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The Role of Biological Change in Fueling Wars and Armed Conflicts in South Darfur State

التغير الحيوي دوره في دعم الحروب والصراعات المسلحة في ولاية جنوب دارفور

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Abstract:

This paper aims to shed light on the phenomena of biological changes and their direct and indirect effects, which severely impact the population through the depletion of natural resources and the emergence and continuation of wars and internal conflicts. The study focuses on South Darfur State as one of the Darfur region's states that has suffered greatly from the effects of wars and their impact on biodiversity in the study area.

The research adopted several methodologies to reach scientific facts, including the descriptive method to describe and analyze the phenomena of biological changes in the study area and identify their underlying causes and influencing factors in order to derive appropriate conclusions and solutions. The historical method was used to interpret biological changes, uncover the factors that led to them, and understand the past to plan for the future to eliminate such phenomena. The statistical method was employed to collect and analyze data to reveal facts leading to the desired results, along with the ecological method to study the relationship between plants, animals, and the natural environment.

The study reached several key findings, most notably that there have been major biological changes in climatic elements, leading to increased temperatures and the dominance of an arid desert climate. Consequently, the biological environment has become uninhabitable for humans and animals, and many plant species have gone extinct due to unsuitable growth conditions. These changes created opportunities for conflict, with desertification prevailing and dust-laden winds blowing throughout the year, causing population displacement and the depopulation of several areas, leaving them exposed to wars and local conflicts.

Before the outbreak of wars, the world experienced excessive population growth, and the study area was also affected. Locals resorted to overexploiting land for agriculture to meet subsistence needs and for export to cover shortages. Moreover, some governments launched large-scale agricultural development projects (such as the South Darfur Project), which led to soil erosion and exhaustion, reducing productivity and fueling conflicts among the population over access to livelihoods. Given that agriculture is their primary activity, disputes over ownership and control of agricultural and grazing lands further intensified local conflicts and wars. This situation was exacerbated by a lack of environmental awareness and the absence of competent authorities.

The study recommends several key measures, including avoiding meteorological drought and addressing its causes, preserving natural resources, developing and managing sustainable resource development programs, and monitoring and assessing scientific research capacities to maintain and protect biodiversity. These actions are essential to reducing conflicts and local wars and preserving natural resources in the study area.

Keywords: Ecological change, wars and conflicts South Darfur.

الملخص:

تهدف هذه الورقة القاء الضوء علي ظواهر التغيرات الحيوية واثارها المباشرة وغير المباشرة في بل تؤثر بشدة علي السكان في شح ا لموارد الطبيعية وقيام واستمرار الحروب والصراعات الداخلية وذلك بالتركيزعلي ولاية جنوب دارفور باعتبارها احدي ولايات اقاليم دارفور التي تعاني من أثارالحروبات بدورها في النوع الحيوي في منطقة الدراسة .اتبعت الدراسة عدة مناهج للوصول الي الحقائق العلمية تمثلت في المنهج الوصفي لوصف ودراست ظواهر التغيرات الحيوية بمنطقة الدراسة للوصول للاسباب والعوامل التي تتحكم فيها لإستخلاص النتائج والحلول المناسبة، استخدم المنهج التاريخي لتفسير التغيرات الحيوية للكشف عن العوامل التي ادت اليها لفهم الماضي والتخطيط المستقبلي للقضاء علي ظواهر التغيرات الحيوية ايضا استخدم المنهج الاحصائي الرياضي لتجميع البيانات وتحليلها للكشف عن الحقائق التي تقود للنتائج المرجوة ،بجانب استخدام المنهج الايكولوجي لدراسة العلاقة بين الحيوان والنبات وبينهم

وبين البيئة الطبيعية .توصلت الدراسة لعدة نتائج أهمها بأن هنالك تغيرات حيوية كبري في عناصر المناخ عملت عملت علي زيادة درجات الحرارة وسيادة المناخ الصحراوي الجاف واصبحت البيئة الحيوية طاردة لسكن اللإنسان والحيوان بجانب انقراض انواع عديدة من النباتات لعدم ملائمة ظروف النمو ساعدت علي خلق فرص للصراعات سيادة التصحر وسيادة الرياح طول العام محملة بالاتربة والغبار عملت علي هجرة السكان وخلو بعض المناطق من الحياة وانكشافهااصبحت مناطق مكشوفة لممارسة الحروب والصراعات المحلية، في فترات ماقبل الحرب, ساد العالم اجمع زيادات مفرطة في السكان وتأثرت منطقة الدراسة بالزيادة في النمو السكان لجأ السكان المحليين لانهاك الاراضي بالزراعة لسد الاحتياجات الذاتية والتصدير الي الخارج لسد فاقد احتياجة، واتجاة بعض الحكومات في انشأ مشاريع التنمية الزراعية الكبري (مشروع جنوب دارفور) كل ذلك ادي انجراف التربة اونهاكها وعدم مقدرتها للانتاج خلق صراعات بين السكان في سبل الوصول للعيش الكريم خاصة وأن الزراعة تعتبر النشاط الاول لهم وايضا الصراعات في الملكيات وتمليك الاراضي الزراعية والرعوية ساعد غلي زيادة الصراعات والحروب بمنطقة الدراسة،هذا بجانب غياب الوعي بامر البيئة والموارد وغياب السلطات المختصة . أوصت الدراسة بعدة نقاط أهمها تجنب الجفاف المترولوجي والعمل علي القضاء عليهأسبابه و الحفاظ علي الموارد الطبيعية وتطوير برامج التنمية المستدامة للموارد وحسن إدارتها متابعة وتقييم إمكانات البحث العلمي للمحافظة والقضاء علي نغير التنوع الحيوي للحد من تقليل الصراعات والحروب المحلية والمحافظة علي الموارد الطبيعية بمنطقة الدراسة.

الكلمات المفتاحية: التغير الايكولوجي، الحروب والصراعات جنوب دارفور .

Introduction:

Biogeography is one of the branches of physical geography that focuses on studying the biosphere, including both plant and animal life. These layers are considered among the most important environmental resources due to their direct role in maintaining ecological balance. Biodiversity is defined as the variability among living organisms within all ecological systems and is closely linked to ecology and its critical issues, especially as human activities have caused significant environmental degradation and led to negative effects on both plant and animal production.

Recently, calls have intensified to conserve the biosphere due to its vital importance to humanity. Consequently, planners have made it a key goal to establish sound foundations for the preservation of biological environments. The phenomenon of biological change has been highlighted and warned against by scientists since the past century, urging the reduction and elimination of its causes. Biological changes are considered among the major environmental issues that warrant thorough study and analysis. Wars are sometimes a major factor causing ecological changes in many regions, leading to the destruction of biological environments.

The problem of the study area lies in the existence of significant biological changes in the lives of animals and plants, which have played a major role in South Darfur State. The continuation of conflicts, wars, and civil strife—especially since 2003—has severely affected the natural environment in the region. To uncover the facts about the role of biological change in contributing to wars and conflicts, this study was conducted. One of its main objectives is to clarify perspectives and propose potential solutions for concerned authorities to address biological and environmental problems in the study area and help reduce ongoing wars and tribal conflicts within the state.

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Significance of the Study:
The importance of this study stems from understanding the role and current state of the biological environment in general, and whether it has become one of the contributing factors to the conflicts and wars that have persisted for more than twenty years in the study area. It also seeks to determine the extent of its impact on plant and animal life in the region.

Objectives of the Study:
The study aims to:

- Identify the conditions of biological change in the study area.
- Provide information on biological characteristics within the region.
- Understand the factors that contribute to the emergence and continuation of wars and tribal conflicts.
- Present proposals and solutions to officials and environmental protection bodies to preserve biodiversity and address related issues.

Problem of the Study:
The research problem is represented by the escalating pace of wars and conflicts in the study area, to the extent that conferences have been convened to discuss their causes and impacts. The study investigates the role of biological changes in the emergence of wars and conflicts. The study seeks to answer the following questions:

1. Are there biological changes occurring in the study area?
2. Have these biological changes contributed to the escalation of armed conflicts and wars in the region?
3. Do government authorities and traditional administrations play a role in protecting the environment?

Hypotheses of the Study:
The hypotheses serve as tools to help the researcher interpret and analyze phenomena to reach accurate findings and propose solutions to the research problem. They can be summarized as follows:

1. The researcher assumes that biological change is occurring in the study area.
2. Biological change has become a contributing factor in wars and armed conflicts within the region.
3. The lack of environmental awareness among local communities and the failure of relevant authorities to protect the environment have contributed to certain biological changes in the study area.

Methodology:
The study relied on several approaches, including:

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1. Descriptive Method:
   Used to describe and analyze the phenomena of biological changes in the study area to determine their causes and influencing factors, with the goal of deriving conclusions and suitable solutions to prevent their escalation in the future (Al-Mubarak, 1992).
2. Historical Method:
   Used to interpret and trace biological changes over time to uncover the factors behind them, understand the past, and plan for the future to eliminate such phenomena (Bahi, 2002).
3. Statistical Method:
   A mathematical approach used to collect data related to the studied phenomena and apply suitable statistical analysis techniques (Previous Reference, 1992).
4. Ecological Method:
   The term *Ecology* refers to the science that studies the interrelationships between animals and plants on the one hand, and between these organisms and their environments on the other. This method was employed to address problems related to the depletion of environmental resources and the mismanagement of natural assets without compensation, as well as to plan for future generations to overcome the crises caused by human activities (Ubaidat, 1999).

Study Boundaries:
South Darfur State is located between latitudes 11° and 14° North and longitudes 24° and 26° East.

Map No. (1): Location of Gedaref State

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Concepts:

1. The Concept of Environment:
The environment is the totality of things surrounding us that affect the existence of living organisms on Earth, including water, air, soil, minerals, climate, and living beings themselves. It can also be described as a complex network of interrelated systems that determine our survival in this small world. (Lynn, 2018)

2. Linguistic Definition of Environment:
Linguistically, the Arabic word *"environment" (البيئة)* is derived from the verb *"bawaa"* (بوأ) or *"tabawwa'a"* (تبوأ), meaning "to settle" or "to reside." The term conveys the idea of stability and establishment. Thus, the environment in its broad linguistic sense refers to the place to which a person returns, where they live and find stability. The association of the environment with "home" carries a clear connotation — it reflects the deep attachment of living beings to their dwelling and surroundings. Therefore, the environment, in its comprehensive sense, should receive the same care and attention from an individual as their home does. (Mohammad, 1994)

3. Diversity of Ecosystems:
An ecosystem is defined as a collection of living organisms and the non-living components of their environment, along with the interactions occurring among them. (Adam, 2012)

4. Definition of Ecosystem Diversity:
Ecosystem diversity refers to the variation among different ecosystems within a given geographical area. It represents all the various habitats of living organisms on Earth, such as forests, deserts, wetlands, and mountains. Each ecosystem encompasses a chain of interactions between its living components (plants and animals) and non-living components (sunlight, air, and water). (Isa, 2013)

5. Human Impacts on the Environment:
Humans are part of the ecological system, and therefore, through their various activities, they influence its functioning. Unsustainable human practices contribute to disrupting the system's resilience by causing the extinction of many species, reducing biodiversity, overexploiting natural resources, polluting the environment, altering land use patterns, and impacting climatic elements.
(Source: www.sciencing.com)
Such activities ultimately harm the balance of the ecological system.

6. Impacts on the Ecological System:
The main factors influencing the ecological system include:

1. Changes in climatic elements
2. Population growth

3. Overconsumption of natural resources
4. Technological advancement
5. Direct harvesting of resources
6. Pollution
   (Source: www.serc.si.edu)

7. The Meaning of War:
War is a form of organized collective violence that affects relationships either between two or more societies or within a single society in terms of power dynamics. It is governed by the *Law of Armed Conflict*, also known as *International Humanitarian Law*, which is closely associated with some of the oldest legal traditions known to humankind. (John, 2002)

Discussion:

Natural Biological Change in the Study Area – Causes and Factors:

Introduction:
Natural factors are among the elements that humans cannot control, yet they directly affect biological changes (both plant and animal). These factors include climatic variations such as rising temperatures, changes in relative humidity, and fluctuations in rainfall, all of which influence water availability and consequently impact overall biodiversity. (Al-Gharizi, 1998)

Climate:
The study area is characterized by a tropical climate in general, influenced by the apparent movement of the sun and the Intertropical Convergence Zone (ITCZ). Among the climatic elements that have played a key role in biological change in the region are:

Temperature:
Because the study area lies within the tropical climate zone, there are local variations in temperature caused by topographic factors. The year is divided into two distinct seasons — a hot summer and a mild, dry winter.

Despite generally high temperatures, the highest averages are recorded in May, reaching **38°C** in 1984, compared to less than **33°C** in earlier years. This demonstrates the direct impact of rising temperatures in the study area.

The sharp fluctuations in temperature have affected air pressure levels in the region. The area has witnessed a decline in average annual air pressure and an increase in evaporation rates — from **7.17 mm** before 1980 to **9.15 mm** after 1984.

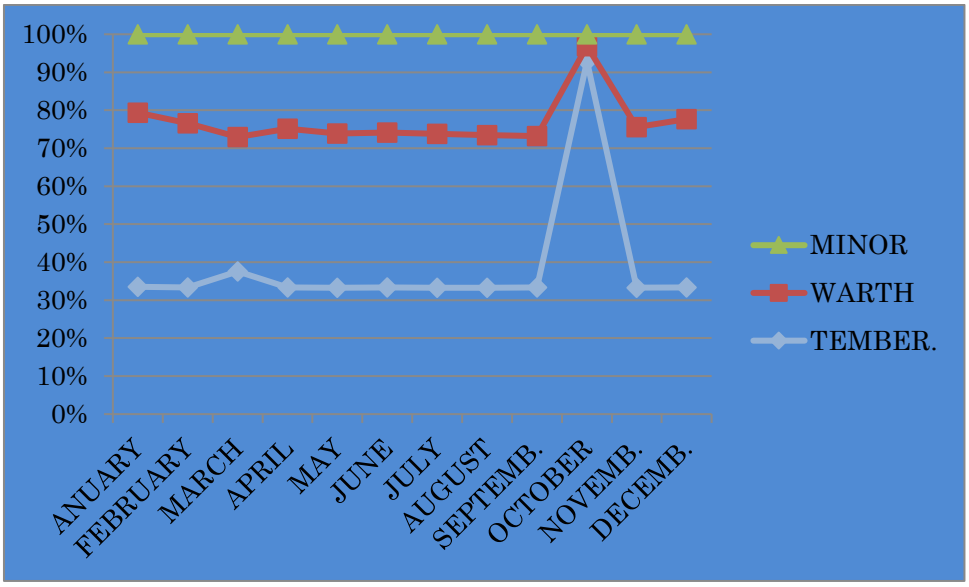
Between **1984 and 1995**, the region experienced extremely high temperatures, often exceeding **40°C**, starting from March and lasting until June. With the onset of the rainy season (July to October), temperatures gradually declined, creating mild and moderate weather, before dropping further during the winter months (November to February), when nighttime temperatures reached around **16°C**. (Abkar, 2019)

Table No. (1)
Monthly Averages of Maximum and Minimum Temperatures in the Study Area (1984–2017)

MONTH	AVERAGE	MAXIMUM	MINIMUM
JANUARY	23.4	32	14.8
FEBRUARY	25.5	33	17.9
MARTH	29.3	27.6	21.1
APRIL	31.1	39	23.2
MAY	31.9	38.9	25
JUNE	30.4	27.2	23.6
JULY	27.9	33.9	22
AUGUST	26.8	32.3	21.4
SEBTEMBER	27.6	33	22.2
OCTOBER	31.8	35.8	27.9
NOVEMBER	25.9	392	19
DECEMBER	22.5	29.9	15.1

Source: Sudan Meteorological Authority, Khartoum (2023)

Figure No. (1): Maximum and Minimum Temperatures During the Months of the Year



Source: Researcher's Work

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Air Pressure and Winds:

The general wind direction in the study area varies according to the main seasons. During winter, atmospheric pressure shifts to the Southern Hemisphere, causing dry northeasterly winds to blow across all Darfur states, resulting in drought conditions throughout this period in the Northern Hemisphere.

In summer, low atmospheric pressure prevails, bringing humid southwesterly monsoon winds that cause summer rainfall in the study area. At the same time, local winds known as "Haboob" blow, increasing in intensity at the beginning of the rainy season and stirring up dust and sand. In recent years, the severity of dust storms has increased due to desertification. *(Abu Al-Zaki, 1998)*

Table No. (2): Wind Speeds and Directions During the Months of the Year

MONTH	Wind speed kilom.	Wind direction
JANUARY	6	Northeast
FEBRUARY	6	Northeast
MARTH	6	Northeast
APRIL	6	Northeast
MAY	5	Southwest
JUNE	5	Southwest
JULY	5	Southwest
AUGUST	5	Southwest
SEBTEMBER	5	Southwest
OCTOBER	6	Northeast
NOVEMBER	7	Northeast
DECEMBER	7	Northeast

Source: Sudan Meteorological Authority, Khartoum (2023)

Figure No. (2): Winds and Their Speeds

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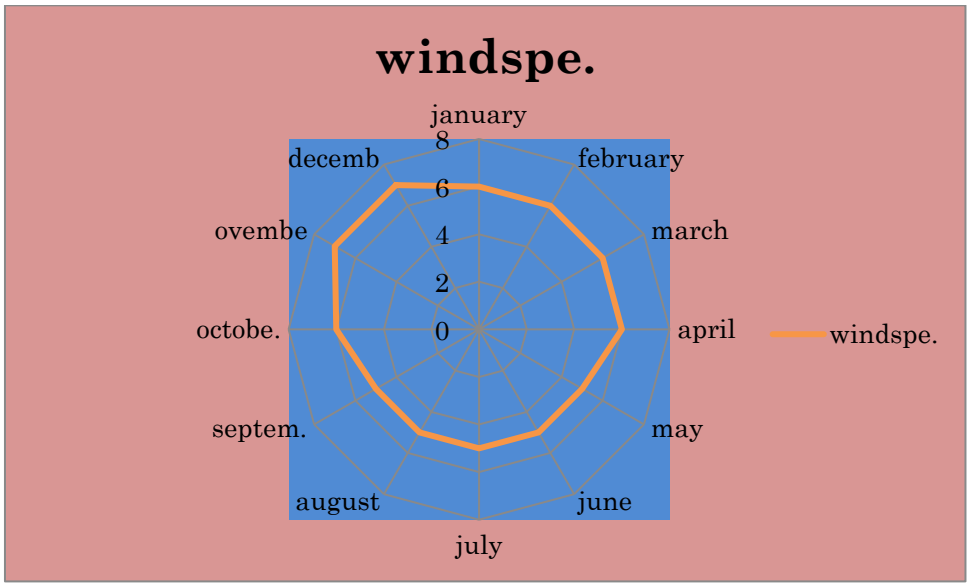


Source: Researcher's Work

Rainfall:

Rainfall in the study area is characterized by fluctuations and instability. The lowest annual rainfall recorded was approximately 19.6 mm in 1998, while in 1984, the annual average was about 3.7 mm, a year when drought struck the African Sahel region, affecting Sudan and causing a general change in biodiversity (both plant and animal). In 2003, the annual rainfall in the study area reached 52.1 mm, which is considered the highest rainfall level recorded, leading to improved vegetation cover and grass growth. *(Abdullah, 2008)*

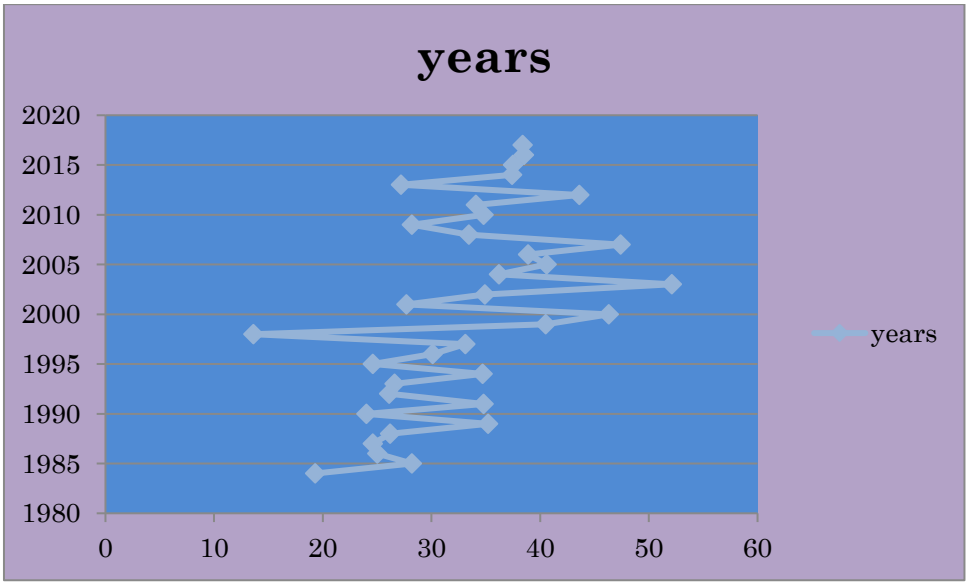
Table No. (3): Rainfall Rates in the Study Area (1984–2017)

Average rainfall mm	years
19.3	1984
28.2	1985
25	1986
24.6	1987
26.2	1988
35.2	1989
24	1990
34.8	1991
26.1	1992
26.6	1993
34.7	1994
24.6	1995
30.1	1996
33.1	1997
13.6	1998
40.5	1999
46.3	2000

27.7	2001
34.9	2002
52.1	2003
36.2	2004
40.6	2005
38.9	2006
47.4	2007
33.43	2008
28.2	2009
34.8	2010
34.1	2011
43.6	2012
27.2	2013
37.4	2014
37.5	2015
38.5	2016
38.4	2017

Source: Sudan Meteorological Authority, Khartoum (2023)

Figure No. (3): Annual Rainfall Percentages (1984–2017)



Source: Researcher's Work

Relative Humidity:

The study area is generally characterized by a dry climate, with relative humidity reaching saturation only during the rainy season. Water vapor levels remain fairly constant during the dry season, which extends from November to April, and evaporation rates are very low. However, humidity rises with the arrival of moist air masses preceding rainfall in May, increasing pressure despite low early autumn rainfall. In July and August, relative humidity and rainfall levels increase, and in September, soil and vegetation retain moisture,

maintaining high humidity levels. As the moist air masses retreat southward, the low-pressure summer season returns. *(Qamruddin, 2003)*

Natural Biological Change and Its Role in Supporting Wars and Tribal Conflicts in the Study Area:

Natural biological changes in the study area have significantly contributed to the initiation and continuation of local conflicts. Climatic changes, such as the gradual rise in temperature over recent years due to drought affecting East Africa, combined with human activities in the area—deforestation, destruction of grasslands, alteration of soil properties, and exposure to wind and water erosion—have all facilitated conditions conducive to conflict. Fluctuations in rainfall and atmospheric pressure, along with the influence of prevailing and local winds, further exacerbated these natural changes, making them key factors in sustaining wars and tribal disputes.

Human-Induced Biological Change in the Study Area:

Introduction:

Dry and semi-arid regions generally face environmental challenges, largely due to unsustainable human practices and overexploitation of vital resources to meet growing population needs. *(Saleh, 2016)*

Human Activities Contributing to Biological Change:

1. Deforestation:
   One of the main human interventions affecting biological change is the extensive removal of plants. This leads to serious consequences for the biosphere, particularly disrupting the balance of oxygen and carbon dioxide in the air. Vegetation normally absorbs sunlight and helps regulate infrared radiation; its removal destabilizes the energy balance and contributes to global warming. Human activities in the study area, including deforestation for fuel and the destruction of grasslands due to conflict-related fires, have significantly reduced vegetation cover.
2. Overgrazing:
   Overgrazing leads to major ecological changes, as plant roots protect soil from erosion. Proper grazing maintains the biological capacity of pastures and supports natural vegetation regeneration. In the study area, excessive grazing has destroyed grasses from their roots, degraded soil, reduced cohesion, increased susceptibility to wind erosion, and negatively affected animal populations over the years. *(Babiker, 2010)*
3. Hunting:
   Use of firearms for hunting and poaching has led to the decline and endangerment of

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many species. Overhunting has historically prompted international measures, such as the 1932 International Whaling Conference, to protect vulnerable species. In the study area, hunting has been practiced for both subsistence and commercial purposes, severely impacting biodiversity. *(Ghoneimi, 1997)*

4. Uncontrolled Agricultural Expansion:
   Agricultural expansion alters ecosystems and is less capable than natural vegetation of maintaining ecological balance. Mechanized farming in the study area has facilitated large-scale clearing of forests and grasslands, replacing them with crops, and further altering natural environmental conditions. *(Mahmoud, 2010)*
5. Population Growth:
   Since the early 20th century, population growth has placed immense pressure on the biosphere. Overexploitation of natural resources to meet growing demands has led to significant environmental degradation. *(Al-Zawka, 1996)*

The study area has experienced increased population density due to wars and tribal conflicts, causing internal displacement and concentrating populations within the state. This has intensified pressure on natural resources, especially vegetation and soil, leading to the degradation and disappearance of many plant and animal species.

Human-Induced Biological Change and Its Role in Supporting Wars and Tribal Conflicts:
Human activities have played a major role in exacerbating wars and conflicts among tribes in the study area, which have persisted for over twenty years. Deforestation has contributed to desertification, while overhunting provided food resources and increased availability of weapons. Population growth, combined with open access to agricultural land and projects, has increased pressure on soil resources, escalating disputes over land ownership, grazing, and farming. Fires resulting from conflicts have further degraded soil and vegetation, perpetuating cycles of war. These factors have been particularly impactful in tribal conflicts between Arab and non-Arab communities, alongside other contributing causes.

Opinions of Respondents in the Study Area on Biological Change and Its Role in Supporting Tribal Conflicts and Armed Wars

1-Age Structure of Respondents

Table No. (4): Age Groups of Respondents

Age	Repetition	Per centum
20-29	12	16%
30-40	42	36%
40-49	30	28%
50	16	20%
Everyone	100	100%

Source: Field Study

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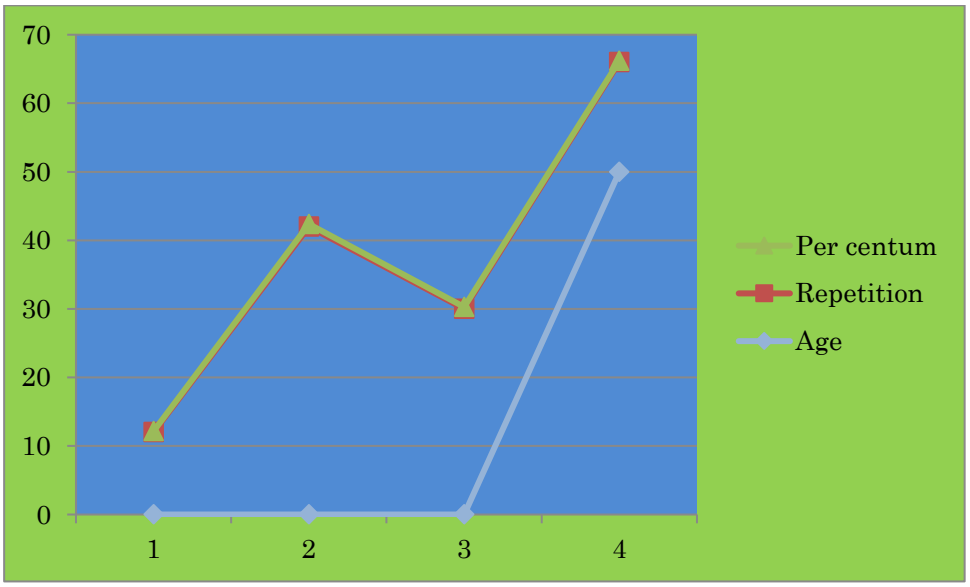
Figure No. (4): Age Groups of Respondents



Source: Researcher's Work

Table No. (4) and Figure No. (4) show that the majority of respondents are between 30–50 years old and above. This age group is the most capable of providing reliable information that can achieve the study's objectives, as they represent mature adults who have experienced the real conditions in recent years. Additionally, respondents in middle age can provide dependable historical information about the study area, while those over 50 years can contribute insights based on older biological conditions. This allows for a comparison across age groups to identify recent biological changes, relying particularly on middle-aged respondents to draw accurate conclusions.

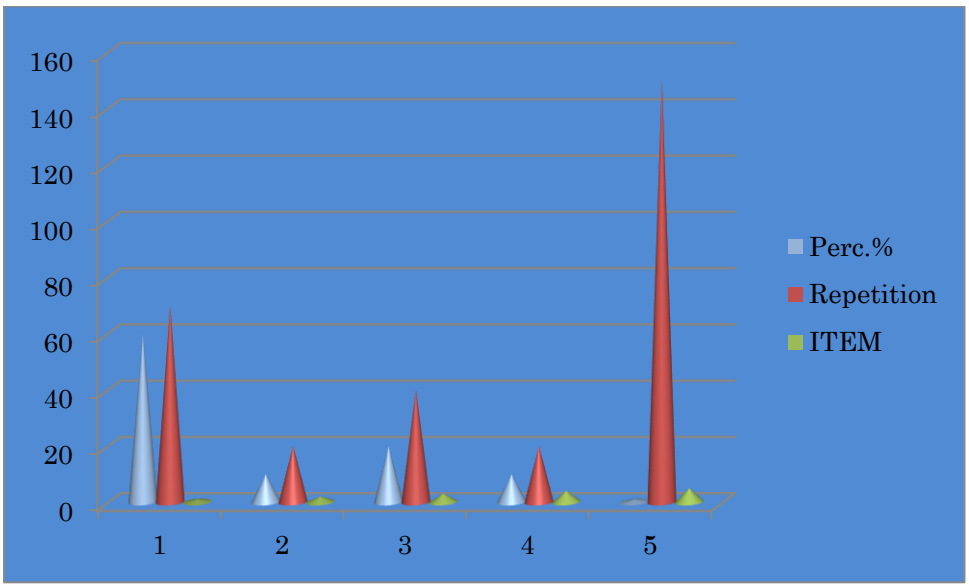
2- Is There Natural Biological Change in the Study Area?

Table No. (5): Natural Biological Changes

Perc.%	Repetition	ITEM
60	70	1.The heat.
10	20	2.Relative humidity.
20	40	3.Wind .
10	20	4.Rain
100%	150	Everyone

Source: Field Study

Figure No. (5): Natural Biological Changes



Source: Researcher's Work

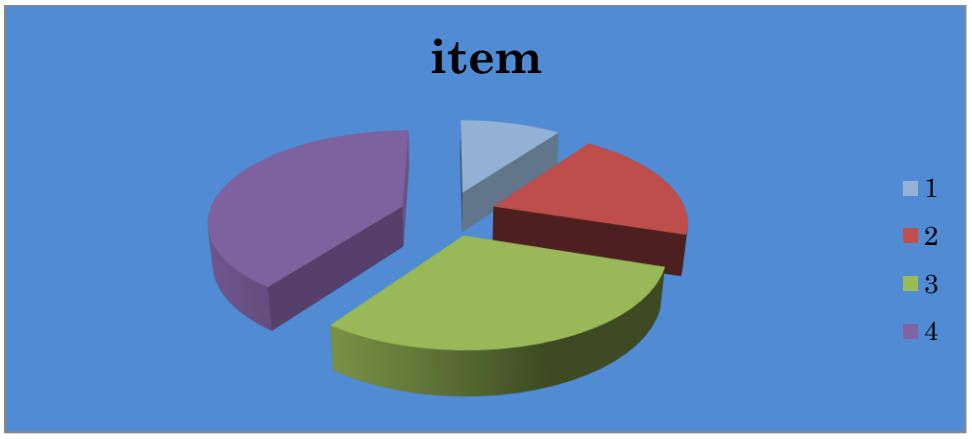
Table No. (5) and Figure No. (5) show that the increase in temperature represents the largest proportion (60%) of natural changes in the study area. This rise in temperature has contributed to the decline of other environmental factors, with relative humidity being very low in comparison. High wind levels—dry winds with high atmospheric pressure, carrying dust and sand—further exacerbate these conditions. The combination of high temperatures, desertification, and sand dune formation also facilitates the spread of diseases and insects, affecting local populations. All these factors collectively contribute to a complete biological change in the study area, significantly impacting the lives of its inhabitants.

3- Is There Human-Induced Biological Change in the Study Area?

Table No. (6) Human-Induced Changes

Item	Repetitions	Perc.%
1. The change in natural vegetation	80	35
2. Overgrazing	40	*10*
3. Soil erosion	60	*20*
4. Agriculture	80	35
%100	260	Everyone

Source: Sudan Meteorological Authority. Khartoum (2023)
Figure No. (6) Human-Induced Changes



Source: Field Work

Table No. (6) and Figure No. (6) show that there is significant human-induced biological change. According to respondents, the highest impact (70%) is on vegetation cover and agriculture, alongside the destruction of natural pastures. Overgrazing also contributed moderately to vegetation degradation, leading to soil erosion. These factors collectively increased desertification, water and wind erosion, and intensified drought in recent periods. Thus, human activities in the study area have accelerated and amplified biological change.

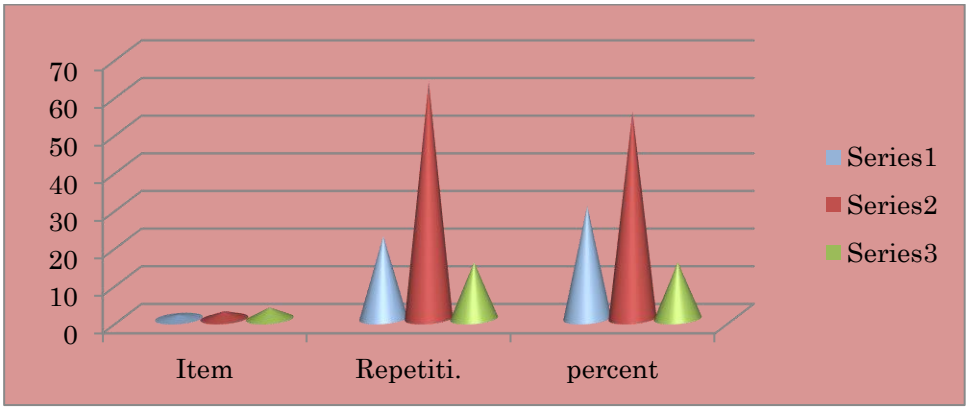
4- Have Natural and Human-Induced Biological Changes, Alongside Other Factors, Contributed to the Emergence of Wars and Tribal Conflicts in the Study Area?

Table No. (7): Total Biological Change Percentages

Item	Repetitions	Percent%
1. Natural change	22	30
2. Human change	63	55
3. Other change	15	15
	100	100

Source: Field Work

Figure No. (7): Total Biological Change Percentages



Source: Researcher's Work

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Table No. (7) and Figure No. (7) show that the total biological change is largely driven by human-induced changes. Human activities in the study area—such as deforestation, overgrazing, and agricultural expansion beyond soil capacity—have accelerated desertification and indirectly intensified natural changes, including rising temperatures, reduced relative humidity, dominant dusty winds, and the spread of diseases and pests. These changes have significantly affected rainfall patterns, leading to drought. The combined effect of natural and human-induced changes, alongside other invisible factors, has contributed to the emergence of conflicts, tribal wars, and survival struggles in the state.

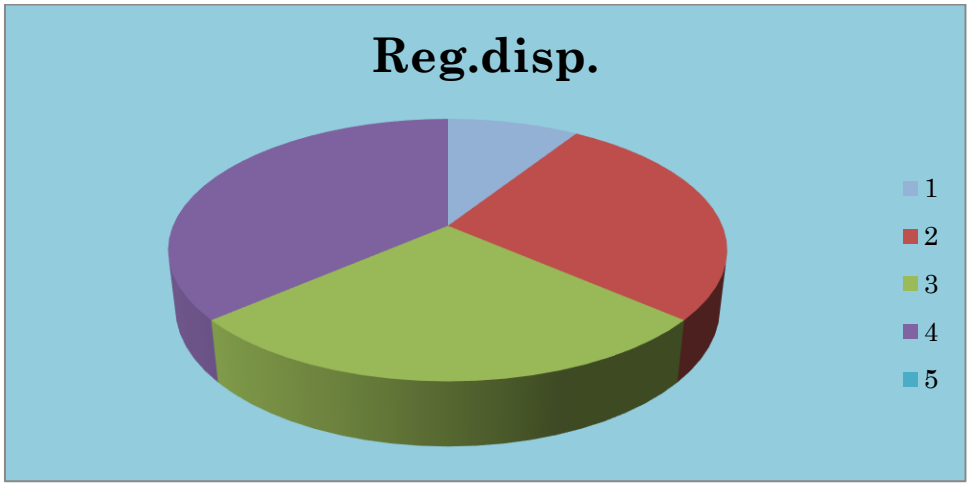
5- Population Displacement Rates Due to Biological Changes:

Table No. (8): Population Displacement Rates in Some Sudanese States Due to Biological Change During the 1980s, According to Previous Administrative Divisions

Region of displacement	Number of population	Number of displaced from the study area	Percent%
1.Central region	2,009,000	200.000	10
2.Eastern region	2.208.800	600.000	27
3.Darfur region	3,188.000	800.000	25
4.Kordofan region	3.594.000	1.100.000	30

Source: National Conference for Refugees/Displaced Persons and International Developments – Khartoum

Figure No. (8): Population Displacement Rates in Some Sudanese States Due to Biological Change During the 1980s, According to Previous Administrative Divisions



Source: Researcher's Work

Table No. (8) and Figure No. (8) show that during the 1980s, Kordofan region had the highest population displacement rates within Sudanese states. Although the population size was

similar to that of the study area at the time, displacement outside Kordofan was higher, whereas the study area's population remained relatively stable due to the suitability of the local biological environment for human habitation. Notably, there was no international migration from the study area during this period, and no significant biological changes occurred in the state.

6- Impact of Wars and Tribal Conflicts:
Wars and tribal conflicts destabilized security, preventing settlement, especially in rural areas, forcing populations to migrate to major cities within the state, while some chose to seek refuge in neighboring countries away from their original communities.

Table No. (9): Current Population Distribution Percentages in the Study Area

Population status	**Repetitions**	**Percent %**
1.Residents	20	**10**
2.Internally displaced persons	70	**70**
3.Refugees to neighboring countries	10	**20**
%100	100	**100**

Source: Central Bureau of Statistics – Khartoum, 2023

Figure No. (9): Current Population Distribution Percentages in the Study Area

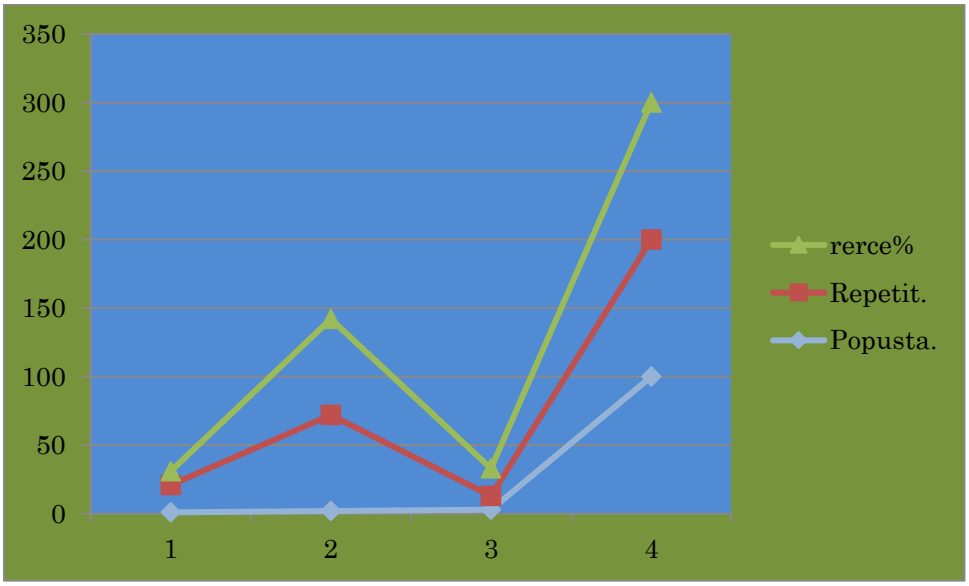


Figure No. (9): Current Population Distribution Percentages in the Study Area

Table No. (9) and Figure No. (9) Analysis:
Based on the respondents' information, the majority of displaced persons, especially from villages to major cities within the state and other Sudanese states, have increased significantly, representing 70% of the current population. This is attributed to the complete bio-geographical changes in the study area. Additionally, about 20% of the population migrated or sought refuge in neighboring countries, while only 10% remained in their

original areas, struggling with the effects of biodiversity changes and deteriorating natural resources.

Conclusion and Results

The study concluded that significant negative effects led to major bio-geographical changes, which contributed to the emergence and persistence of conflicts and wars in the study area for over twenty years. These changes include:

1. Climate Element Changes: Increased general temperatures, decreased relative humidity, fluctuating rainfall in certain years, and the dominance of arid desert climate made the habitat hostile to humans and animals. Many plant species became extinct due to unsuitable growth conditions, creating opportunities for conflicts.
2. Environmental Degradation: Deforestation and land clearing accelerated desertification. Persistent dusty winds contributed to population migration, leaving some areas depopulated and exposed, facilitating local wars and conflicts.
3. Post-war Population Growth: After the war, global population increases affected the study area, with local residents overexploiting land for subsistence and exporting surplus to major cities. Large agricultural projects (e.g., South Darfur Project) led to soil erosion, decreased productivity, and conflicts over livelihoods and land ownership, intensifying local disputes.
4. Lack of Awareness and Guidance: Insufficient local awareness of environmental conservation and the consequences of biodiversity changes contributed to further loss of biodiversity and exacerbated conflicts.
5. Absence of Authorities: The lack of responsible authorities and specialized agencies to monitor and manage environmental issues allowed bio-geographical changes to escalate, fueling tribal conflicts and local wars.

Recommendations

To mitigate bio-geographical changes and reduce local conflicts while preserving natural resources, the study recommends:

1. Preventing meteorological drought and addressing its causes when rainfall falls below annual averages.
2. Preserving natural resources through sustainable management programs and effective resource governance.
3. Developing alternative energy sources, optimizing their use, and improving the country’s capacity in meteorology, weather forecasting, and water resources to anticipate future droughts.
4. Strengthening scientific research and training on desertification, raising environmental awareness, and promoting natural resource conservation.
5. Monitoring and evaluating bio-geographical changes periodically through systematic studies.
6. Managing biodiversity and environmental conditions to prevent the emergence of local wars and conflicts.

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Appendices:
Questionnaire on Biophysical Change in South Darfur State and Its Impact on Wars and Conflicts

Providing accurate and precise answers to the contents of this questionnaire will achieve the intended purpose and contribute to reaching scientific knowledge, facts, and research objectives.

1.1.1 Section One:

- **Gender:**

a. Male ( ) b. Female ( )

- **Age:**

a. 20–29 years ( ) b. 30–40 ( ) c. 40–49 ( ) d. Over 50 ( )

- **Has there been a change in the amount of rainfall?**

a. Yes ( ) b. No ( )

- **If yes, how?**

a. Increase ( ) b. Decrease ( ) c. Same amount ( )

- **What are the consequences of the change in rainfall?**

a. Decrease in water quantities ( ) b. Decrease in vegetation cover ( )
c. Reduction of agricultural lands ( ) d. General change in residents' social and economic life ( )

- **Has there been a change in temperature compared to previous years?**

a. Yes ( ) b. No ( )

- **If yes, describe the temperature levels:**

a. Increase in temperature ( ) b. Decrease in temperature ( )

- **Do residents suffer from lack of relative humidity?**

a. Yes ( ) b. No ( )

- **Do you notice an increase in dust, sandstorms, and prevailing wind intensity?**

a. Yes ( ) b. No ( )

- **If yes, explain:**

a. Increase in wind and dust intensity ( ) b. Decrease in wind intensity ( )

- **Have changes in temperature, wind, rainfall, and humidity led to population displacement and instability in the area?**

a. Yes ( ) b. No ( )

- **Have you noticed any signs of soil degradation in the area?**

a. Yes ( ) b. No ( )

- **If yes, what are the indicators?**

a. Change in vegetation cover ( ) b. Sand encroachment ( ) c. All of the above ( )

- **When did the vegetation change occur (if yes)?**

a. 1–7 years ago ( ) b. More than 10 years ago ( ) c. Longer ago than that ( )

- **What was the nature of the change?**

a. Increase ( ) b. Decrease ( ) c. Disappearance of some plants and emergence of new species ( ) d. All of the above ( )

- **Are there problems in agricultural production?**

a. Yes ( ) b. No ( )

- **If yes, explain the reasons:**

a. Drought ( ) b. Disputes over land ownership and tribal conflicts ( ) c. All of the above ( )

- **Are there tribal wars and conflicts in the area?**

a. Yes ( ) b. No ( )

- **If yes, what are the results of these wars and conflicts?**

a. Increase and recurrence of wars ( ) b. Water scarcity and reduced agriculture ( )
c. Population displacement, especially from rural areas affected by wars and conflicts, with migration to urban centers ( )
d. Seeking refuge in neighboring countries ( ) e. All of the above ( )

- **Have other factors contributed to wars and conflicts?**

a. Yes ( ) b. No ( )