04**
	S G	16.6 ±0.03	25.5 ±0.01	28.5 ±0.03
P. floridanus	**Z M**	17.3 ±0.04	21.5 ±0.02	27.5 ±0.04
	S H	18.7±0.03	23.9 ±0.03	27.6±0.05
	S G	**14.4 ±0.02**	**21.3±0.05**	26.2 ±0.02

Data illustrated in table (3) show that the highest content of amino acids (22.2 ±0.04 mg/g) from filtrate of liquid medium was obtained from *P. floridanus* cultivated on the Zea mays. In case of dried mycelium of liquid medium the highest content of amino acids (22.8 ±0.09 mg/g) was obtained from *P. columbinus* cultivated on Zea mays bagasse. Also, the highest content of amino acids (22.9 ±0.11 mg/g) from dried fruiting bodies was estimated from *P. floridanus* cultivated on Zea mays. The lowest amount of amino acids content was found to be (18.6 ±0.02 mg/g) obtained from filtrate on liquid medium from *P. pulmonarius* cultivated on Sorghum bicolor Giza15. It was observed that all extracts obtained from filtrates of liquid medium, dried mycelia and dried mushroom, for all the five *Pleurotus* spp. were grown on the three agro-wastes in this study have high amino acids contents. While, carbohydrates content was higher than amino acid content (mg/g) of the mushrooms. Chirinang and Intarapichet, (2009) found that, both mushrooms had comparable amounts of total amino acids (21.11 mg/g and 20.12 mg/g) of fresh weight, for *P. ostreatus* and *P. sajor-caju*, respectively. Similar results were obtained by Mattila et al., (2002) and Mendez et al., (2005) for *P. ostreatus*. These results were lower than that of the results in the current study.

Table 3. Determination of amino acids of filtrate from liquid medium, dried mycelia and dried fruiting bodies.

Type of mushroom / Type of waste		Filtrate from liquid medium (mg/g)	Dried mycelia (mg/g)	Dried fruiting bodies (mg/g)
P. ostreatus	**Z M**	19.6 ±0.05	21.6 ±0.12	21.8 ±0.08
	S H	20.7 ±0.03	20.9 ±0.23	**21.7 ±0.12**
	S G	**18.8 ±0.06**	21. 9±0.12	20.7 ±0.17
P. columbinus	**ZM**	**19.6 ±0.07**	20.8 ±0.07	21.4 ±0.18
	S H	18.6 ±0.06	22.8 ±0.09	20.6 ±0.08
	S G	19.6 ±0.03	20.9 ±0.14	21.7 ±0.07
P. pulmonarius	**Z M**	18.6±0.02	21.2 ±0.17	20.8 ±0.15
	S H	19.3 ±0.04	21.5±0.18	21.6±0.11
	S G	20.7 ±0.05	20.2 ±0.12	**20.3 ±0.10**
P. sajor-caju	**Z M**	20.8 ±0.03	20.8±0.023	21.7±0.08
	S H	19.5 ±0.02	22.2 ±0.27	216 ±0.07
	S G	20.5 ±0.01	**20.9 ±0.34**	21.6±0.1
P. floridanus	**Z M**	22.2 ±0.04	22.2 ±0.26	22.9 ±0.11
	S H	19.4 ±0.06	**22.7 ±0.08**	**22.7 ±0.07**
	S G	21.3 ±0.05	22.3 ±0.23	22.4 ±0.09

Table (4) showed that the highest content of lipids from filtrate on liquid medium was found to be (2.9 ±0.02 mg/g) of *P. ostreatus* cultivated on Zea mays. In case of dried mycelia on liquid medium, the highest content of lipids (2.80±0.02 mg/g) was obtained from *P. ostreatus* cultivated on Zea mays. Also, the highest content of lipids (2.7 ±0.03 mg/g) from dried fruiting bodies was estimated from *P. columbinus* cultivated on Sorghum bicolor Horse. The lowest amount of amino acids content was found to be (2.4±0.05mg/g) which obtained from filtrate on liquid medium of *P. columbinus* cultivated on Sorghum bicolor Horse. While, these results were lower than that of the study of Anjana et al. (2016) who reported that the content of lipid extracted of wild edible Nigerian species *Pleurotus ostreatus* was (4.89 ± 0.13%). Also, the lipid content in different species of *Pleurotus* species variably ranges from 0.2 to 8 g per 100 g dried fruit bodies, which have been reported from different studies (Hossain et al., 2007). However, Naraian and Dixit, (2017) found that the analyses showed maximum level of lipid (0.61g) in the fruiting of *Pleurotus sajor-caju* mushroom. Also, the results of Vishwakarma et al. (2017) were found to be (0.42±0.05 - 0.65±0.08%) of lipid content. In a similar observation Alam et al., (2008) determine the lipid content of *P. florida, P. ostreatus* and *P. sajor caju*, were found it to be 0.54, 0.68, 0.57 g/100g, respectively. These findings were lower than that of our study.

Table 4. Determination of lipids of filtrate on liquid medium, dried mycelia and dried fruiting bodies.

Type of mushroom / Type of waste		Filtrate from liquid medium (mg/g)	Dried mycelia (mg/g)	Dried fruiting bodies (mg/g)
P. ostreatus	**Z M**	2.9±.02	2.8±0.02	2.6 ±0.02
	S H	2.6 ±0.02	2.7 ±0.03	**2.5 ±0.05**
	S G	2.7 ±0.02	2.8 ±0.01	2.5 ±0.04
P. columbinus	**ZM**	2.6 ±0.02	2.5 ±0.04	2.4 ±0.03
	S H	2.8 ±0.03	2.4 ±0.01	**2.5 ±0.02**
	S G	2.7 ±0.02	2.5 ±0.02	2.4 ±0.05
P. pulmonarius	**Z M**	2.6 ±0.02	2.6 ±0.03	2.5 ±0.06
	S H	2.5 ±0.02	**2.7 ±0.01**	2.7 ±0.04
	S G	2.7 ±0.01	**2.8 ±0.03**	2.5 ±0.03
P. sajor-caju	**Z M**	2.6 ±0.02	2.6 ±0.02	2.5 ±0.04
	S H	2.7 ±0.02	**2.5 ±0.03**	2.6 ±0.02
	S G	2.6±0.02	2.5 ±0.04	2.5 ±0.03
P. floridanus	**Z M**	2.4 ±0.02	2.7±0.02	2.4 ±0.04
	S H	2.5 ±0.01	2.6 ±0.02	2.6 ±0.02
	S G	**2.7 ±0.02**	**2.6±0.02**	**2.7 ±0.03**

Data presented in Table (5) indicate that the highest flavonoid content (1.48 ±0.07mg/g) was obtained from filtrate in liquid medium of *P. columbinus* cultivated on Zea mays While, the highest flavonoid content (1.53 ±0.08 mg/g) was obtained from ethanolic extracte of mycelia from *P. pulmonarius* cultivated on Zea mays. On the other hand, the highest flavonoid content (1.62 ±0.04 mg/g) was estimated from ethanolic extracte of fresh fruiting bodies from *P. pulmonarius* cultivated on Zea mays. The lowest amount of flavonoid content was found to be (1.21±0.06mg/g) which obtained from filtrate of liquid medium of *P. floridanus* cultivated on Sorghum bicolor Giza 15.

Hamzah et al., (2014) reported that the high flavonoid content in *Pleurotus ostreatus* was found to be higher than that found in an edible mushroom (2.84±0.12mg/g). Obodai et al., (2014) recorded that the total flavonoid contents in the mushroom extracts varied from 0.20 to 2.03 µg of RE/g of dry weight of extracts with a grand mean of 0.85 µg of RE/g of dry weight of extracts.

Table 5. Determination of flavonoid from filtrate in liquid medium, ethanolic extract from mycelium and ethanolic extracted from fresh fruiting bodies.

Type of mushroom / Type of waste		Filtrate from liquid medium (mg/g)	Ethanolic extracte from mycelia (mg/g)	Ethanolic extracted from fresh fruiting bodies (mg/g)
P. ostreatus	**Z M**	1. 35±0.012	1.29±0.07	1.44 ±0.03
	S H	1.26 ±0.013	1.41 ±.09	1.42 ±0.04
	S G	1.37±0.024	1.32 ±0.03	1.53 ±0.02
P. columbinus	**ZM**	1.48 ±0.07	1.34 ±0.05	1.44 ±0.04
	S H	1.40 ±0.08	1.43 ±0.07	1.55 ±0.02
	S G	**1.41 ±0.04**	1.32 ±0.06	1.56 ±0.03
P. pulmonarius	**Z M**	1.39 ±0.12	1.53 ±0.08	1.62±0.04
	S H	1.23 ±0.09	1.44 ±0.02	1.47 ±0.05
	S G	1.36 ±0.07	1.54 ±0.05	1.55±0.07
P. sajor-caju	**Z M**	1.23 ±0.06	1.35 ±0.07	1.43 ±0.01
	S H	1.37±0.03	1.27 ±0.04	1.47±0.04
	S G	1.46 ±0.04	**1.48 ±0.05**	1.38 ±0.03
P. floridanus	**Z M**	1.45 ±0.06	1.38 ±0.04	**1.59 ±0.04**
	S H	1.41±0.07	1.46 ±0.02	1.55 ±0.02
	S G	1.21 ±0.06	**1.28±0.04**	1.64 ±0.03

Data recorded in table (6) clear that the highest ascorbic acid content from filtrate of liquid medium (0.080 ±0.05mg/g) was obtained from *P. ostreatus* cultivated on Zea mays. Also, the highest ascorbic acid content of ethanolic extract from mycelia (0.075±0.04mg/g) was obtained also from *P. columbinus* cultivated on Zea mays. On the other hand, the highest ascorbic acid content from ethanolic extracted of fresh fruiting bodies (0.085 ±0.02mg/g) was estimated from *P. floridanus* on Zea mays. The lowest amount of flavonoid content was found to be (1.21±0.06mg/g) obtained from filtrate of liquid medium from *P. sajor-caju* cultivated on Sorghum bicolor Giza 15. Matured fruit-bodies from *Andropogon* had higher, vitamins in mg/100g ascorbic acid (86.53 ± 6.72) and the matured fruit-bodies from Khaya was ascorbic acid (45.33 ± 2.31) (Okwulehie et al., 2014). However, Sharma and Gautam, (2015) recorded that the bioactive compounds evaluated are fatty acids, amino acids, tocopherol content, carotenoids (*β*-carotene, lycopene), flavonoids, ascorbic acid, and anthocyanidins.

Table 6. Determination of ascorbic acid of filtrate from liquid medium, ethanolic extract of mycelia and ethanolic extracted of fresh fruiting bodies.

Type of mushroom / Type of waste		Filtrate from liquid medium (mg/g)	Ethanolic extract from mycelia (mg/g)	Ethanolic extracted from fresh fruiting bodies (mg/g)
P. ostreatus	**Z M**	0.080 ±0.05	0.060 ±0.01	**0.050 ±0.02**
	S H	0.070 ±0.03	0.050 ±0.02	0.060 ±0.04
	S G	0.060 ±0.03	0.065 ±0.03	**0.080 ±0.06**
P. columbinus	**ZM**	0.055±0.02	0.075 ±0.04	0.025 ±0.02
	S H	0.070 ±0.01	0.070 ±0.03	0.030 ±0.01
	S G	0.060 ±0.02	0.080 ±0.02	0.040 ±0.03
P. pulmonarius	**Z M**	0.070 ±0.03	0.060 ±0.01	0.055 ±0.05
	S H	0.060 ±0.01	0.050 ±0.04	0.068±0.01
	S G	0.050 ±0.04	0.060 ±0.04	0.043±0.04
P. sajor-caju	**Z M**	0.070 ±0.05	**0.050 ±0.05**	0.050 ±0.03
	S H	**0.078 ±0.02**	**0.072 ±0.02**	0.060 ±0.01
	S G	0.060 ±0.03	0.050 ±0.02	0.052 ±0.04
P. floridanus	**Z M**	0.070 ±0.01	0.060 ±0.04	0.085 ±0.02
	S H	0.070 ±0.03	0.050 ±0.02	**0.098 ±0.01**
	S G	0.060±0.01	0.060 ±0.01	0.066 ±0.02

Data in Table (7) showed that the highest amount was found to be (2.60±0.06 mg/g) of phenolic compounds that determined from filtrate on liquid medium of *P. floridanus* cultivated on Zea mays. The highest phenolic content was found to be (2.7 ±0.04mg/g) from ethanolic extract of mycelia of *P. ostreatus* cultivated on Zea mays. On the other hand, the highest phenolic compounds content was found to be (2.70 ±0.04 mg/g) obtained from ethanolic extracted of fresh fruiting bodies of *P. pulmonarius* cultivated on Zea mays. The lowest content (2.11±0.04 mg/g) of phenolic compound was obtained from ethanolic extract from mycelia for *P. columbinus* cultivated on Sorghum bicolor Giza15. Although, Zea Mays mushrooms are very rich in phenolic compounds which are the source of their major antioxidant machineries. While, Kim et al., (2008) showed that the total phenolic content for both *Pleurotus eryngii* and *Pleurotus ostreatus* were 0.03 mg/g and 0.09 mg/g of dry weight, which are lower than the values for the *Pleurotus* spp. in the present study. Also, the results observed by Jayakumar et al., (2009) for *Pleurotus ostreatus* gave 0.71 mg/g of dry weight. In another study, Shirmila and Radhamany, (2013) reported that the total phenolic contents (5.5 mg/g) which was higher than that of the present study. The antioxidant characteristics of certain species result from a higher presence of phenolic compounds, β-carotene, lycopene, ascorbic acid, anthocyanidins, and tocopherol content within them (Sharma and Gautam, 2015).

Table 7. Determination of phenolic compounds of filtrate from liquid medium, ethanolic extract from mycelium and ethanolic extracted from fresh fruiting bodies.

Type of mushroom / Type of waste		Filtrate from liquid medium (mg/g)	Ethanolic extract from mycelia (mg/g)	Ethanolic extracted from fresh fruiting bodies (mg/g)
P. ostreatus	**Z M**	2.3 ±0.1	2.7 ±0.04	2.5 ±0.04
	S H	2.4 ±0.2	**2.4 ±0.01**	2.4 ±0.03
	S G	2.5 ±0.09	2.2 ±0.03	2.6 ±0.03
P. columbinus	**ZM**	2.2 ±0.08	2.2 ±0.02	2.5 ±0.02
	S H	2.4 ±0.03	2.2 ±0.01	2.4 ±0.05
	S G	2.3 ±00.3	2.5 ±0.03	2.6 ±0.04
P. pulmonarius	**Z M**	**2.2 ±0.01**	2.4 ±0.02	2.7 ±0.04
	S H	2.8 ±0.02	2.5 ±0.04	2.5 ±0.04
	S G	2.5±0.04	2.3 ±0.03	**2.6 ±0.05**
P. sajor-caju	**Z M**	2.2 ±0.16	2.4 ±0.04	2.6 ±0.03
	S H	2.3 ±0.04	2.6 ±0.02	2.5 ±0.04
	S G	2.5 ±0.06	2.3 ±0.01	2.5 ±0.05
P. floridanus	**Z M**	2.6 ±0.16	2.5 ±0.03	2.4 ±0.02
	S H	2.6 ±0.02	**2.4±0.04**	2.5 ±0.03
	S G	**2.5 ±0.05**	2.3 ±0.05	2.3 ±0.04

In general, during this study, it was observed that, ethanolic extract from mycelia and fresh or dry fruiting bodies have higher phytochemical compounds than filtrate from liquid medium for all five *Pleurotus* spp. cultivated on the three agro- wastes. T

hese results are agreeing with the results of Morris et al., (2017) who reported that, fruiting body and mycelia for *Pleurotus* spp. contain secondary metabolites and their isolated showed strong versatile health-promoting and therapeutic effects. In addition, It was observed that the submerged liquid fermentation in liquid medium (SmF) was suitable for the growth of all *pleurotus* species, (*P. ostreatus, P. columbinus, P. pulmonarius, P. sajor-caju* and *P. floridans*) when, cultivated on each of the agro-wastes used in this study (Zea mays, Sorghum bicolor H0rse and Sorghum bicolor Giza15). Our results were in harmony with (Friel and McLoughlin, (2000) and Yang and Liau, (1998).

They found that submerged liquid fermentation (SLF) give rise to possibility of high mycelial production in a compact space and shorter time with lesser chances of contamination. On the contrary, other studies found that SSF is the best culture system to study differences between aerial hyphae and those that penetrate in the solid matrix (Hölker et al., 2005).

CONCLUSION

Data showed that carbohydrates, soluble protein, amino acids, lipids, ascorbic acid, phenolic compounds and ethanolic extract were obtained in a higher contents from *Pleurotus* spp. cultivated on Zea mays waste these indicted that Zea mays was the best waste than the other two which have been giving mushroom more quality and more rich from these compounds were tested in this article.

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The Effect of Global Warming on Water Resources in Africa

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Abstract

The occurrence of greenhouse effects is a result of the accumulation of specific gases covering the planet human reside, and the general term for these gases refers to greenhouse gases, such as carbon dioxide, methane, nitrogen oxide, and fluorinated gases. Sunshine radiates from the effects of greenhouse gases into the planet Earth's surface, and the heat from the sun is ensnared and radiates back into the surface of the Earth. The negative impacts of global warming have resulted in hydrological cycle instability, which has led to water scarcity because it determines the availability of water for the community's many uses, most notably agricultural purposes. Africa is one of the most sensitive continents that are prone to climate change and variability. Climate change's direct implications on the water-food-energy nexus are expected to pose a growing quantity and variety of dangers to life and livelihood in Africa. This research examines the consequences of global warming on African water resources, focusing on four regions of the continent: West Africa, North Africa, East Africa, and South East Africa, all of which are experiencing water insecurity in their respective locations. This review aims to describe the relationship between global warming and water resources in Africa.

Keywords: Global warming, Climate change, Water resources, Africa

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INTRODUCTION

Global warming refers to a progressive increase in the mean temperature of the world, it occurs due to the activities of people and this has been in play for several years. Global warming can modify the hydrological cycle in varied ways, including increased cloudiness and latent heat fluxes, resulting in more intense and frequent precipitation extreme events (such as droughts, storms, and floods). These extreme events have garnered significant attention in recent decades as a result of the related economic losses, deaths, and a slew of other serious effects on the human environment (Wang and Liu, 2023). Climate change has become the focus of constant attention of living things and civilizations take into account the climatic parameters determined their lifestyles. Climate increasing or decreasing in changes affect living things negatively. Decrease in productivity, especially in agricultural production causes (İstanbulluoğlu et al., 2013).

Soil temperature decreases, plants that are not suitable for climatic conditions and resistant to cold will be affected by root and cause drying. As a result, a constantly increasing soil temperature will adversely affect plant life. It will decrease the efficiency (Bağdatlı and Ballı, 2020). The atmosphere is unsuitable for microbial growth because of high light intensity, drastic temperature fluctuations, low concentrations of organic matter, and minimal water content (Aydin et al., 2020).

Their effects have been measured and seen formed dangerous consequences on the ecosystem such as melting of ice, upsurge of sea and ocean, drought, salinity which is a result of aggregation of salts in the soil, continuous desertification, and several others. Water quality is crucial for various water uses. The pollution of drinking water sources, such as lakes and reservoirs, is significant for both individual and public health. Numerous strategies have been developed to protect watersheds from contamination (Bayhan et al., 2017). The warming of the earth is determined by the greenhouse which results from the progressive discharge of gases like carbon dioxide, nitrous oxides, methane, hydrocarbons, and water vapor, all these serve as hindrances to the dissipation of the heat formed through solar (Mella, 2022). Increasing the necessary studies and measures to minimize the emissions of carbon emissions should be taken all over the world and measures that will minimize the greenhouse gas effect will play an important role in reducing the effects of global warming (Bağdatlı and Arıkan, 2020). Global climate change affects the world negatively day by day and reveals negative results in agricultural product yield. In particular, it is inevitable to evaluate the regional temperatures and to review the product pattern in parallel with the increasing global climate change (Bağdatlı et al., 2014).

Changes in the Climatic conditions have led to an alteration in the atmospheric conditions, Hence, an alteration in the standard duration and range of rainy and sunny seasons, and this invariably resulted in increased oceans. Water resources are a crucial native asset that is essential to human life, they encompass people's daily activities and other forms of creature. A good environment is assessed based on the accessibility and characteristics of secured water. Availability of secured water has been identified to be the most constraint for rural dwellers in nations undergoing development, with almost 2.5 billion people living in inadequate surroundings. About seventy percent of clean and clear water is utilized for agricultural purposes, therefore, clean water is essential to people living in an environment for consumption, agriculture, and several uses (Ayanlade et al., 2022). Practices like conserving agricultural biodiversity, efficiently managing water resources for irrigation, and minimizing agricultural waste establish a framework for eco-friendly sustainable development, thereby protecting natural ecosystems (Unlukal and Erguven, 2024) Climate change and global warming are reducing the available water resources almost everywhere in the world (Uçak and Bağdatlı, 2017). The decrease over time of the changes in the surface of the water is noticeable. This also shows itself as the effect of disorder in the vaporization and current precipitation regime in the water sources dependent on climate change (Albut at al., 2018). The increase in the impact of global climate change will cause global water crises between countries. Necessary measures and measures should be taken in advance to reduce the impact of global climate change (Bağdatlı and Arslan, 2019). Changing climate conditions will be an important factor in the current situation and the problems that may arise in the coming years. For this reason, solutions are needed for global warming and reduction of greenhouse gases that cause climate change (Bağdatlı and Arslan, 2020). Africa is one of the most sensitive continents that are prone to climate change and variability. Climate change's direct implications on the water-food-energy nexus are expected to pose a growing quantity and variety of dangers to life and livelihood in Africa (Tedla et al., 2022).

Water reserves in Africa's semiarid regions have been exposed to different distress for the past 40 years, with caution levels almost at the critical points of water tension. The activities of climate change have increased water instability in Africa and some other places which has led to observed controversy on water value such as its usage, accessibility liberty, and water sustenance. Characteristics of water insecurity are as follows: Insufficient clean water, and a higher need for water than its quantity (Dinko and Bahati, 2023).

This research examines the consequences of global warming on African water resources, focusing on four regions of the continent: West Africa, North Africa, East Africa, and South Africa, all of which are experiencing water insecurity in their respective locations. This review seeks to describe the relationship between global warming and water resources in Africa. This review article is carried out based on a rapid review pattern of articles about the effects of global warming on water resources of Africa and this has strengthened the review article. The method of this review is categorized as a rapid review because it does not follow all the standards of a systematic review which involves the application of two reviewers for the assessment of all involved articles (Bezner Kerr et al., 2022) I employed different search techniques for resources related to my topic paper in writing this review such as Google Scholar, Springer, and Elsevier Science. I concentrated on research articles, short notes, and review articles that are practically and theoretically published. I read the abstracts, results discussion, and conclusion to determine the suitability of the articles. Search engines are employed in searching keywords like Global warming, Climate change, water resources, and Africa. The keywords made it possible to have a more extensive quality and quantity of articles. During the search for resources from several databases about 50 articles were found related to the topic and keywords searched. 17 articles were selected and used based on the following points of reference: Global warming effects, water resources, and Africa. Double-searched techniques were used for Google Scholar in the selection of the reference method of the article correctly. I ensured that I selected the most recent article with a recent publication date of less than 10 years.

CASE of EAST AFRICA

Ethiopia Awash River Basin

The Awash River basin in Ethiopia is exposed to considerable climate variability, with periodic floods and droughts. The basin is already under water stress, with more demand than supply. For example, research predicted an average annual runoff of 4640 MCM (million cubic meters), whereas the average annual demand is 4670 MCM. The basin experiences significant intra-annual variability, with the Awash Basin Authority recognizing dry season water scarcity as a barrier for diverse activities such as irrigation and domestic water delivery. There are examined projected irrigation expansion and demand satisfaction in the basin and discovered that, under the existing 'business-as-usual' scenario, the dry season faces unmet water demand, with the driest month (January) facing about 15 MCM of unmet water demand. Population growth, agricultural expansion, industrialization, and urbanization are all expected to drive up water demand. Climate variability has already had a significant impact on population and economic output in the Awash basin. Severe droughts in the basin have reduced crop output and killed animals, increasing food insecurity. A minor (5%) decrease in rainfall was expected to reduce the basin's GDP by 5%, with a 10% decrease in agricultural production (Taye et al., 2018; Mersha et al., 2018). Food production is a major concern that might be affected by climatic fluctuations (Bağdatlı et al., 2023; Elsheikh et al., 2023).

A similar report was obtained from the research by Orke et al., (2022) Evaluating the impact of climate change on hydrometeorology and droughts in the Bilate Watershed, Ethiopia and their findings revealed that Climate change effects on variables are expected to increase due to a significant rise in projected temperature, resulting in water storage depletion, which may lead to water scarcity, affect the length of the growing season, crop development, crop evaporation, and the amount of irrigation water used, and reduce crop yield. It might also result in significant droughts and the loss of livestock.

According to the assessment carried out by Tadese et al., (2020), the report that area's expanding population may be potentially detrimental to crop yield and food security. The loss of water supplies combined with population growth, will intensify droughts and food insecurity in the Awash Basin Authority (ARB), particularly in the Lower and Middle Awash. Likewise, the study by Guyasa et al., (2024) projected that climate change will affect the balance of water elements and drought between thirty to sixty years in the river basin, and their result revealed water accessibility could be remarkably and negatively impacted.

CASE of NORTH AFRICA (EGYPT)

Egypt is located around the northern eastern part of North Africa, surrounded by the Mediterranean Sea and the Red Sea on the northern and eastern coasts. Approximately over 95% of the fresh-water assets of Egypt are from the Nile River source, another source of water resource in Egypt is recycled water from effluents. Mostafa et al., (2021) studied on Potential climate change impacts on water resources in Egypt. The study was carried out in the Middle Egypt environment. The outcome of their research indicated that an increase in temperature on the region part could amount to 2.12 by 2050 and 3.96 by 2100 due to increased accumulation of discharge of world greenhouse gases which will negatively impact the mean temperature of the atmosphere and lead to negative impact on future irrigation system for crop production due to alteration in climatic condition.

CASE of WEST AFRICA

West Africa is rich and abundant with several water sources which are restored by the medium of the standard hydrological cycle (Coulibaly et al., 2018).

Nigeria Case

Nigeria is situated in the tropical zone, on West Africa's Atlantic Coast, between latitudes 40 N and 140 N and longitudes 20 21 and 140 301 E. Nigeria has a total size of 923,800 square kilometers. According to the Nigeria Water Resources Master Plan, Nigeria's population is 183,523,432 people, with a projected increase to 380,394,709 by 2030. Nigeria is abundant with vast water resources. Water is essential and beneficial to various sectors of the economy, including manufacturing, agriculture, cattle rearing, water transportation, and hydropower generation (Ezra et al., 2023). The analysis of Ezra et al., (2023) indicates a reduction in the average yearly precipitation and evaporation progression between −9.682 and −0.1709, appropriately. The reduction in the precipitation of and evaporation calls for action as these elements are major influences and forces behind hydrological activities and ecological services. The decrease in the elements projected a low rate of rainfall and evaporation which are capable of negatively affecting water accessibility and agricultural production in the environment. Their observation suggests an increased level of heat due to low rainfall and precipitation and this eventually abates soil dampness and a decreased flow. This climatic alteration will result in continuous and extreme droughts, reduction in crop production, and water shortage.

Another study by Ogunrinde et al., (2022) evaluated the impact of climate change and drought attributes in Nigeria, the trend of their data suggested that Nigeria's drought frequency and severity would grow from 2035 to 2100. Projections of the change in drought frequency based on the assessment models are expected to be higher than estimates, indicating a higher atmospheric water demand due to global warming.

In general, studies on quality characterization can provide insights into the time-dependent variation of polluted water parameters. The results of these studies indicate that poluted water bodies exhibits temporal and spatial changes. If it is necessary to determine the composition of receiving environments from a specific site, conducting water analyses is essential. The duration of these analyses should be extended to capture seasonal variations, especially due to rainfall (Yildirim et al., 2018).

Drought frequency is expected to decline in the near and distant future, whereas drought occurrence is expected to rise. The decreased frequency of droughts suggests that precipitation will increase, particularly as the twenty-first century comes to an end. Drought frequency and severity will increase during the twenty-first century as a result of climate change.

Senegal Case

Senegal is situated in the western part of Africa, and according to history, the country is the entrance to West Africa. Agriculture is the major source of finance in Senegal, especially the income from produce such as peanuts and cotton, and this aspect is greatly affected by drought and the lower cost of items. The fast increase in populace size has placed huge pressure on Senegal’s small land assets, agricultural produce, and water assets. More than eighty percent of the populace resides in the western part of the nation, and almost seventy percent are involved in the farming business meanwhile, the city populace experiences an increase continuously. Mbaye et al., (2019) Assessed Impacts of 1.5 and 2.0 0C Global Warming on the water balance Components of Senegal in West Africa. Their findings indicated that Senegal has the possibility of experiencing a reduction of year and season-average precipitation due to the influence of global warming. Meanwhile, there is a prediction of future evapotranspiration which will increase the rate of water dissipation through topsoil, oceans, and vegetation, this event will lead to water scarcity in the years to come.

CASE of SOUTH EAST AFRICA (MALAWI)

Climate change threatens Malawi's economic development and the living conditions of the impoverished and susceptible populace. Malawi's sensitivity to climate change stems from the point that agriculture, which provides 80% of Malawians' incomes, is non-irrigated. Furthermore, Malawi's industrial first line is primarily farmers, making the entire economy extremely sensitive to the effects of climate change. Malawi is ranked 171 out of 189 wealth and poverty nations, with a Human Development Index (HDI) of 0.477. Despite a 40% increase in HDI between 1990 and 2017, more than half of the population (50.7%) lives below the poverty line, with a quarter (25%) experiencing chronic poverty. More than 90% of the population relies on rain-fed agriculture, Climate extremes, such as droughts and floods, have the potential to reduce production and, as a result, food security (Dinko and Bahati, 2023). Similar work by Mtilatila et al., (2020) Indicated that Changes in precipitation and temperature have a significant impact on lake levels and the associated lake outflow. Temperature increases and precipitation decreases, affecting both lake level and lake discharge from Lake Malawi.

Lake outflow does not stop even with a 5°C temperature increase or a 20% drop in precipitation. The impact of combined temperature and precipitation fluctuations on river flows and resulting hydropower generation. Climate predictions concur that rising temperatures and decreasing precipitation result in lower mean lake levels, outflow, and Shire River discharge.

It is possible to come across many studies in the literature to reveal the effects of global climate change on agriculture and water resources. These studies have attempted to reveal the causes of global warming and the dimensions of the factors that cause climate change (Afreen et al., 2022; Bağdatlı and Belliturk 2016a; Elsheikh et al., 2022a; Bağdatlı and Can 2019; Bağdatlı and Belliturk 2016b; Elsheikh et al., 2023; Bağdatlı et al., 2015; Elsheikh et al., 2022b; Bağdatlı and Can, 2020)**.**

CONCLUSION

This review has revealed the relationship between global warming and water resources in Africa. From the four regions that have been examined which include: West Africa, North Africa, East Africa, and South East Africa, It has been established that global warming is a key driver of water insecurity in the parts of Africa examined, and this lack of water invariably affects other aspects of life such as social, ecological, political, and economic aspects of life.

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Evaluation of the Landscape Design of Kindergarten Gardens

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Abstract

Education is the most important activity in human life. The behaviours a person has at birth (breathing, movement, etc.) only ensure their survival and their survival depends on education. The fact that education is so important has also ensured that planned events are carried out systematically. At this point, schools have become an important part of human life. School is a living area where rest, learning, and personal development are supported, environmentally sensitive, healthy, and active individuals are raised in this space. In addition to education and training, the school provides an environment for children to play with their friends, especially during breaks and lunch hours, which constitute the breaks between classes. lay is a part of real life and the most effective learning process for children it can be purposeful or not, with or without rules, but in any case, the child willingly and with pleasure takes part in it, the basis of physical, psychomotor, emotional, social, mental and language development. The study aims to determine how children perceive the outdoors and what the needs of preschool education institutions are in terms of landscape design. The effects of the physical environment on children's perception were discussed, and surveys and drawings were conducted in the study. They preferred wood materials for wall and floor elements. This preference is followed by natural stone and podima. Children generally liked the natural-looking, warm-colour, and aesthetically appealing material examples. School garden design should be made in line with the wishes and demands of the children.

Keywords: Kindergarten, Landscape Design, Landscape, Outdoor, Niğde

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INTRODUCTION

The period from birth until a child starts primary school is called the ‘preschool period’. The first five years of life are when the child develops rapidly and has a high learning capacity, as well as when they need love and attention the most. This period is also described as when the child is most open to the effects of the environment (Karatekin and Çetinkaya, 2013). Children go through different developmental processes from the moment they are born. Children in the 0-3 age group depend completely on their families and are under their influence. Children in the 4-7 age group are more independent, but still in a controlled period. Especially from the age of 6-7, a period begins in which they can now play on their own and do not need much parental supervision. During this period, the child is in his/her most active period, while at the same time being much more interested in his/her environment.

During this period, which includes the 7-14 age group and is also called the primary school age, the school now constitutes the environment where the child spends the most time and is, therefore, most affected. The information he/she receives from this environment and the events he/she observes will form the foundation of the child's integration into society as a healthy individual (Erdönmez, 2007).

During this period, the child leaves egocentrism (the period in which the child discovers his/her environment, believes that this environment was created for him/her, does not care about anyone else, and covers the ages of 2-6, the self-involvement period) and begins to socialize. He/she establishes relationships with his/her peers and those who are younger and older than him/herself. Interest in dynamic group games, desire to move constantly, imitate those who are older than him/herself, development of psychomotor skills (Psychomotor skills are the organism gaining mobility depending on the will as a result of brain and spinal cord development together with physical growth and development. In other words, psychomotor skills can be defined as coordinated muscle activities directed by conscious mental activity used during the performance of a task. For example; handwriting, typing, etc.) become evident in this developmental stage (Özgen and Aytuğ, 1992). The experience and information that the child gains by living and playing in the schoolyard during break times play as big a role as the information he/she receives from school and other educational tools. According to Özgen and Aytuğ (1992), the child ensures the development of his/her emotional, physical, and social existence feelings through play and establishes a relationship with the environment. By satisfying his/her experimental needs, he/she develops his/her individualization and socialization together and gets to know nature.

As Yıldızcı (1982) stated in his study on urban green space planning; children's playgrounds provide children with an environment where they can play and develop their creative skills in a place separate from their family environment, and in this environment, the child should be able to find the form of play, tools and human environment within their own instincts, tastes and imitation tendencies, away from all influences. Especially, considering the great role that play plays in child development, the planning of primary school gardens, where the child spends most of his time during this important period in the development process, is an issue that needs to be addressed with importance. Children are open to all kinds of influences coming from the environment. Therefore, they are also affected by the changes that occur with the urbanization process. The problem of adaptation to the environment arises differently in children whose personality development is occurring or continuing. Children are quickly and easily affected by their environment due to the characteristics of the age they live in. Therefore, the child will be in harmony or conflict with his/her urban life to the extent that the conditions surrounding him/her are positive or negative. Since our country is a developing country, it has a largely young population and it is impossible to think that preschool children within this population will not be in the landscape design process (Sivri, 1999).

Children need constant movement and they need to play for their healthy development (Arslan et al., 2021). Pre-school education ensures that children develop physically, mentally, and emotionally, gain good habits, and prepare for primary education Dağlı, 2007; Karatekin and Çetinkaya, 2013). The period when a child is most affected by his/her environment is the preschool period when most of his/her psychomotor development is completed. It is seen how important the spatial quality of preschool education institutions is where the child spends most of his/her time (Gül, 2012).

For this reason, it is not possible to ignore these areas in the designs. The spaces and equipment which is used by children in preschool education buildings should be suitable for the child and should appeal to the child's spiritual comfort within the space. It is difficult for children to continue their education and develop in spaces where they feel anxious and psychologically disturbed. Dynamics and flexibility are important in the architectural planning of spaces in kindergartens. If flexibility is provided in the area, it will be possible to rearrange the area according to the activities and to get rid of the monotony of the space. A flexibly designed area allows children to organize their environment with the help of themselves and their educators. Children have a very rich imagination and creativity. They do not like boring and monotonous orders. They like places and toys that allow them to use their creativity and are surprising, fun, and open to discovery (Yuvacı and Dağlıoğlu, 2016). The aim of this study is to determine the quality and quantity of the criteria to be sought in school gardens in Niğde, with the student opinions, to develop spatial organizations in existing schools and to create a typical model for the design of newly constructed school gardens in line with the findings obtained.

MATERIAL and METHOD

The study focused on the outdoor landscape design of preschool educational institutions where 5-6-year-old children spend most of their time during their preschool education. The study is based on a methodology developed on visual surveys and drawings. In order to obtain healthy results in this section, the child must have acquired certain characteristics, such as the ability to hold a pencil, create composition in a picture, and be socially competent. The 5-6 age group was particularly preferred because they had completed their psychomotor development. Within the scope of the study, three preschool education institutions, two private and one public, were selected in the central district of Niğde.

Sefa Kelebek and Niğde Özel Vuslat Kindergartens are private schools; Emine Çetin Kindergarten located on the Niğde Ömer Halisdemir University campus is a public school. The number of samples was determined as 90; however, considering the possible errors and the number of classes where the application was made, the number was increased to 100. A visual survey was applied to photographs of garden walls, garden gates, plant design examples, outdoor flooring examples, pergolas, and children's play groups selected by the perception levels of 5-6-year-old children. Children have indicated their preferences by colouring the box under the photographs. According to the literature reviews (Özdemir, 2011; Soydan et al., 2014; Vural and Yılmaz, 2018), the number of photographs to be applied varies under each subject heading.

Six photographs were determined for limiting elements, floor coverings, doors, pergolas, playgroups, form to plant design, and colour in plant design, four for emphasis in plant design, and three for texture in plant design. Since the survey focused only on wishes, children were asked to draw the garden of their dreams to support the survey. While points, lines, surfaces, textures, forms, and colours are visual design elements, integrity, balance, emphasis, alignment, and proximity are considered visual design principles. The examples in the photographs were selected according to design elements and principles, and the photographs were grouped according to these principles.

In the examples, those with different characteristics in terms of colour, form, texture, and material and those in harmony with their surroundings were prioritized. Analyses were made on the photographs that children mainly selected. 'They chose the example with a cold colour, formal structure, and fine texture' was interpreted as a deduction. To determine the garden of the children's dreams, the objects in the pictures were counted and an attempt was made to reveal why the objects in the majority were important to the child. The children's preferences were determined by the survey and the pictures drawn. In the surveys, children were given options and an attempt was made to determine what the gardens they could not express but could imagine were like through drawing pictures. Thus, children's expectations were revealed in a healthier way with two studies.

RESULTS and DISCUSSION

The survey study was conducted in pre-school education institutions in the Niğde Central Region and applied to 100 children aged 5-6 in three different schools. 43 of the children are girls, 57 are boys, 46 are 5, and 54 are 6. 27 students are in Private Vuslat Kindergarten, 29 are in Sefa Kelebek Kindergarten, and 44 are in Emine Çetin Kindergarten. 61 of the children's mothers have bachelor's degrees, 24 have associate's degrees, and 15 are high school graduates. 32 fathers have bachelor's degrees, 27 have associate's degrees, and 11 are high school graduates. The survey study which consisted of nine parts was applied over photographs. These parts are limiting elements, covering, pergola, door, playgroups, and also form, colour, emphasis, and texture in plant design. Photographs have six different characteristics for the limiting element have shown in Figure 1.

Figure 1. Limiting elements examples

Among the limiting elements, wooden fence was selected as the first with 38%, natural stone cladding as the second with 29%, and travertine cladding as the third with 24%. Wooden fences make decorative look and feel more natural. These fences are virtually maintenance-free and a long-lasting solution that offers strength and durability for sturdy and beautiful spaces that will last a long time. Natural stones, known by different names such as "decorative stone" and "culture stone" are increasing their popularity daily.

Various types are created by taking molds of natural stones using pumice, sand, cement, and colour pigments. Decorative stones have been prominent as a material used in construction projects for many years. Many types of stones in nature indicate the existence of different natural stones. Each stone has its unique characteristics. With the advancement of technology, these stones are used for decorative purposes today. Photographs have six different characteristics for the floor covering have shown in Figure 2.

Figure 2. Floor covering examples

In the flooring samples, wooden flooring ranked 1st with 47%, natural stone flooring ranked 2nd with 33% and podima stone flooring ranked 3rd with 25%. Wood is a flooring type that is both modern, natural, and aesthetic. Its models have evolved from the past to the present and are constantly renewed. Wooden flooring is a product that can be easily used in many places. There are different product groups for these flooring products for each place. In recent years, wooden flooring has become preferred in many places due to its increased ease of use, warmer appearance, stylish appearance, and increased colour and texture options.

Natural stone flooring is inherently unique and captivating in its appearance. Each stone floor has its own unique pattern, grain, and colour variation, ensuring that no two floors will ever look exactly the same. This unique uniqueness adds a personalized touch to any space that reflects the beauty and diversity of the natural world. The appeal of natural stone lies in its imperfections and variations, which contribute to a rich, textured appearance that synthetic materials cannot replicate. Podima stone is a natural material and is usually obtained from volcanic rocks. It has a smooth structure and absorbs water well.

This way it prevents the roots from rotting by absorbing excess water accumulated in the soil. Podima stone also creates air pockets in the soil. Photographs have six different characteristics for the pergola have shown in Figure 3.

Figure 3. Pergola examples

When selecting pergola samples, special attention was paid to their different forms. Modernist design pergola ranked first with 56%, metal pergola ranked second with 43% and suspension system ranked third with 21%. The modernist pergola is an informal form and is made of artificial material. Natural material wood was used in the roof and seating areas and warm colors were preferred. Metal pergola with formal form is made of artificial material and cold colour. Suspension systems are structural elements that can easily applied to different spaces and designed in different geometric shapes. Flexibility provides great freedom to architects and designers.

Thanks to their lightweight structures, they do not add additional load to the structure and can be easily installed on existing structures. Suspended tension systems also have a great appeal in terms of aesthetics. Their clean and modern appearance can adapt too many architectural styles. Different lighting effects can be achieved by using transparent or opaque materials. This adds a unique atmosphere to the structure. Photographs have six different characteristics for the playgroup have shown in Figure 4.

The simple plastic game group ranked first with 50%, the plastic very complex game group ranked second with 34% and the complex wooden game group ranked third with 14%. The simple plastic playgroup is an artificial material containing slide types in different forms such as tunnel, straight, and curved, and consists of warm colours. The complex wooden playgroup is cold-coloured and has a large form. It has a complex structure that includes different game systems and its material is natural. Photographs of different forms used in planting design were evaluated in the survey (Figure 5).

Figure 4. Playground examples

Figure 5. Forms examples used in planting design

Simple plant design ranked first with 48%, informal plant design ranked second with 20%, and plant design with herbaceous ranked third with 16%. A visual with fine texture and plant heights was preferred in the simple design. Herbaceous plants used in plant design, have flowers in different warm colours and are low-growing like ground covers. In informal plant design, there is a wider viewing angle. Plants of various shapes and sizes were used. A non-linear, scattered visual was preferred. The plants used in the visual are predominantly green. Species with different leaves and flowers were selected. The design made shrubs and herbaceous has a little more closed feature. The colour green is predominant, and there are taller species than in the design using herbaceous. Photographs of different colour used in planting design were evaluated in the survey (Figure 6).

Figure 6. Colour examples used in planting design

Green and purple were selected as the first with 35%, pink as the second with 32%, and purple as the third with 22%. The green and purple colours in the first photo are in the cold colour group. The pink in the second selected image is a sign of hope. It is a positive colour that inspires warm and comforting feelings and creates everything will be okay. The third photo is dominated by purple. Purple is in the cold colour group and makes the space look narrower and colder than it is. Photographs of emphasis used in planting design were evaluated in the survey (Figure 7).

Colour emphasis was selected first 47%. Crown structure emphasis was selected second 35%. The first photo shows a tree species with different colours. The second photo shows a tree species that attracts attention with its long and thin trunk. Photographs of texture used in planting design were evaluated in the survey (Figure 8). The photo with finely textured species is in first place with 55%. The photo with rough textured species is in second place with 21% and the photo with medium textured species is in third place with 12%. The other parts of the plants can be easily perceived in the first photo. In the second photo are species with coarse texture and compact structure. In this image, the trees cannot be perceived completely and the closed feature is at the forefront. Privacy, surprise, etc. situations can be provided with the closed feature.

In the last photo, these features are a little weaker, some areas can be perceived among the species, although few. Photographs of the garden door were evaluated in the survey (Figure 9).

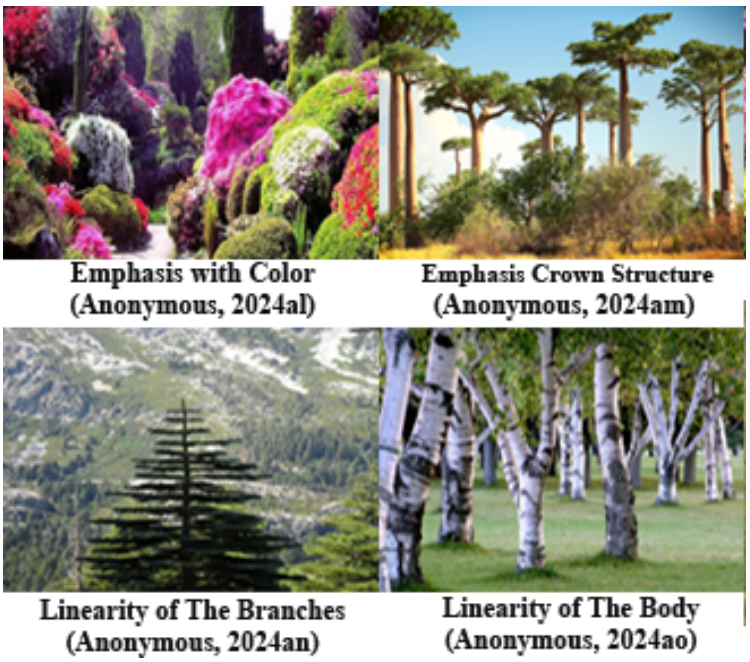

Figure 7. Emphasis examples used in planting design

Figure 8. Colour examples used in planting design

The iron-closed door is in first place 34%. The wooden wide door is in second place 29% and the wooden narrow door is in third place 25%. In the first photo, there is a large door made of iron, an artificial material. Since it has a closed form, it provides privacy between two spaces.

The second photo has a large door made of natural material. The door has a closed feature rather than a hollow form. This eliminates visibility between the two spaces and creates privacy. The third photo is similar to the first and second photos in size, but unlike them, it has a more natural appearance, and like the second photo, it has a closed feature.

The pictures drawn by the children were separated into 5 and 6 age groups, and the objects were determined and counted (Figure 10).

Figure 9. Garden door examples

The objects in the pictures are slides, swings, seesaws, plants, animal figures, a limiting element (wall), informal toys, a road, a house, a flag, a pool, and sitting (Figure 11). These figures were determined and counted separately for 5 and 6 age groups. It was observed that among these figures, slides, swings, and plants were the most drawn objects. The number of children in the 5-year-old group is 46 and the number of figures in the pictures they draw is as follows; slide in 9 pictures, plant in 12 pictures, house in 10 pictures, door in 5 pictures, human in 6 pictures, Ferris wheel in 4 pictures, car in 1 picture, swing in 10 pictures, toys in different shapes in 8 pictures, animal figure in 5 pictures, boundary element in 3 pictures, flag in 1 picture, pool in 4 pictures and more than one figure can be found in 7 pictures.

The number of children in the 6-year-old group is 54 and the number of figures evaluated is as follows; slide in 39 pictures, swing in 25 pictures, plants in 30 pictures, houses in 15, people in 9, toys drawn in different shapes in 10 pictures, seesaw in 9 pictures, animal figure in 18 pictures, boundary element in 1 picture, road in 3 pictures, flag in 4 pictures, and car figure in 5 pictures. Both age groups are slide, swing, plant, house, people, seesaw, informal toys, and animal figures. The survey study conducted in preschool education institutions in Niğde was applied to 100 children aged 5-6 in three different schools. . These schools are; Sefa Kelebek Kindergarten, Özel Vuslat Kindergarten and Emine Çetin Kindergarten.

The 5-6 age group is especially preferred because they have completed the necessary psychomotor development; to obtain healthy results in the visual survey and drawing section conducted within the scope of the study, the child must have acquired certain characteristics such as the ability to hold a pencil, create composition in a picture and sociability.

Figure 10. Picture from different kindergarten

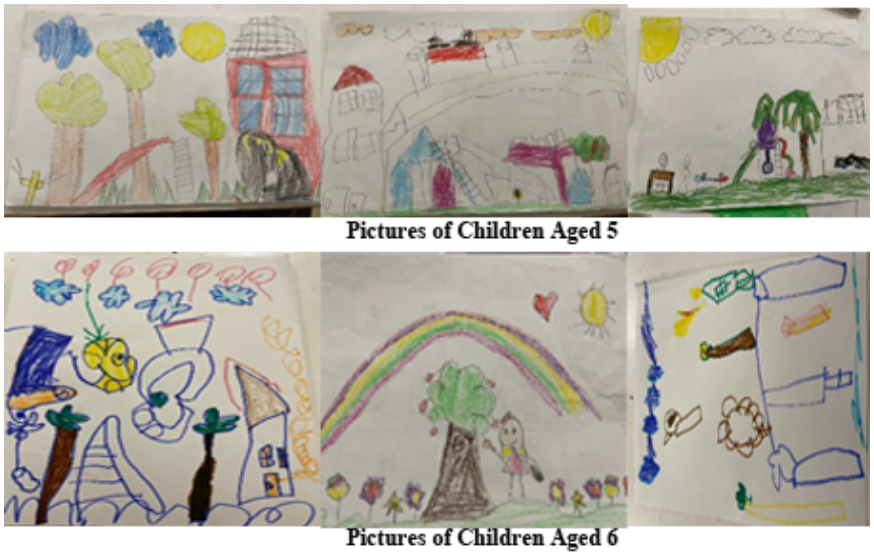

Figure 11. Pictures of children aged 5-6

They liked wooden materials such as walls and flooring. Wooden fences and natural stone coating come to the wall. At this point, it is revealed that children prefer walls visually rather than for their features such as enclosure and privacy, and they choose walls that are naturally open. While wooden flooring was the first choice of covering, natural stone, and podima came after. Children liked the natural-looking, warm-coloured, and aesthetically appealing material examples. It has been observed that children pay attention to features such as natural material, warm or cold colours, design differences, and interesting points in pergolas. The primary choice in playgroups is the simple play group dominated by warm colours. Then, a complex playgroup with artificial materials. It has been revealed that colourful and short plants can attract more attention in gardens created for children.

In planting design, while the group of tall trees and shrubs is created from green or one of different cool colours, it is possible that species such as seasonal ground cover can be more striking. In the photos shown under the title of texture in plant design, the most liked is the fine textured design example. Children like designs with dense crowns and closed features in plant design. When the wall example was examined, the opposite result was seen. Children want the elements that limit and hide them to be made of natural cover, that is, vegetation. The last category they evaluated was the garden door. They liked the close, high, and wide iron door. Based on these results, it is revealed that a significant portion of the children care about the door being large. In the painting "Dream Garden", it was observed that children mainly drew play elements. There is also a significant amount of vegetation, but while not every painting contains a plant figure, there is a play element in every painting. Based on this point, it is noteworthy that focal points o are objects that create play opportunities due to their age.

CONCLUSION

Based on the survey results and the pictures drawn, the design criteria to be considered when creating an area for children in preschool education institutions can be listed as follows; the wall should have a perforated form and should not be closed, the flooring should be warm-colour, natural or patterned, and if a shading element is to be used, it should be noted that the dimensions of this element should be large and have an attractive form. It will be more interesting for children if the play elements to be used are simple or complex when using different forms in plant design, plainly arranged or colourful non-tall ground covers dominated by lively-warm or cold colours can be preferred, and in tall tree or shrub species, green or other cold-colour flowering species can be preferred. When it is desired to create emphasis in plant design, species that attract attention with their colours, and colours can be preferred, the texture of the plant design can have a fine feature, in other words, it can be created from fine-textured species, and the door to the garden with the outer environment should be as wide and high as possible. When the results of the pictures drawn are taken into consideration; The presence of at least one playgroup in the garden, emphasis on plant design, and also the inclusion of structural elements such as houses is a situation that children want more; However, it should not be forgotten that this study was not conducted equally among a large group and private schools or schools affiliated with the national education system and reflects the results of a specific region (Soydan et al., 2014).

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Performance of the Grain Legumes National Cooperative Testing (NCT) Project in Visayas State University, Baybay City, Leyte, Philippines

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Abstract

Before a variety is recommended to the National Seed Industry Council (NSIC), it must undergo a series of tests across several locations and seasons throughout the country. Therefore, regional NCT trials have been implemented to test the stability of the variety in terms of its characteristics, particularly on agronomic characteristics and pest and disease resistance. The Visayas State University (VSU) is one of the cooperating stations that conducted varietal trials and evaluated promising genotypes of legumes produced from the breeding programs from the government and private institutions. The University's involvement in the NCT trials for Legumes started in 2017. To facilitate the conduct of the different legume varietal trials, a project proposal was submitted to the VSU's Research, Development, Extension, and Innovation Office for funding support. After about five years of project involvement, there are already three (3) NSIC Mungbean, and two (2) NSIC Peanut registered varieties that can be used by the farmers and interested clients nationwide.

Keywords: National cooperative testing, Peanut, Pest resistance, Yield evaluation

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INTRODUCTION

To answer the demand for the leguminous crop products on peanut and mungbean, a continuous breeding program to develop resilient and high-yielding varieties of these commodities was done from the breeding stations in the government and private agencies (Sarcol and Cagasan 2016). Peanut (*Arachis hypogaea* L.) and mungbean (*Vigna radiata* L.) are the two (2) important grain legumes grown in the province of Leyte, Philippines. They belong to the Fabaceae family and are cultivated across Asian countries for their edible seeds. These are considered the cheapest plant protein and minerals sources, such as calcium and sodium. Legume crops are extensively grown in all soil types under varying climatic conditions. They can be planted not only as a monocrop but also as a rotation crop, relay crop, and inter-crop of late maturing crops like corn and upland rice due to their drought tolerance and early maturity (Labuschagne et al., 2016). Peanut and mungbean are also fast-growing crops with more herbage, making them excellent crops for green manuring (Peanut Growers, 2020).

Thus, growing legumes and integrating the whole crop into the soil as green manure is good, especially in rehabilitating marginal areas. Since legumes can fix nitrogen from the atmosphere, green manuring can maintain or improve soil fertility without direct costs for fertilizer (Singla and Babbar, 2015).

The market demand for this crop is increasing due to its various industrial uses. Hence, researchers and plant breeders have tried to breed and select resilient and high-yielding legume varieties to produce and release recommended NSIC legume varieties. Before a variety can be recommended to the National Seed Industry Council (NSIC), it must undergo a series of tests across several locations and seasons throughout the country. Regional NCT trials have been implemented to test the stability of the variety in terms of its characteristics, particularly on growth and yield, as well as on pest and disease resistance and tolerance (Escototo, 2020). VSU has been chosen as one of the cooperating stations of the National Cooperative Testing Program for Legumes. Hence, this project was implemented to develop and recommend high-yielding, pest, and stress-tolerant legume varieties to the National Seed Industry Council; and determine the best legume varieties for farmers in Eastern Visayas. In this article, the author would like to assess the performance and contribution of this NCT project not only to the farmers but also to the University's four-fold functions; instruction, research, extension, and production.

MATERIAL AND METHOD

The procedure for conducting NCT trials for legumes was based on the manual and guidelines developed by the technical working group (TWG) and approved by the National Seed Industry Council (NSIC) board. The experiment was laid out in randomized complete block design (RCBD) with four (4) replications. Different promising genotypes of legumes (peanut and mungbean) served as the treatments with NSIC Pn18 and NSIC Mg 17 as the national check varieties for peanut and mungbean, respectively (Bernabe, nd). The plot size was 5m x 2m with four rows per plot. Alleyways of 1.0 m between replication and 0.5 m between treatments were provided to facilitate farm operations and data gathering. The drilling method of planting was followed with a plant population of 7-10 plants per linear meter for peanut and 15-20 plants per linear meter for mungbean. A total amount of inorganic fertilizer was applied to peanut and mungbean with the recommended rate of 30-30-30 kg ha^{-1} N, P2O5, K2O. Complete (14-14-14) fertilizer was applied one week after seedling emergence. In addition, recommended cultural management practices such as weeding and irrigation were provided to maintain the crops' optimum growth and yield performance.

Every after harvest, the data will be placed in the data form a template developed by the NSIC Technical Working Group (TWG) for grain legumes.

RESULTS AND DISCUSSION

The project Contribution to the University's four-fold functions

The project goal followed the four-fold function of the University's, instruction, research, extension, and production.

University's four-fold functions	Project's Contribution
1.Instruction	The project will serve as the demonstration area for legume production that will cater to agriculture students to observe their farm activities from land preparation up to harvesting and collecting pests in the field for the pest management significant students in the University.
2.Research	The project will also provide the latest legume varieties as a source of planting materials used for research activities by the student's thesis and faculty.
3.Extension	The project will serve as a site demonstration for the extension project of the Department of Agronomy, such as technical assistance to the farmers to improve their peanut yield.
4.Production	This is only for research and extention purposes not for production and to gain net income.

Self-Assessment of the Project

Overall Management

Items	Last Year's Performance Rating (1-10 scale), NA if not applicable	Details or justifications for the rating provided
1. Able to sustain the gains of the project carried over from the previous administration	5	The year 2021 was considered a failure for the cropping season due to the Covid 19 Pandemic and typhoons damaging some of the experimental crops. As a result, no students and clientele are allowed to enter the University.
2. Able to manage and improve the efficiency of workers	7	Due to the faculty's heavy workload on instruction and research activities and the transition period for the online classes.
3. Able to implement initiatives to improve the productivity of workers	8	The project was improved interms of project operations in field, delivery of seeds as planting materials from the breeders. This project was managed by one and managed by oone research assistant, one laborer and one the study leader.

4. The project falls within the mandate of the unit	10	This is part of the department and university's goal to provide the university's four functions (instruction, research, extension, and production).
5. Maintenance of a peaceful environment in the project	8	No requests for mediation to settle disputes within the project and environment.
6. Worker turn-over degree	8	None
7. Worker retrenchment	9	No reduction of workers
8. Frequency of requests for mediation to settle disputes within the project	4	No requests for mediation to settle disputes within the project
9. Adherence to BOR/ CHED/DBM policies/guide lines	9	The project protocols adhere to the DBM policies
10. Practicing transparency in all transaction	10	All activities in the field, laborers, and other field costs were monitored by the COA. The sales were remitted directly to the cash division office.

Research Management

The project provided a research component and was managed by the personnel to deliver the output to the students and other clientele interested in the legume crops. Hence, this was evaluated based on the project leader assessments.

Items	Last Year's Performance Rating (1-10 scale), NA not applicable	Details or justifications for the rating provided
1. Have made improvements/innovations in the project based on research results	6	No proper research/interventions were done on the farm sites. Still, the project proposal was submitted to VSU RDEI Office.
2. Extended support to the research community to improve research capability	6	No proper research/interventions were done on the farm sites. Still, the project proposal was submitted to VSU Extension Office.

3. Provided infrastructure to improve research capability	6	The laborers only maintained irrigation canals. No other infrastructure was established.
4. Adoption of relevant technologies	7	Farmers and interested clientele follow modern legume technology, such as certified seeds and proper use of inputs (chemical fertilizers and pesticides).

Extension Management

The project provided a demonstration area for the visitors, and students conducted practicum for their skills development and on-the-job training. Also, for other individuals who are interested in studying legume crops.

Items	Last Year's Performance Rating (1-10 scale), NA not applicable	Details or justifications for the rating provided
1. Alignment of the project with instruction and extension	7	Caters major agronomy students for their laboratory classes and demonstration for extension
2. Formulated and implemented creative outputs to bring project output to intended clientele	8	The NCT project was utilized by the Agronomy major students as a training demonstration site and also for the department's extension activities.
3. Provided mentoring services and established partnership arrangements with clientele or interested parties	7	Cater's primary agronomy students for their laboratory classes, thesis, and any individual interested in growing legume crops.
4. Sustainability of implementing a project	8	Sustainability of production system for the farmer.
5. Transfer of knowledge and expertise to interested parties	7	Caters major agronomy students for their laboratory classes and research.
6. Technologies extended or demonstrated	8	Provides training program on the production and management of the different cultural management practices for the grain legumes to agronomy major students specifically for their skills development (practicum) and also to interested farmers/technicians on their NC II and III in Crop Production.
7. The extent to which the project is used for the University's extension function	7	The project serves as a laboratory facility for instruction and research and the department's extension program activities as the training demonstration area.

Production Management

Items	Last Year's Performance Rating (1-10 scale) NA is not applicable	Details or justifications for the rating provided
1. Level of revenue /yield generated from the project	6	The yield of legumes was relatively lower because of erratic climatic conditions that affect the operations, especially during wet season cropping. However, during the dry season cropping, it was suitable for the legume crops.
2. Number of other potential marketable products of the project	5	The project for NCT legumes is solely for genotype screening. Thus no other product was produced in the project.
3. Employed strategies or technologies to increase income generation or production	5	Adoption of low-cost land preparation, other cultural management practices, and proper/efficient use of inputs must be observed in the project operations.
4. Level of income generated from commercialization of products generated from technology developed	6	The introduced technology or the newly approved/registered NSIC legume varieties need to propagate in all cooperating stations throughout the Philippines to have more quality planting materials to be used by farmers and other interested individual.

Financial Management

Items	Last Year's Performance Rating (1-10 scale) NA is not applicable	Details or justifications for the rating provided
1. On-time payment of salaries and benefits	NA	On-time salary of workers in the NCT project is to be prioritized
2. On-time payment to suppliers	NA	None
3. Adherence to COA policies	8	Job order workers are in adherence to COA rules and regulations.
4. Efficiency in the utilization of GOP budget	NA	No GOP needed
5. Efficiency in the utilization of income	8	The income in the project was also monitored and submitted to the university cashier's office.
6. Amount of annual savings	8	The money was deposited in the cash division office under the general fund

8. Practice record keeping	10	Income generated from sales was properly recorded and remitted to the treasury of the University.
9. On-time submission of financial reports	9	Sales report was supported by sales receipts from the commercial buyers and checked by the IASSO personnel. In addition, financial reports were submitted to IASSO.

Logic Framework

The VSU-NCT 1718 Project uses the standard protocols to conduct the National Cooperative Testing Project through the NCT Legumes manual (Singla et al. 2015).

INPUT	ACTIVITIES	OUTPUT	OUTCOME	IMPACT
• Experimental area • Mechanization (tractor) • Field supplies • Human resources (Research Aid & laborer) • Project Funds	• Land Preparation • Planting • Hilling up • Weeding • Fertilizing • Harvesting • Processing • Data gathering	Conducted two wet seasons and two dry season trials for peanut and mungbean yearly	Efficiently utilized the data from the trials. Thus, three new Mungbean varieties were recommended by the TWG and approved by NSIC in 2021 for release as new varieties.	More NSIC legume varieties have been released. Food Security

Summary Output Matrix

The VSU-NCT 1718 Project follows the National Cooperative Testing Program for Legumes manual using the matrix below (Loko et al. 2020).

Expected Output	Details (2021)	Target/ Planned (2022)	Actual Accomplishment/ Output To Date	Percent Accomplished
Place National Cooperative Testing Program for Legumes	Established four trials per year using ten entries for each crop (mungbean and peanut)	Conduct 2 trials in wet and dry seasons for both mungbean and peanut	Collected and analyzed data for two croppings (wet and dry season) for two crops (mungbean and peanut)	100%
Patent Three promising genotypes of mungbean recommended to NSIC	Submission of complete data of the three recommended mungbean genotypes	Approval by the NSIC of the three recommended mungbean genotypes	NSIC approved the three recommended mungbean genotypes as new NSIC varieties	100%

People Mentoring students in research	Conduct thesis for one agronomy major student	Graduated one agronomy major student	Graduated and mentored one agronomy student	100%
Product New NSIC-recommended Mungbean varieties	Conduct trials and evaluate data for recommendation to NSIC	NSIC released Mungbean varieties	Submitted data to TWG for evaluation	100%
Policy NCT manual	Review and amend NCT manual in conducting the trials	Improved NCT manual	Revised NCT manual	100%
Publication Published article	Develop two papers for publication in referred Journals	Submit papers for publication	Submit two papers for publication	80%

Problems Met and Action Taken

Problems Encountered	Actions Taken
1. LOW PRODUCTION- caused by the following factors: a. Weather Conditions Continuous rains and frequent visit of typhoons which affected field operations and cultural management practices like the application of fertilizer and pesticides b. Lack of Inputs	• Adjusted activity schedule and implementation • Timing of planting to minimize damage/sterility of grains caused by continues raining and strong wind (southeast moonson or habagat). • Proposed support on the credit of fertilizer and other chemical inputs to the cultivator

CONCLUSION AND RECOMMENDATION

The project served as the techno-demo for the grain legume crops that will cater to agriculture students and other interested stakeholders. The project served 15 students, five faculty, and 25 farmers who conducted their extension project on legume production technology. They also published other significant outputs of the projects, like the latest performance of NSIC-released legume varieties in Eastern Visayas. The project conducted two trials for the wet season and two for the dry season for both mungbean and peanut. The data were consolidated and submitted to NSIC for review and evaluation. In 2021, three promising lines of mungbean and one peanut were released by the NSIC as new legume varieties.

It is also recommended that the new workers must be trained for modern cultural management practices for grain legumes crops. In addition, the adoption of low-cost weed and nutrient management must be properly observed.

LESSONS LEARNED

1. An integrated crop management approach (water, soil fertility/nutrients, weeds/pests/diseases, and post-harvest processing) is vital to maximize the productivity and profitability of legume farmers/cultivators.
2. All technologies and practices should be used synergistically to help farmers increase and maintain yields and reduced production cost.
3. Improving the quality of legume seeds and shelling recovery will enhance farmers' profitability.
4. We need to train the extension staff and equip them with adequate technology to educate their farmer-clients on modern legume farming.

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Sustainable Material Production from Agricultural Wastes: Bio-nano Carbon

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Abstract

Agricultural activities play a key role in the production and supply of the food needed to sustain life. In recent years, agricultural activities have accelerated to meet the food demands of a rapidly growing world population. However, intensive agricultural activities generate a significant amount of waste and by-products. These wastes are mostly composed of organic materials, and if not properly stored, disposed of, or managed, they cause soil-water-air pollution and threaten the environment and public health. Therefore, the recycling of agricultural wastes is of great environmental and economic importance. In addition, recycling agricultural wastes and transforming them into high value-added products by subjecting them to various resource recovery processes contributes to the concept of sustainability and circular economy and provides access to raw materials from local resources in a cheap and easily accessible manner. In this context, in this study, apple and its by-products, which are among the wastes of agriculture and food processing industry, were collected from the apple orchards and apple juice production plant of a company operating in the local region and bio-nano materials were produced from these wastes in a sustainable manner. In the study, the wastes were carbonized using hydro-thermal synthesis method and then reduced to nano size by grinding. FESEM, EDX and XRD analyses were carried out on the carbons produced in the study. The results of the study showed that bio-nano materials can be sustainably produced from agricultural wastes.

Keywords: Agricultural waste, bio-nano material, hydro-thermal synthesis, Resource recovery, sustainability

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INTRODUCTION

With the development of science and technology, human life has become longer and more comfortable. Due to increased comfort and health facilities, human life has been prolonged, and the population has increased rapidly. The increase in human life expectancy and population growth has rapidly increased the demand for food and energy. To meet this demand, activities in these areas have become more intensive. As a result of these intensive activities, many wastes are generated, and these wastes cause various public health and environmental problems. The main environmental problems are soil-water-air pollution, release of toxic substances and heavy metals, pH imbalance in soil and water, damage to ecosystems, risk of species extinction and inefficiency of agricultural land.

Waste management is critical to minimizing or eliminating these environmental impacts. Through recycling processes, resource recovery and circular economy concepts, both environmental and economic benefits can be achieved by recovering these wastes and transforming them into high value-added products. In addition, it aims to contribute to sustainability by supporting concepts such as green economy, resource recovery and recycling through various plans, programs, policies and strategies (Dehkordi et al., 2024).

Hydrothermal synthesis is a carbonization process that takes place under high pressure and temperature, allowing the upcycling of agricultural waste. Hydrothermal synthesis is widely used to produce carbon materials, biofuels and other valuable products from biomass. Due to their high organic and carbon content, agricultural wastes are highly suitable sources for carbon production by hydrothermal synthesis. However, various wastes are generated as a result of agricultural activities and the contents of these wastes vary (Zamani et al., 2019). In this direction, the types of agricultural wastes to which hydrothermal synthesis parameters can be applied are discussed as follows:

I. Wastes with high content of cellulose and lignocellulose:
Lignocellulosic biomasses such as wood chips, corn stalks and rice husks are highly suitable wastes for hydrothermal synthesis. Such wastes allow to obtain hydrocarbon-rich products thanks to the lignin, cellulose and hemicellulose in their structure. Under high temperature (180-250°C) and pressure, these components can be decomposed into carbon-based materials.

II. Waste with low carbon content:
Biomasses with high moisture content and low carbon content, such as fruit and vegetable wastes, are not suitable for hydrothermal synthesis. Such wastes reduce the energy efficiency due to their high water content and can negatively affect the quality of the target products (e.g. hydrocarbons, carbon materials). However, these wastes can be included in the process after pre-drying or concentration.

III. Tailings with high protein and fat content:
Wastes from the food processing industry (e.g. meat, fish, dairy wastes) often contain proteins and fats. The use of such wastes in hydrothermal synthesis can lead to the formation of by-products (e.g. ammonia, fatty acids). As this can adversely affect the purity of the carbon structures, the usability of such wastes is limited.

IV. Wastes Containing Toxic and Inhibitory Substances:
Pesticide residues or agricultural wastes containing heavy metals should not be used in hydrothermal synthesis. Such substances can damage process equipment and reduce the quality of the resulting products. They may also pose environmental and health risks.

V. Fibrous and heterogeneous wastes:
While fibrous and heterogeneous biomasses such as cotton stalks and sunflower stalks are suitable for hydrothermal synthesis, process efficiency must be optimized. Pretreatments such as shredding and grinding allow for more efficient conversion of such wastes in a homogeneous reactor environment.

Hydrothermal synthesis is a suitable process for agricultural wastes with high carbon content and low moisture content. However, the choice of process parameters (temperature, pressure, time, catalyst usage) should be optimized according to the type of waste. For wastes with high moisture content or containing inhibiting substances, pre-treatment processes are required.

Therefore, the applicability of hydrothermal synthesis depends on both the physicochemical properties of the waste and the type of product to be produced (Fathy et al., 2020).

Bio-nano materials are defined as nanometer-sized materials inspired by biological systems or obtained by direct use of biological structures. These materials generally have a physical and chemical structure that can interact with biological organisms, are biocompatible, or simulate biological functions. Due to their nanoscale properties, bio-nano materials are used in many fields such as agriculture, energy, environment, construction, medicine, chemistry and food industry (Gado, 2022).

Bio-nano materials can be produced by various physical, chemical and biological methods. These methods can be basically listed as top-down, bottom-up, biosynthetic methods, chemical vapor deposition and carbonization. Bio-nano materials have the potential to make a significant contribution to sustainability. The raw materials needed to produce biomaterials are usually biomass resources, and they enable the production of environmentally friendly and recyclable materials using natural biological processes. For example, biodegradable alternative materials can solve the problem of plastic waste. At the same time, bio-nano materials that increase energy efficiency and are used in renewable energy technologies can provide environmentally friendly solutions by replacing fossil fuels. In terms of sustainability, bio-nano materials offer advantages with their environmentally friendly production processes, energy efficiency and recyclability (Rasool et al., 2024).

Bio-nano-carbon materials contain carbon structures in which carbon atoms are organized at the nanoscale and are inspired by biological processes or produced from biomass-based sources. These materials can generally be listed as carbon nanotubes (CNT), graphene, carbon nanofibers (CNF), carbon dots (CDs). Due to their chemical, physical and biological properties, these materials have important applications especially in areas such as construction, energy storage, catalysis, sensors, medical and environmental engineering (Huang et al., 2021).

Bio-nano-carbon materials can be produced using biological processes as well as traditional manufacturing techniques. These production methods can be listed as Chemical Vapor Deposition (CVD), Biomass Derived Carbonization, Hydrothermal Carbonization and Electrospinning. These methods are basically the same, but the process details and input parameters differ. Bio-nano carbon materials contribute greatly to sustainability in terms of raw materials, production methods and applications. Carbon nanomaterials produced from sustainable biomass sources can be used as an alternative to fossil fuel-based carbon materials and can reduce the carbon footprint (Goswami et al., 2024).

In the study, apples and their by-products, which are commonly used in the agricultural and food processing industries, were selected as the biomass source and supplied by a local company. They were then subjected to different carbonization processes and their material properties were studied with different analyses.

MATERIAL and METHOD

In this study, apples and wastes used as raw materials for the bio-nano carbon production were obtained from the apple orchards and factory outlets of a company operating in the region, which is engaged in both apple growing and fruit juice production from the apples it grows.

The wastes were subjected to physical pretreatments. First, the waste was thrown into a shredder and then passed through a screen with a mesh size of 60-80 mesh. Apples and wastes subjected to physical pretreatment are shown in Figure 1. At the end of the physical pre-treatment, the apple waste was separated from hard-to-carbonize materials such as stalks, seeds and peels, and brought to a more homogeneous structure.

Figure 1. Apple wastes after physical treatment.

After the physical pretreatment, the finished waste was dried for 24 hours in an oven set at 105ºC. At this stage, the moisture and water in the waste were removed and the dried waste was then transferred to the hydrothermal synthesis reactor. Carbonization of biomass to high surface area particle sizes was achieved for 6 hours at a temperature of 250 ºC, which was determined as a result of literature studies (Correa et al., 2017; Zhao et al., 2018). The carbon produced at this stage was synthesized as carbonized biomass with large particle sizes. As part of the study, a Fritsch Pulverisette 6 ball mill was used to reduce the size of the carbonized material to nano sizes. The size reduction process with the ball mill was carried out at a maximum frequency of 35 Hz, a maximum operating speed of 650 rpm, a centrifugal acceleration of 29 g, and a minimum time of 3 hours. The size of the material obtained after the size reduction process with the ball mill at the specified parameters was aimed to be < 1 µm. Bio-nano carbon synthesis scheme can be seen in Figure 2.

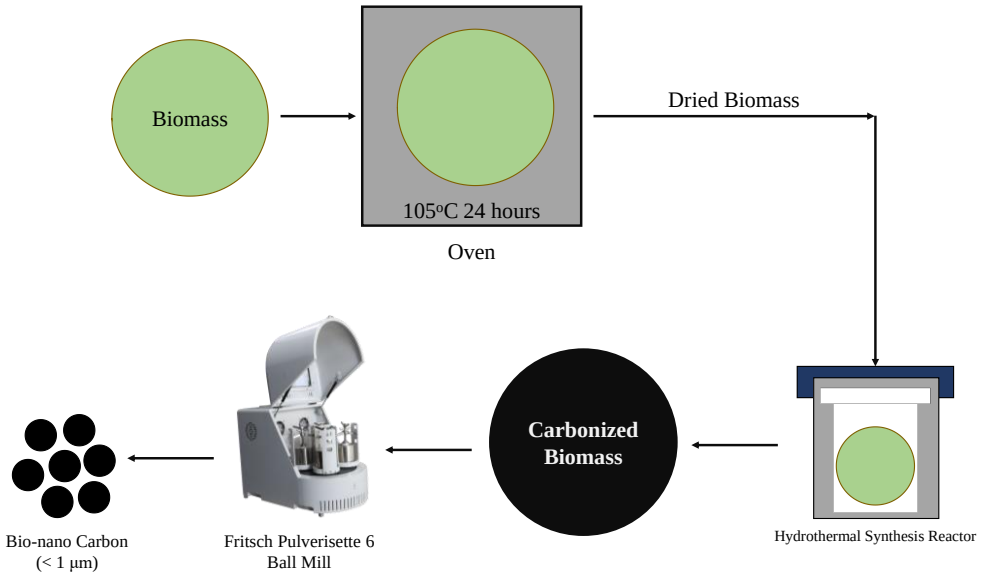

Figure 2. Bio-nano carbon synthesis scheme.

In the last step, FESEM images of the material obtained after the size reduction process were taken and the physical properties of the nanomaterial were analyzed. In addition, the morphological structure of the material was further investigated by EDX and XRD analysis.

RESULTS and DISCUSSION

The results of the study showed that biomass from apple waste was successfully used for bio-nano-carbon production. Homogenization of the waste by physical pre-treatment and removal of moisture prior to carbonization increased the efficiency of the carbonization process. The hydrothermal carbonization process, which was performed at 250 °C for 6 h according to the literature, allowed the biomass to be carbonized in large particle sizes. This step demonstrated that apple waste is suitable for the production of carbon structures even at low temperatures.

The ball milling process carried out after carbonization succeeded in reaching nano sizes using a Fritsch Pulverisette 6 ball mill. With a frequency of 35 Hz, a speed of 650 rpm, and a centrifugal acceleration of 29 g, the particle size was reduced to <1 μm during a total grinding time of 3 hours. This result shows that the grinding parameters were correctly selected and effective in producing nanostructures.

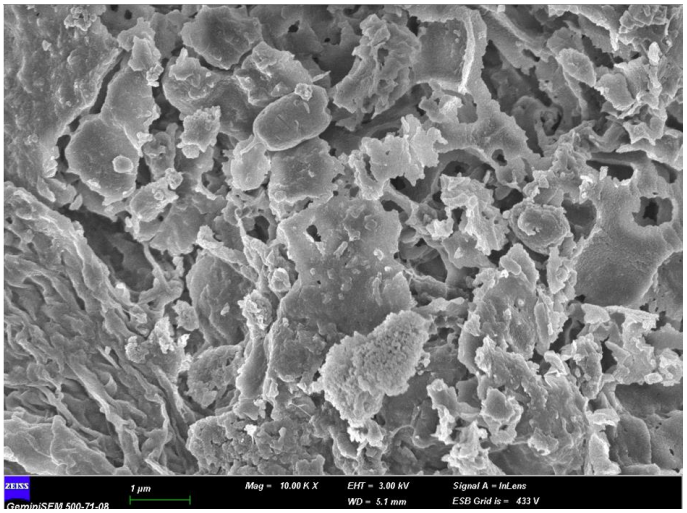

Figure 3. FESEM images of carbonized apple waste.

The physical and morphological properties of the obtained nanocarbon were analyzed using advanced imaging techniques. FESEM images taken under the parameters Mag= 10.00 K X, EHT= 3.00 kW, WD= 5.1 mm. FESEM imaging (Figure 3) revealed that the surface morphology of the obtained nanocarbon is highly homogeneous and well dispersed. In addition, temperature-dependent cracks, fractures and distortions can be observed on the surface of the material. These results indicate the effects of physical pretreatments and grinding parameters on the structural integrity of the material (Konovalova, 2021). Figure 4 shows the graphs of the EDX and XRD analyses. The EDX analysis revealed the elemental composition of the nanocarbon, confirming that the carbon content is rich, and the impurity level remains low. Moreover, the results obtained by XRD analysis showed that the crystalline structure of the material was successfully transformed into carbon structure and the formation of amorphous carbon was limited (Sabet and Mahdavi, 2019).

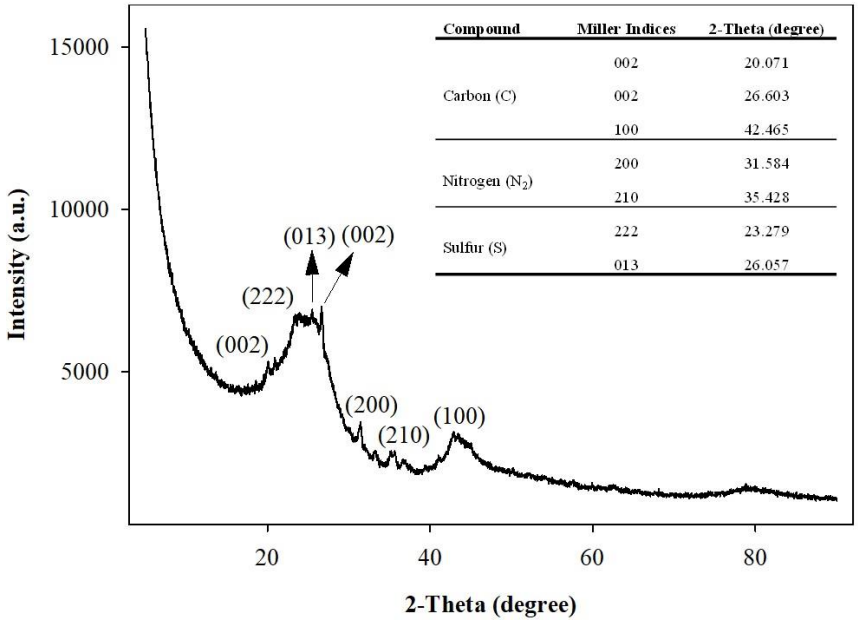

Figure 4. EDX and XRD mapping.

In Figure 4, carbon (C) peaks are observed at Miller indices 002, 002, 313 at 20.404, 26.603, 41.666 degrees, respectively. In addition, a CO_2 peak was found at Miller Index 110 and 22,313 degrees. The presence of CO_2 can be explained by the atmospheric conditions under which the samples were stored up to and during the analysis. The N_2 peak is observed at Miller Index 101 and at 28.509 degrees, and the presence of the N_2 peak can also be explained by atmospheric conditions. The analyses also found additional SiO_2 peaks at Miller indices 112 and 202 and at 31.362 and 36.191 degrees, respectively. The presence of SiO_2 is a common occurrence in studies of carbon produced from biomass. The elements C and Si are abundant in nature and in biomass-derived sources, and both elements are chemically very close to each other (Chen et al., 2022). For this reason, the element Si and the compounds formed by this element are often found on activated carbon in XRD analysis (Fekri et al., 2022).

The XRD pattern shows well-defined peaks corresponding to carbon (C), nitrogen (N), and sulfur (S) phases, with specific Miller indices indicating crystallographic orientations such as (002), (013), (100), and others. The presence of crystalline phases is evidenced by sharp peaks, but the lower-intensity peaks may suggest the existence of amorphous regions or minor crystallinity. Surface cracks often disrupt the regular crystal structure, leading to peak broadening or reduced intensity in XRD patterns. These defects can decrease crystallinity and alter the mechanical integrity of the material. Carbon-based materials with sulfur and nitrogen doping, like those indicated here, are promising in applications such as energy storage (e.g., supercapacitors or batteries) or catalysis. However, cracks could impact conductivity and mechanical stability, which might limit their use in structural applications but enhance their catalytic or adsorption performance.

FESEM imaging is crucial to confirm the presence, distribution, and extent of surface cracks. If cracks are numerous or deep, they may compromise the material's structural stability but could increase the surface area, which is beneficial for catalytic or energy storage applications. Uniform and minimal cracks could indicate better mechanical properties, making the material suitable for structural applications.

High crack density, especially with sharp-edged cracks, might indicate brittleness but provide pathways for ion transport, enhancing electrochemical performance.

EDX analysis can validate the elemental composition identified in the XRD, particularly the distribution of sulfur, nitrogen, and carbon. Uniform elemental distribution would support the presence of homogeneous phases, while segregation might imply localized defects. Cracks could expose the material to the environment, leading to oxidation or contamination, which may affect the elemental composition detected in EDX. Elemental mapping from EDX could help determine whether cracks alter the uniformity of the material's composition.

Surface cracks, if extensive, could lower the material's mechanical strength, limiting its application in load-bearing environments. Cracks may enhance specific applications like supercapacitors or batteries by increasing the surface area for charge transfer and enhancing ion accessibility. Cracks may improve catalytic activity by exposing more active sites, especially if the material's elemental composition (e.g., N and S doping) supports catalytic properties. Surface cracks could hinder electron transport in applications requiring high conductivity unless the cracks are minimal, and the material maintains a continuous crystalline network.

CONCLUSION

In the current study, bio-nano-carbon materials were successfully prepared from apple waste by the hydrothermal synthesis method. The recovery and utilization of agricultural wastes is of great importance both in terms of sustainable material production and circular economy. Apple waste, which usually has low economic value as a by-product of agriculture and food industry, was transformed into high value bio-nano-carbon materials by the processes applied in this study. This approach is an important example of efficient use of resources and strengthening of waste management policies.

Considering the contribution of the study to sustainability, the recycling and reuse of biomass contributes to the reduction of environmental pollution. While the disposal of biological wastes usually represents a significant cost and environmental risk in waste management processes, the conversion of these wastes into high-tech materials contributes to the reduction of the carbon footprint and reduces the consumption of natural resources. The use of apple waste in the production of bio-nano-carbon provides an effective method for the utilization of renewable resources and contributes to the development of sustainable production strategies.

In the context of the circular economy, the conversion of apple waste into bio-nano-carbon material is an important contribution to the development of closed-loop production processes as an alternative to linear production models. In this process, the recycling of waste materials into valuable products not only provides economic benefits, but also supports the efficient use of resources by reducing the need for raw materials. Particularly in light of developments in nanotechnology and materials science, the integration of biomass resources such as apple waste into advanced technologies enables the development of innovative products.

This study demonstrates that high value-added products can be obtained from waste and that food industry by-products can be converted into innovative and environmentally friendly materials. Bio-nano-carbon from apple waste has the potential to be used in a wide range of applications. For example, in energy storage, these materials could be tailored for use in supercapacitors or as electrodes in batteries, taking advantage of their high surface area and conductivity. In addition, bio-nano-carbon materials could play an important role in environmental purification technologies, such as water filtration systems, due to their porous structure and adsorption properties. Exploring these specific applications can help bridge the gap between laboratory-scale research and real-world implementation.

In the future, the applicability of such approaches on a larger scale will contribute significantly to the development of sustainable production and recycling processes. Further research could focus on optimizing the properties of bio-nano-carbon materials to improve their performance in energy and environmental applications, as well as investigating their economic feasibility and scalability.

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The Impact of Glacier Melts on Food Production in North Zone of Russia

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Abstract

Food production has emerged as a critical issue for nations with varying levels of economic development, which is always had to contend with an unfavorable weather.The climatic variability changes including temperature, rainy days, humidity, precipitation and sunny days. Therefore, this have direct and indirect effects on food production (agriculture, aquculture, meat and dairy products). One of the regions where unfavorable climate is causing significant mass loss of glaciers melt in Siberia (the northern part of Russia). As well as, climate change and glaciers melting is projected to positively and negatively effects the availability of foods and food productions in this region. In this research, we tried to draw attention to the effects of ice melt occurring due to global warming in the northern region of Russia on food production. For this purpose, some climate parameters (Temperature, Total Precipitation, Rainy days, Humidity, 1991-2021; Sunshine duration, 1999-2019) observed for many years in the northern regions of Russia were statistically analyzed. As a result of the study, the average Temperature: 5.7 ^{0}C ± 10.268; Min temperature: 1.9 ^{0}C ± 9.412; Maximum temperature: 9.0 ^{0}C ± 11.00; Total Precipitation: 678 mm year^{-1} ± 14.607; Humidity: 76% ± 8.039; Number of rainy days: 89 days year^{-1} ± 0.831; Sunshine duration: 6.3 hours day^{-1} ± 4.345. In other studies conducted on climate change and food production in this region, it can be said that food production is affected by global warming and this situation shows an increasing trend.

Keywords: Global Warming, Glacier Melts, Food Production, Russia

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INTRODUCTION

Glaciers are large masses of ice that develop from compacted snow over a long period of time in areas when snowfall is greater than melting. They can be found in arctic locations as well as high-altitude mountainous locales. Glaciers are regarded as one of nature's best "thermometers" since they act as recorders and sensitive indicators of climate change (Pollack, 2010), as well as they integrate and react to most key climatic prameters such as precipitation, temperature, humidity, cloudiness and radiation (Thompson et al., 2004). The cumulative volume loss of ice sheets, sea ice, and glaciers is a result of global warming's considerable impact on the cryosphere in contemporary Earth surface ecosystems (Howat and Eddy, 2011; Kochtitzky et al., 2022; Lindsay et al., 2015; Shepherd et al., 2018; Zemp et al., 2019). The North Zone of Russia, It is affected by glacier melt because of its cooler climate and abundance of glaciers, and includes areas like Siberia and the Russian Arctic (Fondahl et al., 2020; Vorobyeva et al., 2015). The middle of the 19th century, and climate change has increased more over the recent decades in all Polar Regions than in any other region of the planet (Assessment, 2004).

Enough water is provided by snow and glacier melt to support the agriculture and cultivation of food crops necessary for millions of people to maintain a healthy diet (Biemans.,et al 2019). In many areas, glacier meltwater provides a significant source of freshwater for irrigation (Sorg et al., 2012).

As glaciers shrink and melt, less meltwater is available, which causes water shortages during crucial times for agriculture. Crop yields and agricultural output may suffer as a result (Munir et al., 2021; Biemans et al., 2019). In dry seasons, abrupt influxes of water can occur as a result of glaciers melting more quickly, disrupting ecosystems and reducing the amount of water available for agriculture downstream (Vuille et al,.2018). (Gaudard et al., 2018; Vuille et al., 2018; Ingram et al., 2011).

Thus, climate change has had a strong influence on the Arctic ecosystems and to mitigate the impacts of glacier melts on food production in the North Zone of Russia, it is important to focus on sustainable water management practices, including the efficient use of available water resources and the development of alternative irrigation techniques. Furthermore, promoting diversified agricultural practices, such as agroforestry and greenhouse farming, can help reduce dependence on glacier meltwater and enhance food production resilience in the face of changing climatic conditions (Unlukal and Erguven, 2024).The objective of this study is to examine the Impact of glacier melts on Food Production in North Zone of Russia. However with current and projected environmental changes on the horizon there is an urgent need to measure and analysis the impact of these changes.

MATERIALS AND METHODS

This study was conducted to assess climate change in the northern regions of Russia. The location of the study area is shown in Figure 1. The northern section of Russia lies into the Arctic Circle It spans the regions of Arkhangelsk Oblast. It is renowned for its folk art traditions, particularly for its wooden construction, carvings of wood and animal bones, and painting (Lebedev, 2022; Nakvasina et al., 2017; O'Shea and Zvelebil, 1984; Duryagin and Knyazev, 2022; Lakhtine, 1930).

Figure 1. The location of study area

Mountain glaciers are common in the continental portion of the nation, while continental ice sheets are found on the islands and archipelagoes of the Russian Arctic region, where they currently span an area of around 3,480,000 km^2. In the Russian Arctic, continental ice sheets are found on islands and archipelagoes, while mountain glaciers are common in the continent where the ice currently covers an area of about 3,480.000 km^2 (Khromova et al., 2016).

However the entire amount of Arctic sea ice has drastically decreased in recent decades due to the region's swift climatic change (Mokhov, 2019; Alekseev, 2015; Alekseev et al., 2016; Mokhov, 2015). As result many Russian glaciers have already shrunk to their lowest points. İn this study linear regression method and the standard deviation (SD) was calculated for the analysis of climate data.

In this study, temperature, precipitation, rainy days, humidity between the years 1991-2021 was used. Sunny hours data were used as the average of 21 years of climate data between 1999-2019. Linear regression model was used to evaluate the data. Regression analysis is a method for describing quantitative connections between one or more explanatory factors and a response variable (Rezaeianzadeh et al., 2014; Salihi and Üçler, 2021).

RESEARCH FINDINGS

In this research, some climate data were examined in the northern regions of Russia. Figure 2 shows the distribution of long-term average minimum temperature changes by month.

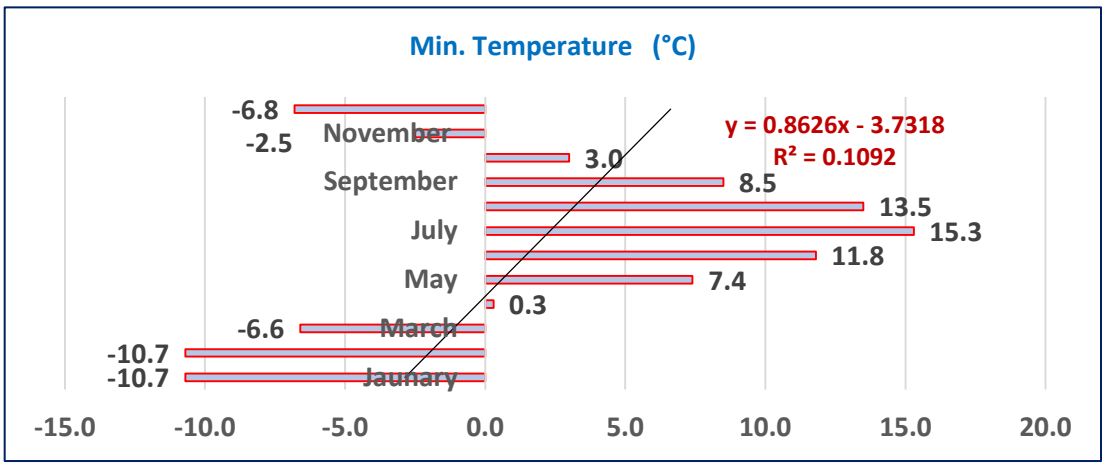

Figure 2. The Changes of Minimum temperature

The lowest minimum temperature in the northern regions of Russia was found to be in February with -1.7 ^oC. The highest minimum temperature was calculated as 15.3 ^oC in July. The long-term minimum temperature average in this region was found to be 1.9 ^oC. There was no significant relationship between the minimum temperatures and the R^2 value was found to be 0.1092. Figure 3 shows the distribution of maximum temperatures by month.

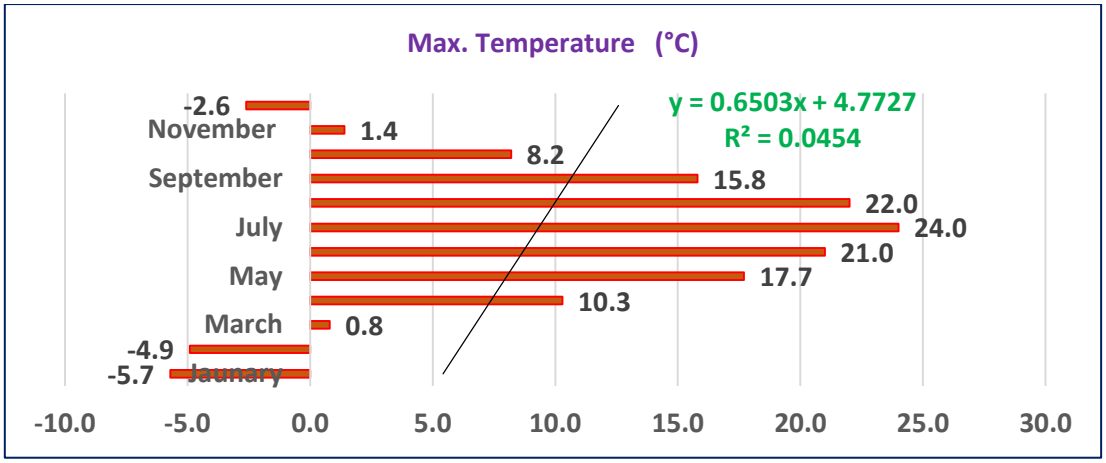

Figure 3. The Changes of Maximum temperature

When the distribution of maximum temperatures by month is examined, the highest maximum temperature was recorded as 24.0 ^{o}C in July. The lowest maximum temperature was determined as -5.7 ^{o}C in January. The average maximum temperature value for many years was calculated as 9.0 ^{o}C. It was concluded that there was no significant relationship between the maximum temperatures (R^2: 0.0454). The distribution of average temperatures by month is shown in Figure 4.

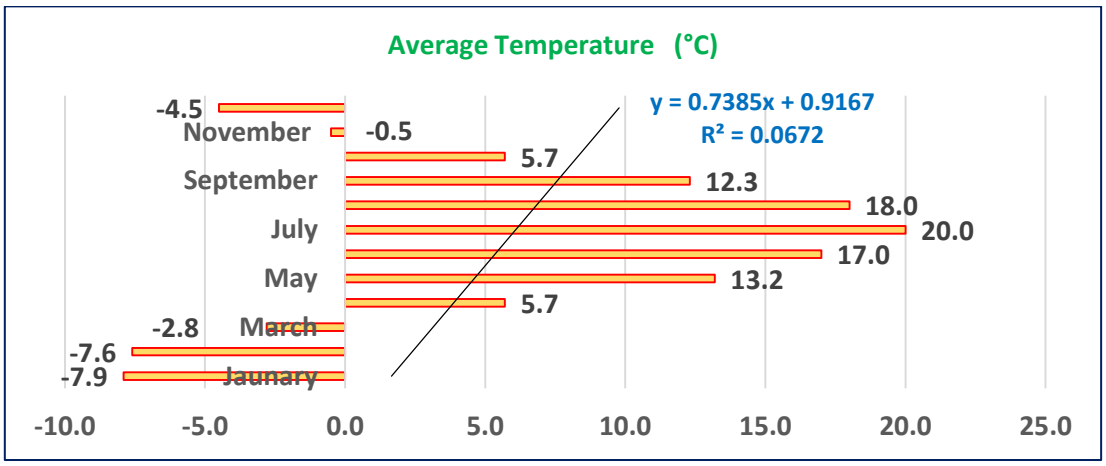

Figure 4. The Changes of Average Temperature

The distribution of average temperature values by month is examined, the lowest average temperature value was observed in January with -7.9 ^{o}C. The highest average temperature value was observed in July with 20.0 ^{o}C. The average temperature value for many years was calculated as 5.7 ^{o}C. No significant relationship was found between the average temperature values (R^2: 0.0672). The distribution of total precipitation values by month is seen in the graph given in Figure 5.

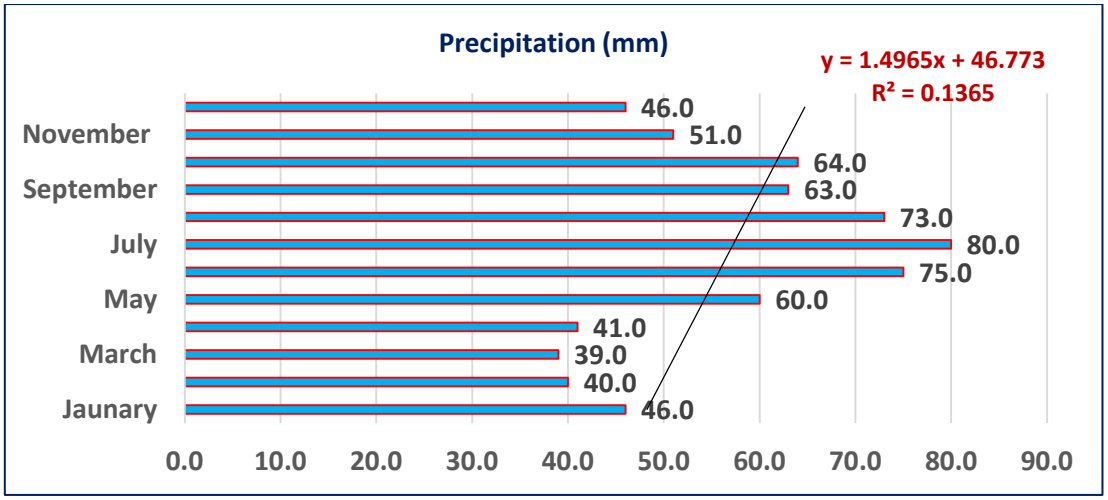

Figure 5. The Changes of Total Precipitation

The total rainfall amount calculated as the long-term average in the northern regions of Russia was found to be 678 mm. The minimum rainfall amount was 39 mm in March, and the maximum total rainfall amount was 80 mm in July. It was also seen as a result of the calculations that there was no significant relationship between the rainfall data (R^2: 0.1365). The graph regarding the distribution of the number of rainy days by month is presented in Figure 6.

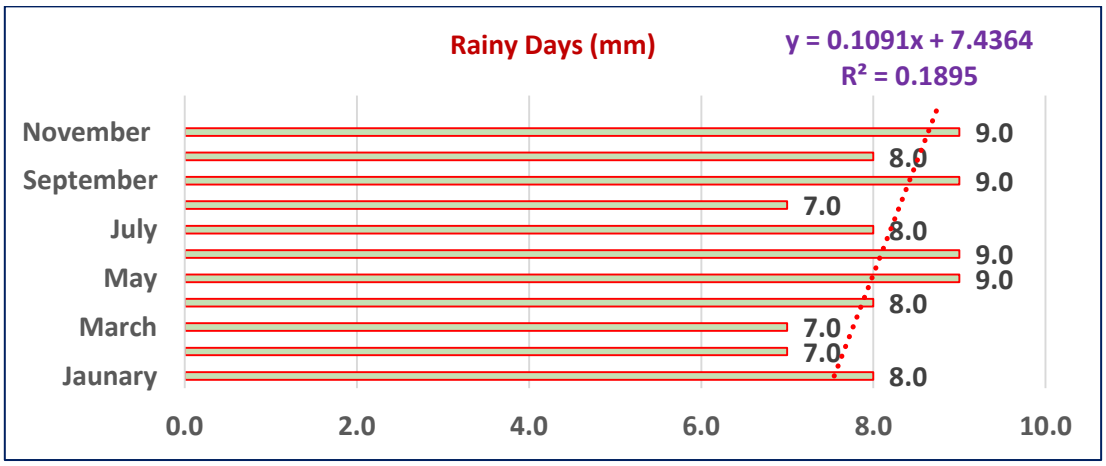

Figure 6. The Changes of Rainy days

The distribution of rainy days by month is examined, it is seen that the lowest number of rainy days is in February, March and August with 7 days. The highest number of rainy days is in May, June, September and November with 9 days. The total number of rainy days calculated by taking the long-term average is found to be 89 days. No significant relationship (R^2: 0.1895) was observed between rainy days. The monthly distribution graph of humidity amount is presented in Figure 7.

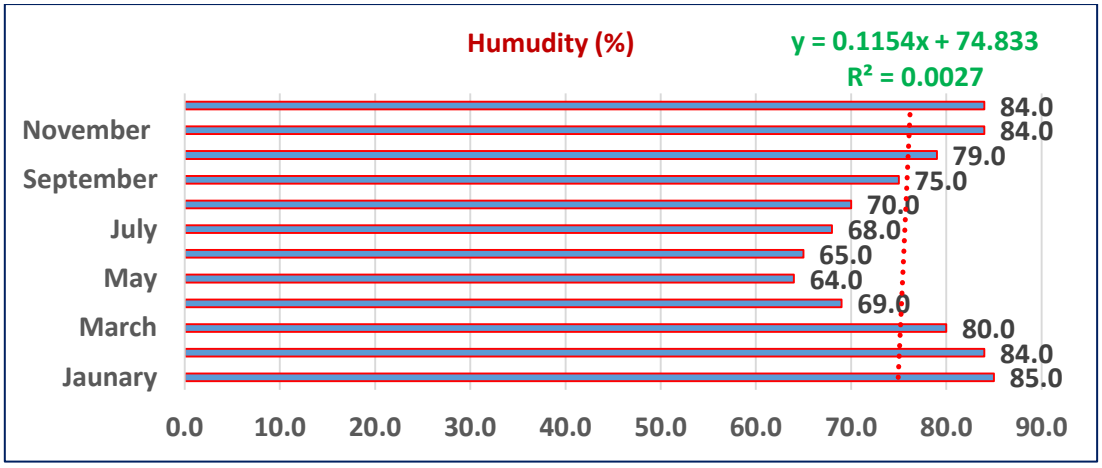

Figure 7. The Changes of Humudity changes

When the distribution of monthly humidity changes is examined, it is seen that the highest humidity rate is in January with 85%. The lowest humidity rate is observed in May with 64%. The average monthly humidity rate for many years is calculated as 76%. As a result of the analysis, it is concluded that there is no significant relationship (R^2: 0.0027) between monthly humidity rates. The monthly distribution graph of the number of sunny days is given in Figure 8.

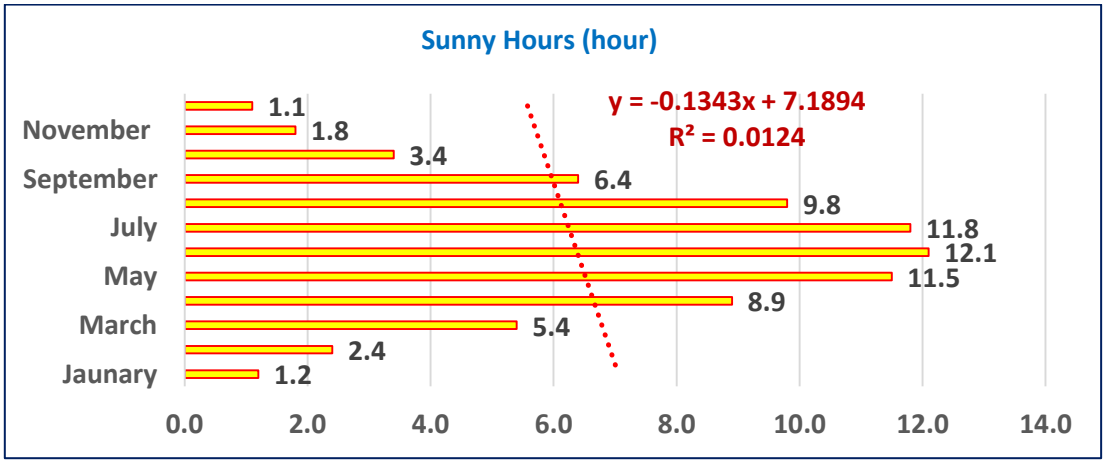

Figure 8. The Changes of Sunny days

When the distribution of sunshine durations by month is examined, it is seen that the highest sunshine duration is in June with 12.1 hours, and the lowest sunshine duration is in December with 1.1 hours. The average sunshine duration for many years is found to be 6.3 hours. No significant relationship (R^2: 0.0124) was found between the monthly distributions of sunshine durations. Long-term average values of some climate parameters in the northern parts of the Russian region are given in Table 1.

Table 1. The average or total values and standard deviation of some climate data

Climate Parameters	Average	Standard deviation
Average Temperature (°C)	5.7	10.268
Min. Temperature (°C)	1.9	9.412
Max. Temperature (°C)	9.0	11.000
Precipitation (mm) (Total)	678	14.607
Humidity (%)	76	8.039
Rainy Days (Total)	89	0.831
Sunny Hours (hour)	6.3	4.345
Temperature, precipitation, Rainy days, humudity (1991-2021) ; Sunny hours (1999-2019)		

In these analyses It is found that the total precipitation: 6798 mm ± 14.607 which is followed by maximum temperatures 9.0 °C ± 11.000, average temperature 5.7 °C ± 10.268, minimum temperature 1.9 °C ± 9.412, humidity, 76 % ± 8.039, sunny hours 6.3 hour ± 4.345 and rainy days 89 day ± 0.831.

Glacier melts are expected to have both positive and negative impacts on food production change in the Russian Arctic during the last half of the twentieth century White et al., 2007. As mentioned above, One of the regions where these changes cause the glaciers melt is Siberia (the northern part of Russia). According to researchers ,the climatic variability change is causing significant mass loss of glaciers in high mountains worldwide Kaltenborn et al 2010 . This cause direct and indirect effects on food web and food production. The average world temperature is predicted to increase 1 to 5 ^{0}C by the end of the 21 century (IPCC, 2013) So, This increase in temperature has already affected food production, traditional lifestyle, well-being and health of the Indigenous Peoples in the North Zone of Russia (Jaakkola et al., 2018). Because, the sunlight that strikes the water as the glaciers melt provides energy for microscopic algae to flourish. Wharton et al 1985. This algae feeds as a food product the minuscule zooplankton, which in turn feed birds, whales and fish. This small arctic cod or polar cod found in the North Russian that is a very important part of the food (Nilsen et al., 2022; Datsky et al., 2022).

Because, for whales, bears, seals, and birds, it serves as their primary food source. The other positive effects of lengthy snowless season and the warm temperatures during the growing season in the northern portion of Russia as a result of climate change are beneficial for plant productivity and the expansion of the feed base for reindeer's and new-born calves (Tveraa et al., 2013; Mårell et al., 2006; Bogdanova et al., 2021).

Through this food production, the people of northern Russia can survive, additionally, the melting of glaciers has an impact on the ecology, and the health of thelocal people and their traditional way of life. According another researches, warming and ice melting can result in the potential re-emergence of anthrax (Revich, 2011), biological pollution (Stibal et al., 2012). It increases the risk of forest and tundra fires (Malevsky-Malevich et al., 2008), migration of birds (Černý et al., 2021) and livetock mortality (Johnston, 2006). So, these factors and events have nagavie effects on food products and their way of lifestyle.

CONCLUSION AND RECOMMENDATIONS

According researches and studies, the North Zone of Russia, is affected by glacier melt because of its cooler climate and abundance of glaciers. Additionally, it is anticipated that the melting of the glaciers will have both beneficial and negative consequences on the region's food production and availability. From a positive perspective, plant productivity of the reindeer's feed base and newborn calves is benefited, as well as sunlight that touches the ocean as glaciers or ice melt providing energy for microscopic algae that in turn feed birds, whales, and fish. The melting of glaciers more quickly during dry seasons, unexpected water influxes can happen, which upsetting ecosystems and lowering the amount of water access for future survival. It also increases the risk of forest and tundra fires, migration of birds and livetock mortality.

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Detecting Forest Fire Damage Using Remote Sensing

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Abstract

Forest fires have become a huge and global problem in recent years. Although the large fires seen in almost every continent and country have started due to natural causes or human activities, the general management policies of forests are being questioned in many ways in the context of fires. The direct and indirect effects of reasons such as changes in climatic temperature and precipitation regimes, the decrease in rural population due to migration, the reduction of wild animals and livestock in natural environments and forests, and the accumulation of excessive amounts of flammable organic matter on forest floors are being discussed in wide circles from academic circles to the public. Climatic changes resulting from human activities over time, the rapid increase in the world population, and incorrect application in forests indicate that forest fires will continue to be a serious problem for humanity in the coming years. The important point of forest fires is the amount of burned area. Geographic Information Systems and Remote Sensing are the most preferred methods for determining the amount of burned area with satellite images. The study aims to determine the calculation of the fire in Izmir in the summer of 2024. Satellite images were obtained before and after the fire in the study. Normalized Burn Ratio and Normalized Difference Vegetation Index analyses were applied to the obtained satellite images, and the amount of burned area was calculated with both methods. Finally, it was determined that remote sensing and geographic information systems can be used to calculate the amount of burned area, and the resolution of the satellite image used is important. It was also determined that the difference between the determined amount and the data of the Regional Forestry Directorate is small.

Keywords: Forest, Forest Fire, Remote Sensing, Environmental Management, İzmir

Research article
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INTRODUCTION

In addition to having significant impacts on the ecosystem and climate, forests are among the most vital renewable natural resources that contribute to the nation's economy in some sectors, including industry, tourism, health, and the economy. Forest fire is defined as an anthropogenic and natural disturbing phenomenon that has an impact on the ecosystem, biodiversity, and human health and has increased significantly in the world (Bar et al., 2020). Forest fires are frequently seen, especially in the Mediterranean and Aegean regions greatly affected by fires due to the effect of the climate in Turkey. Forests that burn cause great economic and ecological damage in the region every year (Karabulut et al., 2016).

Turkey is located in the Mediterranean climate zone, a large part of the forests under the threat of fire, and 60% of the total forest area consists of first and second-degree fire-sensitive areas. For this reason, forest fires are among the priority issues of our country's forestry (OGM, 2021). In the last 20 years, 45,681 forest fires have occurred in Turkey and a total of 183,756.2 hectares of forest area have been burned (OGM, 2019). Forest fires can be caused by natural events and various reasons such as the involvement of human factors (Beşli and Tenekeci, 2020). Forest fires show different behaviors depending on topography, flammable material, and the factors affecting it (wind, climate, elevation, slope, type and amount of the flammable material, etc.) (Küçük et al., 2005). While there is no control over meteorological and topographic factors, flammable materials can change and be controlled in time and space. This important feature gives flammable materials critical importance in the planning and activities carried out for forest fires (Yılmaz et al., 2021).

The greatest power of today's world is accessing information. Accessing the right data on time, organizing data, and managing data on the way to accessing information depends on information technologies. Remote Sensing comes first among these information technologies. Remote sensing is a method of obtaining information from a certain distance with satellite sensors without physical contact with objects (Figure 1) (Çağlak and Özelkan, 2019).

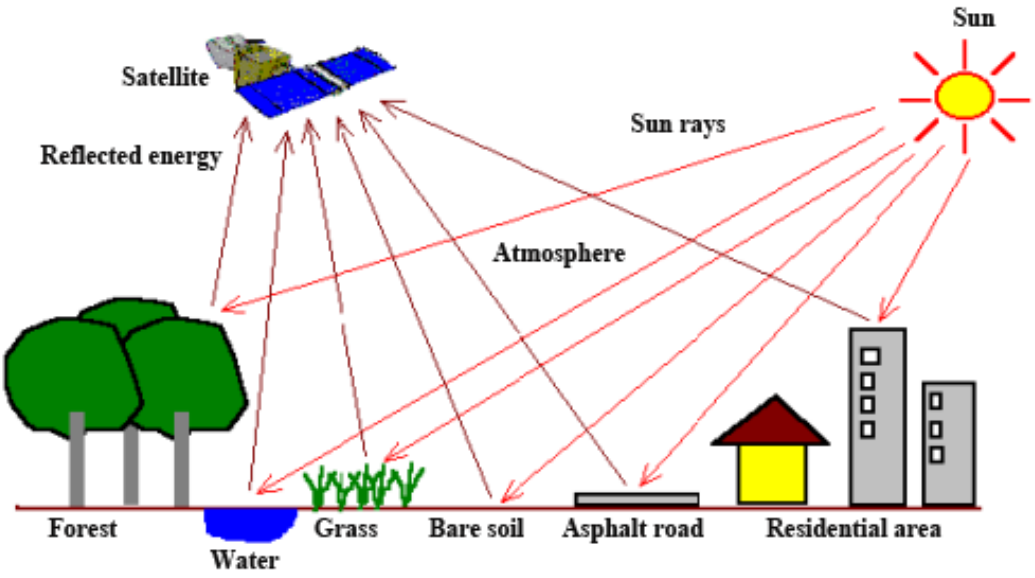

Figure 1. Optical remote sensing (Gövdetaşan, 2022)

Remote sensing techniques, models and indices are designed to convert spectral information into a form that can be easily interpreted.

The applicability of remote sensing measurements should be realized in solving environmental problems (Bannari et al., 1995). The development of remote sensing devices has provided the opportunity to evaluate the recovery of vegetation after forest fires (Riano et al., 2002). It is possible to examine the changes in the study area with remote sensing and satellite data after the fire (Aksoy and Çabuk, 2018).

Remote sensing technology has provided successful studies in recent years thanks to significant developments in the technology. These studies increase the importance of indices that are used especially for short-term and rapid changes such as forest fires and provide both time and financial benefits (Sabuncu and Özener, 2019). Remote sensing technology can be used in different stages of fire management (estimation, detection, and evaluation). Remotely sensed data provides information about the characteristics and structures of plants spectrally (Algancı et al., 2011). It is possible to evaluate and monitor the direction and intensity of the fire in places where access is not provided during the fire with remote sensing techniques (Sarp et al., 2018). In addition, comparing and analyzing satellite data with ground data increases the importance of remote sensing (Özelkan, 2019). In other words, the reason for the effective use of remote sensing is that the data obtained through satellite technology provides different spatial and spectral analyses (Özdemir et al., 2010).

This study aims to determine the destroyed area with Landsat 8 OLI satellite images after the forest fire that occurred on August 15 2024 in the Karşıyaka, İzmir and caused the destruction of approximately 1600 (ha) (16.00 km²) area. In the study, the performances of the NBR and NDVI remote sensing indices were calculated with pre- and post-fire images, and the indices used in the study and the remote sensing data used were evaluated.

MATERIAL and METHOD

In this study, various analyses were conducted to evaluate the performances of different remote sensing indices and different sensors using pre-fire and post-fire Landsat-8 OLI images to determine the burned forest area (Figure 2). The fire, which broke out on Yamanlar Mountain in Karşıyaka district at around 21:00 on August 15, 2024, spread to a wide area due to the wind. Residential areas were also affected by the fire. 17 houses were burned in the fire, 105 houses were evacuated. 44 workplaces were also evacuated. Therefore, the entire district borders were included in the study.

A single sensor was used in this study. Landsat-8 OLI includes 11 spectral bands with 30 m spatial resolution (100 m - thermal, 15 m panchromatic). Landsat-8 OLI; It has Coastal/Aerosol (0.433-0.455 μm), Blue (0.450-0.510 μm), Green (0.530-0.590 μm), Red (0.640-0.670 μm), Near Infrared (0.850-0.880 μm), Short Wave Infrared (1.570-1.650 μm), Short Wave Infrared (2.100-2.290 μm) and Cirrus (1.360-1.380 μm) bands with 30 m spatial resolution. It is an important data source especially for monitoring long-term changes (Mert et al. 2016; Yılmaz et al., 2022). Landsat-8 OLI, two pairs of images were studied on July 20, 2023 and September 1, 2024. NIR stands for near-infrared, SWIR stands for shortwave infrared.

Detection of burnt areas after forest fire is carried out quickly and with high accuracy with remote sensing technology. In this study, burnt forest area was determined with different remote sensing indices using Landsat-8 OLI images which are freely available, and the obtained results were compared. Landsat-8 OLI images were first acquired before and after the forest fire to identify burned regions using photographs from those times. After applying the cutting process to these images, they were processed with various indices selected according to the results of the literature research. Then, the differences between the index images calculated before and after the fire were determined.

Separate accuracy assessment analyses of these difference indices were made with error matrices for both sensors and finally, the conclusion was reached by making comparisons and evaluations.

Figure 2. Study area

Spectral index-based methods are widely used to determine burned areas (Liu et al. 2020). In this study, Normalized Difference Vegetation Index (NDVI), Normalized Burning Intensity (NBR), Difference Normalized Burning Intensity (dNBR) were selected to determine the burned area using Landsat-8 OLI satellite images.

These difference indices were used to determine the pre- and post-fire changes. In this study, Normalized Difference Vegetation Index (NDVI) (Eq. 1), Normalized Burning Intensity (NBR) (Eq. 2), and Difference Normalized Burning Intensity (dNBR) (Eq. 3) were selected to determine the burned area using Landsat-8 OLI satellite images. These difference indices were used to determine the pre- and post-fire changes.

$$NDVI = \frac{NIR\ (Band\ 5) - Red\ (Band\ 4)}{NIR\ (Band\ 5) + Red\ (Band\ 4)} \quad (1)$$

$$NBR = \frac{NIR\ (Band\ 5) - SWIR\ (Band\ 7)}{NIR\ (Band\ 5) + SWIR\ (Band\ 8)} \quad (2)$$

$$\Delta NBR = NBR_{Before\ Fire} - NBR_{After\ Fire} \quad (3)$$

If the NDVI value approaches -1, it means that the vegetation has decreased, and if it approaches 1, it means that the vegetation has increased. A high NBR value means healthy vegetation (Keeley, 2009). The NBR value range is -1 to 1. NDVI is one of the most well-known and widely used indices that exploit the strong absorption of visible red light by green vegetation, in contrast to the high reflectance of near-infrared light in areas covered with healthy vegetation. When vegetation is damaged by fire, NDVI values decrease significantly. Therefore, it is an effective method to obtain accurate results for burned areas (Fornacca et al. 2018). In theory, when the Difference Normalized Burning Intensity index was analyzed, the results obtained ranged from -2.00 to +2.00. The values for burnt areas vary from 0.10 to 1.35, whereas those for unburned regions range from -0.10 to +0.10. Furthermore, values ranging from -0.50 to -0.10 were reported for plants that demonstrated advanced re-growth following the fire (Key and Benson, 2006; Sabuncu and Özener, 2019; Soydan, 2022) (Table 1).

Table 1. Burn severity categories (Sabuncu and Özener, 2019)

dNBR	**Burning Intensity**
< - 0.25	High Post-Fire Greenery
-0,25/ -0.1	Low Post-Fire Greenery
-0.1/0.1	Unburnt
0.1/0.27	Low Burning Intensity
0.27/0.44	Medium/Low Burning Intensity
0.44/0.66	Medium/High Burning Intensity
>0.66	High Burning Intensity

After all the operations, it is important to perform an accuracy assessment analysis to determine the thematic accuracy of the results. Accuracy assessment evaluates how accurately pixels are assigned to the correct land cover and land use classes (Rwanga and Ndambuki, 2017). In this study, the error matrix method was used to determine the thematic accuracy of the calculated indices. The error matrix is a square matrix containing rows and columns expressing the number of pixels corresponding to that category according to the reference data (Vanwambeke et al., 2007). User Accuracy (UA), Producer Accuracy (GCA), Overall Accuracy (GA), and Kappa Statistics are calculated using the generated error matrix (Yılmaz et al., 2021).

RESULTS and DISCUSSION

Using Landsat-8 OLI satellites, the area destroyed after the İzmir/Karşıyaka forest fire was detected and the performances of different methods and different data were compared with the accuracy assessment results. Figure 3 shows the NDVI analysis for Landsat-8 OLI before and after the fire. To detect fire damaged areas, NDVI and NBR indices were calculated, respectively. The value range for the before and after NDVI index was obtained between approximately -1 and 1. The reason why the NDVI value became negative after the fire is that the vegetation was damaged due to the fire because if the NDVI value approaches -1, the vegetation has decreased, and if it approaches +1, the vegetation has increased.

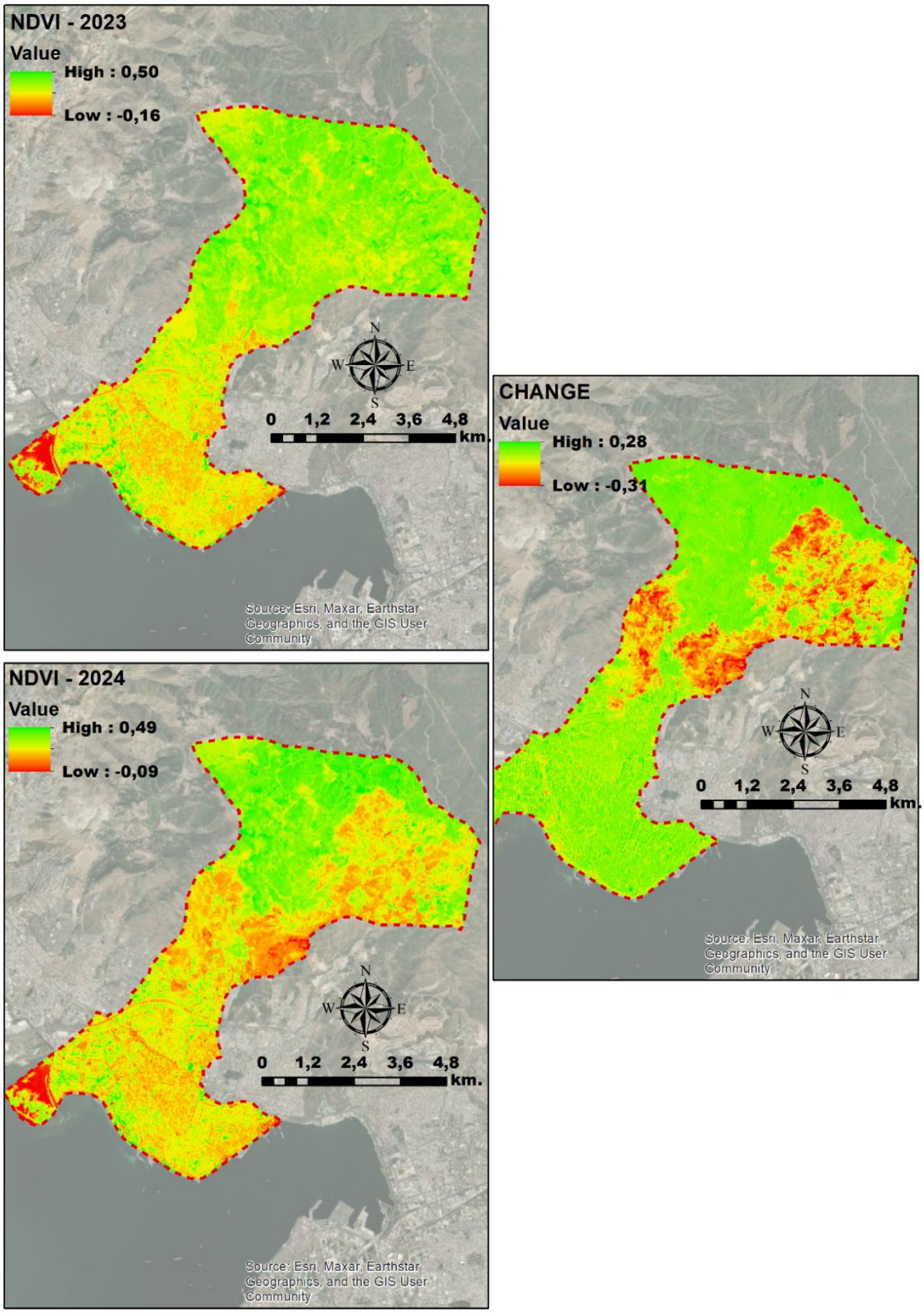

Figure 3. NDVI analysis

An NBR analysis was conducted for the research region. After creating two distinct maps for the pre-fire and pro-fire phases, NBR analysis was used to identify the burned areas. (Figure 4).

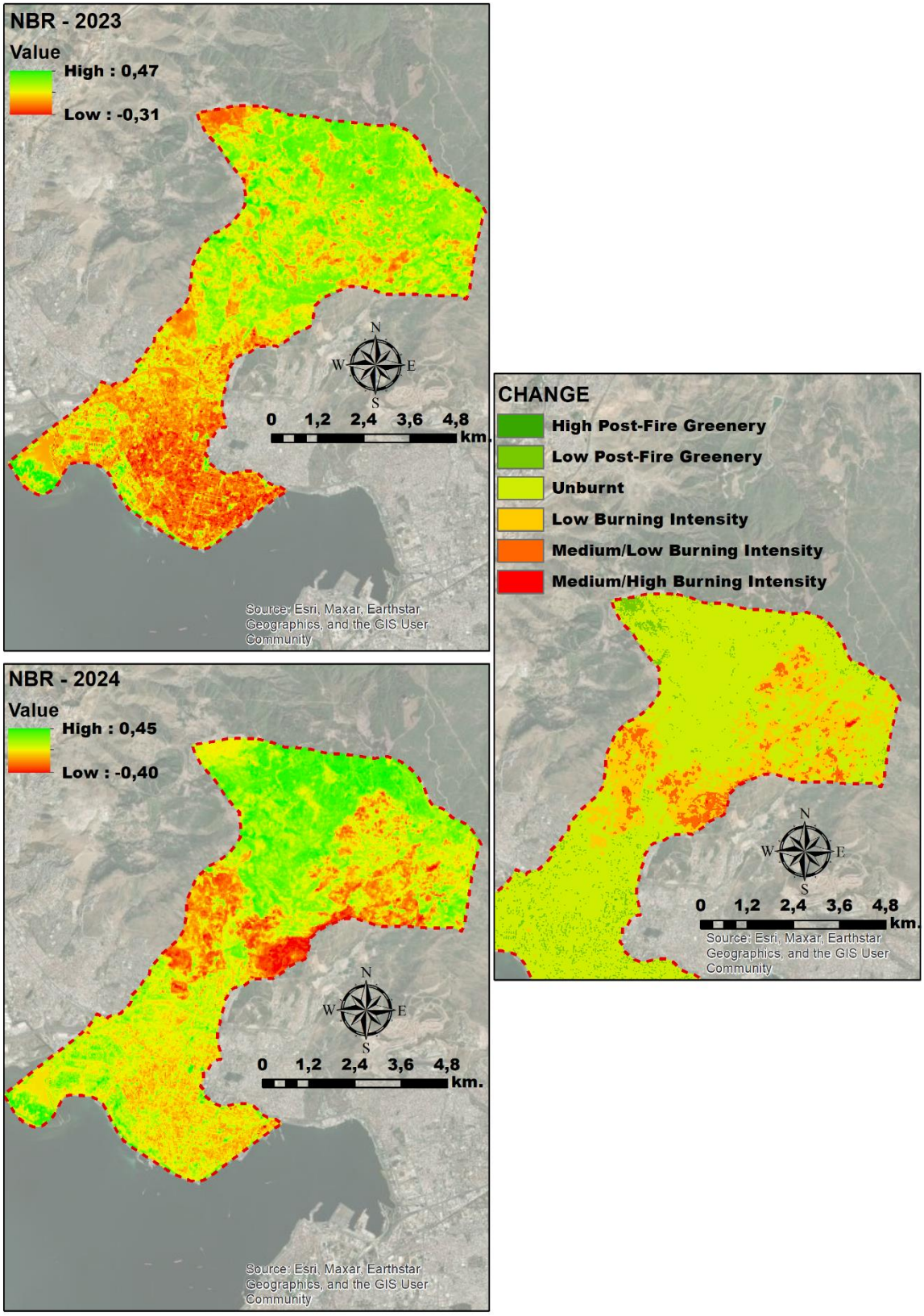

Figure 4. NDVI analysis

This study uses Landsat 8 satellite images and two remote sensing analytic methods to map the area burned by a forest fire in Karşıyaka, İzmir, on August 15, 2024.

The approaches are NBR-dNBR and NDVI-NDVI, respectively. The forest areas burned by fire were identified as 20,65 ha using NBR-dNBR and 18,85ha using NDVI-NDVI change detection analysis. According to the General Directorate of Forestry's damage assessment studies in the area after the fire, some 16,000 hectares of forest land had burnt, which was in line with the findings of the remote sensing studies. The accuracy assessment of the obtained difference images was performed using the error matrix. For the accuracy assessment, a total of 100 test points were selected to represent the randomly distributed region and the two categories we wanted to detect homogeneously, 50 for burned areas and 50 for unburned areas, and error matrices were created for all calculated difference indices and two different sensors.

According to the accuracy assessment results obtained, dNDVI was determined as the index with the highest overall accuracy and Kappa statistic value for Landsat-8 OLI. According to the results, the highest accuracy value for Landsat-8 OLI was calculated as 0.87 and the Kappa value as 0.91. The lowest overall accuracy value was found as 0.82 with dNBR for Landsat-8 OLI. Kappa statistic values were calculated as 0.81 dNBR (Landsat-8 OLI). The highest user accuracy was calculated as 0.97 with dNDVI for Landsat-8 OLI for burned areas. The highest producer accuracy for Landsat-8 OLI was calculated as 0.94 with dNDVI for burned areas. As a result, among the selected indices, dNDVI was determined to be the index that determined the burned forest area with the highest accuracy for the selected region. After the accuracy assessment process, the burned area boundary obtained by digitizing the high spatial resolution data obtained by Maxar Technology via Google Earth was compared with the burned area values obtained from Landsat-8 OLI images with different indices. The burned area boundary obtained with the reference data was calculated as 16 km^2. The closest area value to the reference was obtained with both Landsat-8 OLI dNDVI index. It was determined that the areas calculated with the difference of the indices were lower than the area value produced from the reference data for both images.

CONCLUSION

In recent years, forest fires have increased worldwide and this situation causes deforestation. Turkey, located in the Mediterranean basin, is under high threat from forest fires increased by global climate change. Therefore, detection of forest fires and determination of their damage is one of the necessary elements for sustainable forest management. For all these reasons, the study was carried out in Izmir province, located in the Aegean Region in the west of Turkey. The aim of the study was to determine the amount of burned area after the forest fire in Karşıyaka district of İzmir province with NDVI and NBR indexes. According to the analysis results, it was determined that the NBR index gave the closest value to the reference value. NBR is the index used to detect burned areas. Near infrared (NIR) and short wave infrared (SWIR) wavelengths are used when calculating NBR. The land ecosystem shows different reflections before and after the fire. While burned areas have low reflection values in NIR, they have high reflection values in SWIR. Information about the burning status is obtained by taking the difference between NIR and SWIR with the NBR index. NBR is an index created directly depending on the burned areas. However, NDVI may differ according to the type of land surface. It can also give results on the region affected by the fire and the ecosystem in its immediate surroundings. For this reason, it is said that NDVI analysis gives more accurate results than the NBR test. Due to the high spatial resolution of Landsat satellite images, some problems have been encountered: (i) overestimation of burned areas, (ii) classification of pixels outside the burned area as burned areas. These problems arise from the large pixel size of Landsat satellite images, which classifies a pixel as burned when it is not completely burned.

However, considering the size of the study area, Landsat satellite images can be easily obtained and used in such studies, as they are free of charge. In addition, with comprehensive data and sufficient computer hardware systems, the boundaries of the study can be expanded regionally, nationally, continentally or globally. The main purpose of these operations is to manage forests and forest fires under sustainable land management. Ultimately, to establish a sustainable forest management system. Thus, forests can be protected, managed in the best way, transferred to future generations, and forest fires can be reduced and prevented. It is envisaged that this study will serve the sustainable forest management system in İzmir and Turkey.

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The Negative Effects of Climate Change in Asia

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Abstract

Climate change is a major environmental concern issues, that climate change will have far-reaching effects on the ecologies, economic growth, and human well-being. one of the world's region, including Asia, the changing climate will have a wide range of effects over the course of the next century and beyond ,which vulnerability to climate change is an important set of interactions between society and the environment. Since this continent is one of the most vulnerable regions against climate threats due to its (temperate deserts, semi-deserts, vastness) and relative underdevelopment due to economic reasons. Therefore, this revised article discusses the negative effects of climate change in Asia. These Climate variabilities in Asia can have negative impacts on enhanced temperatures, glaciers, sea-level rise, agriculture, aquaculture, and fishing, migratory birds, health.

Keywords: Climate change, Global warming, Asia

Review article
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INTRODUCTION

Climate change is one of the gravest dangers and challenges confronting humanity. It is widely acknowledged and has been a point of consensus among scientists that "the climate change will have far-reaching effects on the ecologies (Hoegh-Guldberget al., 2010; IPCC, 2014), economic growth (Dell et al., 2014; Burke et al., 2015), and human well-being." In addition to thoroughly confirming the threat posed by this phenomena, new scientific papers, methodological developments, and new data sets are used to shape the IPCC's final report in 2022, which considers climate change to be more serious than anticipated. (Tollefson, 2020). Increasing the necessary studies and measures to minimize the emissions of carbon emissions should be taken all over the world and measures that will minimize the greenhouse gas effect will play an important role in reducing the effects of global warming (Bağdatlı and Arıkan, 2020a; Bağdatlı and Arıkan 2020b). Evidence from observations of the climate system has led to the conclusion that human activities directly and indirectly effects climate change. The main factors affecting the concentration of air components or features of the Earth's surface that absorb or scatter radiant energy are the burning of fossil fuels and changes in land cover (Unlukal and Erguven, 2024).

In particular, increases in the concentrations of greenhouse gases (GHGs) and aerosols are strongly implicated as contributors to climatic change observed during the twentieth century. (Sivakumar et al., 2011). For the majority of the world's regions, including Asia, the changing climate will have a wide range of effects over the course of the next century and beyond. (McCarthy et al., 2001; Preston et al., 2006; Watson et al., 1998).

Asia has some of the world's highest levels of cultural, economic, and biological diversity. It is the largest and most populous continent in the world, home to more than 60% of the world's population, and more than half of whom reside in coastal regions. Therefore, nearly 9% of the Earth's surface is occupied by Asia. (Preston et al., 2006). Due to the unique features of the continent (people, topography, economic structure, GHG emissions, and sensitivity to natural disasters), Asia is one of the regions that is most vulnerable to climate threats. (Islam et al., 2018) In general, climate trends and variability in Asia can be characterized by increasing temperatures (Sivakumar et al., 2011). Recent decades, the observed increases in some parts of Asia have ranged between less than 1–3°C per century. (Cazzolla et al,. 2019). Climate variability in Asia have negative impacts of enhanced temperatures, on Glaciers melting and sea-level rise, Agriculture, Aquaculture and Fisheries, Migratory birds, Health and so on. Here are some of the specific negative impacts that Asia is experiencing due to climate change:

Impacts of Enhanced Temperatures

Overall, temperatures in Asia have been increasing due to climate change. This trend is consistent with global temperature rise, but some parts of Asia have experienced more pronounced warming (Revadekar et al,. 2013). The Intergovernmental Panel on Climate Change (IPCC) reports that average temperatures in the region have increased at a rate higher than the global average. High temperatures can lead to heat-related illnesses, crop failures, increased energy demands for cooling, and even loss of human life, resulting in both direct and indirect consequences for human and natural systems (McMichae et al,. 2003). As well as climate change is altering monsoon patterns, leading to shifts in rainfall distribution and intensity. Some regions are experiencing more intense rainfall events, resulting in flooding and landslides, while others face prolonged dry spells and droughts. These changes have significant implications for agriculture, water availability, and overall ecosystem health (Lemi et al,. 2019; Loo et al,. 2015; Hussain,. 2016).

Glaciers and Sea-Level Rise

World effects of global warming caused by changes in the climate system of the highest peaks, ocean depths, is felt throughout much of the world from the equator to the poles. The polar ice caps are melting, sea level is rising and soil losses are experienced in coastal areas. Sea level due to melting of glaciers Increasing the temperature rose from 10 to 20 centimeters (Bağdatlı and Bellitürk, 2016a). Another important component is an upsurge in sea-level because of changes in climate, leads to the destruction of forests which are key source of food in many countries (Afreen et al., 2022). Increasing world population, changing climate conditions and economic activities are growing with each passing day makes it more important than water (Bağdatlı and Bellitürk, 2016b). The decrease over time of the changes in the surface of the water is noticeable. This also shows itself as the effect of disorder in the vaporization and current precipitation regime in the water sources dependent on climate change (Albut at al., 2018).

Another manifestation of changes in the climate system is a warming in the world's oceans. As temperatures increase, ice sheets and glaciers melt, contributing to sea-level rise. (Solomon et al 2007). Therefore, the glaciers across the High Mountain regions of Asia have shown measurable signs of recession. However Rising temperatures have accelerated the melting of these glaciers, leading to their extinction (Thompson et al,. 2011; Pritchard et al,.2007). Available climate change impact assessments have shown an increase of both the risk of flooding and water shortages, as the natural storage capacities of glaciers diminish while glacial lake outburst floods become more likely (Palmer et al,.2008). As a result, the dependency on rainwater increases. While flooding risks will increase in the Asian monsoon region due to heavy precipitation and runoff (Kumari,.2019). According Sivakumar et al., 2011 mentioned Sea level rise in Asia's coastal regions is currently estimated to be between 1 and 3 mm/year, which is slightly faster than the global average. The rate of sea level rise has been measured to be 3.1 mm/year over the last ten years as opposed to 1.7–2.4 mm/year over the twentieth century, suggesting that the rate has increased in comparison to the long-term average. (Sivakumar et al., 2011). Coastal regions in Asia, including low-lying areas and small island nations, are at risk of flooding, saltwater intrusion into freshwater sources, and increased coastal erosion. This poses threats to human settlements, agriculture, and biodiversity.

Agriculture

Climate change has become the focus of constant attention of living things and civilizations take into account the climatic parameters determined their lifestyles. Climate increasing or decreasing in changes affect living things negatively. Decrease in productivity, especially in agricultural production causes (İstanbulluoğlu et al., 2013)**.** Global climate change affects the world negatively day by day and reveals negative results in agricultural product yield. In particular, it is inevitable to evaluate the regional temperatures and to review the product pattern in parallel with the increasing global climate change (Bağdatlı et al., 2014). As the soil temperature decreases, plants that are not suitable for climatic conditions and resistant to cold will be affected by root and cause drying. As a result, a constantly increasing soil temperature will adversely affect plant life. It will decrease the efficiency (Bağdatlı and Ballı, 2020). According to pervious research, climate change has already adversely affected economic growth and development in Asia (Gouldson et al., 2016; Ahmed et al., 2019) As a result; the agricultural industry has been negatively impacted by climate change and is predicted to suffer more significant in the future. Therefore, current research confirm that the five main factors of climate change would impact the productivity of agricultural crops are changes in temperature, precipitation, carbon dioxide (CO_2) fertilization (Abeysekara et al., 2023). According to (Jablonski et al. 2002; Ainsworth and Long 2005), the impact of increased CO_2 on plant growth and yield would vary based on species, development stage, photosynthetic pathway, and management practices such applying water. By raising water consumption, higher temperatures may potentially have a counterproductive effect on CO_2 emissions. (Guoju et al. 2005). Due to the shortened crop life cycle, particularly the grain filling period, higher temperatures are mainly due to cause a drop in yields. (Zhu et al,. 2019). Gradually decreasing rainfalls due to climate changes endanger the living habitat. As a precaution, precise solutions are needed to reduce carbon dioxide in the air and slow down global warming and eventually end it. In this way, greenhouse effect and global warming can be prevented (Bağdatlı and Can, 2019).

Aquaculture and Fisheries

Asia also produces 80% of the world's aquaculture, which is of high quality, and 52% of the wild fish collected globally, which accounts for 77% of the value added. (Nguyen, 2015; Suryadi, 2020). Aquaculture has been significantly impacted by a number of climate extremes throughout Asia, including unpredictable rainfall, drought, floods, heat stress, salinity, cyclones, ocean acidification, and rising sea levels. (Ahmad et al., 2019). For instance, Hilsa Ilisha constituted the largest fishery in Bangladesh, India, and West Bengal and S. Yangi in China have lost their habitat because of climate variability. (Jahan et al., 2017; Wang et al., 2019).

Migratory birds

The migration of birds is one of their most fascinating characteristics. When habitat, food supply, climate, and other conditions change, they gain the ability to migrate hundreds or thousands of kilometers across borders to different parts of the world which, there are almost 828 species of migratory birds in Asia, while in Europe, there are 429 species (Wilcove et al., 2008; Gilroy et al., 2016). One of the most important aspects of migratory bird studies has been emphasized: the impact of climate change on the food sources and habitat of migratory bird species. (Walther et al., 2002). Food production is a major concern that might be affected by climatic fluctuations (Bağdatlı et al., 2023; Elsheikh et al., 2023). It is established that recent climate change effects have an impact on migratory bird movement patterns. (Both et al., 2006; Harris et al., 2013). According to Harries et al. (2013), some birds in Southeast Asia experience a change in their migration schedule due to climate change. Due to lengthier stays in northern breeding grounds due to warmer temperatures, long-distance migrants are delayed. The yearly cycles of migratory animals may be worn down by delayed arrivals in winter habitats, such as shifting the arrival date in breeding habitats, which can affect fitness. As a result, climate change may provide particular challenges for migratory birds that live in distant parts of the world and migrate at different times of the year. (Sillett et al., 2000).

Health

Changes in temperature, precipitation patterns, and extreme climatic events could ultimately lead to the spread of diverse human diseases (Kinney el al., 2008). The environment is unfavorable for microbial growth due to intense light, extreme temperature variations, low levels of organic matter, and limited water availability (Aydin et al., 2020). As rising temperatures can increase the concentrations of unhealthy air pollutants, , pollen pollution, wildfire smoke and smog all these can bring about diverse symptoms such as , headache, eye irritation, , wheezing, nasal stuffiness, coughing, chest pain and skin irritation. (Kim el al., 2013). Those most at risk from the effects of climate change include small children, the elderly, and people who have respiratory conditions including asthma, emphysema, and bronchitis. (Drechsler et al., 2005). Due to recent rapid economic growth and fossil fuel consumption, Asian countries have severe adverse health effects from air pollution (Kanat and Erguven, 2020). (China and India in particular suffer from PM2.5 and tropospheric ozone pollution. (Lelieveld et al., 2015; Rohde et al., 2015; Ghude et al., 2016). According to a World Health Organization (WHO) research, more than half of all air pollution-related deaths worldwide in 2015—6.5 million people occurred in Asia. (Landrigan et al., 2017).

As a result, Asian nations are important participants and contributors in ensuring the success of global climate mitigation. (Calvin et al., 2012; Paltsev et al., 2012). The relationship between air quality and health benefits in Asian nations has, however, barely been studied.

CONCLUSION

According to the data that has been studied, Climate change is one of the most challenges facing the world today that It is caused by global warming, which is caused when human activities, such as burning fossil fuels and deforestation, release more carbon dioxide into the atmosphere as compared to natural processes. So, Asia is one of the most vulnerable regions in the world to climate change in view of the huge population, geographical location, and undeveloped technologies, inappropriate soil and management practices on marginal lands in the semi-arid regions leading to increasing rates of land degradation. It affects both natural ecosystems and mankind, with potential impacts ranging from increased flooding to shifting weather patterns that threaten crop yields and increase risk of disease. So, Asian people are facing these problems that reducing gas emissions is essential to limit the pace and severity of climate change, and the world's nations must work together to tackle the problem. Countries in Asia have been taking steps to mitigate and adapt to climate change, including implementing renewable energy projects, promoting sustainable agriculture practices, and developing climate resilience strategies. Changing climate conditions will be an important factor in the current situation and the problems that may arise in the coming years. For this reason, solutions are needed for global warming and reduction of greenhouse gases that cause climate change (Bağdatlı and Arslan, 2020). The increase in the impact of global climate change will cause global water crises between countries. Necessary measures and measures should be taken in advance to reduce the impact of global climate change (Bağdatlı and Arslan, 2019; Elsheikh et al., 2022a). According to scientists, climate is the air that could modify in the atmosphere, means climate known as collection of different atmospheric actions. Generally, Change in climate means variations in weather for centuries which can be occur naturally or by human actions (Elsheikh et al., 2022b).

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