Food Security in the African Sahel within the context of Climate Change: An Analytical Approach

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Abstract:

The article examines climate change as one of the most significant security challenges that have affected the African Sahel in recent years, and the profound consequences it has had on food security in the region. Relying on an analytical approach, the study highlights the impacts of rising temperatures, changing rainfall patterns and volumes, and increasing desertification and drought on the agriculture and animal husbandry sectors, which constitute the primary sources of food in the region, thereby undermining food security. This has contributed to widespread poverty and malnutrition, and various diseases, in addition to pest infestations such as irregular migration, organized crime, and terrorism. Moreover, internal and inter-state conflicts have increased, particularly in countries experiencing political instability, state fragility, and limited governance capacity.

Keywords: *climate changes; African Sahel; food security; repercussions; impacts.*

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Introduction:

Global developments have led scholars of international relations to reconsider the basic assumptions of security theories. While earlier security studies mainly focused on economic, political, and social threats, climate change has emerged as a significant additional factor. It has introduced new non-military threats, such as malnutrition, poverty, and famine, which affect the stability and security of societies. Consequently, climate change has become a central topic in academic research and domestic and foreign policy debates, reflecting growing concern about its accelerating impacts on the security of individuals, communities, and states, particularly food security.

Although the causes of food insecurity vary across regions and are often primarily linked to economic and political factors, the African Sahel presents a unique case. Food insecurity in this region cannot be attributed solely to political or economic reasons. Considering the Sahel's geographic location, many of the famines and episodes of malnutrition experienced there have been associated with climatic factors, which have posed significant threats to food security in particular and to human security more broadly in the region.

This study aims to examine the extent to which climatic factors in the African Sahel affect the achievement of food security, by highlighting the security repercussions of climate change and how these have exacerbated the region's inability to ensure its food security. From this emerges the central research problem of the study: In what ways do climatic factors shape and challenge food security in the African Sahel?

To answer the research problem, the following hypothesis is proposed: The higher the levels of greenhouse gas emissions, the more severe the climate changes become, which in turn negatively affect food security in the African Sahel, as this region is the most impacted to such changes.

1. Climate Change/Food Security: A Conceptual Introduction to the Study:

a. Definition of climate change:

Climate change is one of the most prominent issues on the international agenda, representing a challenge that affects all of humanity. This phenomenon is no longer discussed solely within scientific and ecological circles; it has become relevant across all vital sectors and in every country, both developed and developing, due to its multiple dimensions and widespread impacts.

Academic attention to this phenomenon soon followed, leading to numerous definitions—some simple, others technical and scientific. However, there remains no single definition of climate change that is internationally agreed upon. (Maifi, 2019, p. 371)

The United Nations Framework Convention on Climate Change defines climate change as follows: climate change refers to a change in the global atmosphere that is caused directly or indirectly by human activities, resulting in to alterations in the composition of the atmosphere, in addition to natural climate variability occurring over comparable time periods.(Tawahriya, 2020, p. 352)

However, the Intergovernmental Panel on Climate Change defines climate change as any form of change that can be expressed statistically and may persist over consecutive decades resulting either from human activities or from internal interactions within the components of the climate system. (Bakhta, 2025, p. 19)

Consequently, climate change refers to disruptions in normal climatic patterns such as temperature, wind, and rainfall. While it can result from natural factors like volcanic activity, orbital variations, and solar changes, (Rimoch, 2025, p. 209) it is increasingly driven by human activities—especially fossil-fuel combustion and deforestation—which raise greenhouse gas concentrations and contribute to global warming. (Salim, 2025, pp. 28-29)

Among the most evident and unprecedented impacts of climate change are the warming of the atmosphere and oceans, the decline of snow and ice cover, rising sea levels, and shifts in rainfall patterns, causing recurrent droughts in some regions and floods in others. These changes are accompanied by more frequent natural disasters and increased evaporation due to higher temperatures, leading to shortages of drinking and irrigation water (Baaj, 2025, p. 389). As a result, global food production declines, threatening food security—particularly in developing countries and notably in the study area: the African Sahel. It is important to note that these areas are not the main contributors; the largest share of greenhouse gas emissions comes from major industrialized countries.

b. Definition of food security:

The recognition of access to food as a human right dates back to the adoption of the Universal Declaration of Human Rights in 1949, as reflected in Article 25, which affirms the right of the individual and their family to an adequate standard of food. By contrast, the concept of food security has been in use since the sixties within the international development literature, and the first formal institutional attention to the concept of food security was given by the World Food Security Committee in 1974, in the aftermath of the global food crisis of 1970. Since then, food security has become a central and strategic issue, attracting significant attention from international organizations and the academic research community and experts. (Ibtisam Ramdani, 2017)

The concept of food security has known various interpretations, as is the case with many concepts in the social sciences; within this framework, some of the main definitions can be outlined as follows:

- Some scholars define it with a focus on the quantity and type of food required to achieve food security. Among them, some consider his quantity relative, linking it to the individual's income and living conditions within society, while some others treat it as absolute, which implies ensuring that every person has access to the caloric intake necessary for a healthy life, regardless of their income or social conditions. (Munir, 2008, p. 06)
- The Food and Agriculture Organization defines food security as ensuring that all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and preferences for an active and healthy life. This definition encompasses three dimensions of food security: food availability, stability, and access. (Zidan, 2010, p. 22)
- The Arab Organization for Agricultural Development defines food security as the continuous provision of food in the quantities and types necessary for activity and health for every individual within the population, relying primarily on local production, taking into account each country's comparative advantage in producing food commodities, and ensuring availability to all individuals at prices compatible with their income and financial capacity. (Maifi, 2019, p. 373)
- The World Bank, on the other hand, defines food security as access by all people at all times to sufficient food for an active and healthy life. Its definition emphasizes the temporal dynamics of food insecurity, distinguishing between chronic food insecurity, associated with persistent or structural poverty and low income, and food insecurity caused by natural disasters, economic collapse, or conflicts. (Yezza, 2018, p. 16)

Consequently, it can be concluded that food security is closely linked to a state's capacity to meet the food needs of all its citizens promptly, under all circumstances, without discrimination or exclusion. This can be achieved through domestic production or food imports, with priority naturally given to local production if the state seeks stable and sustainable food security. Achieving this requires the effective deployment of national natural, human, and financial resources.

c. Implications of Climate Change on Food Security:

Climate change represents an increasing threat to food security, and consequently to the right to food, across all countries of the world. Its expected impacts are numerous, including rising temperatures, water scarcity, declining productivity of arable land, effects on animal husbandry and fisheries, increasing rates of desertification, disruption of ecosystems, and loss of biodiversity. All of these factors negatively affect the ability to ensure adequate food for the world's population, as agriculture provides livelihoods for approximately 65% of the poor, according to World Bank estimates in 2021 (Hanafi, 2022). These impacts collectively impose pressure on local and global food systems, increasing the

likelihood of supply chain disruptions and intensified competition for limited resources

The negative effects of climate change were among the factors contributing to the two global food crises of 2007–2008 and 2010–2011, resulting from extreme climatic events in major food-producing countries, such as the droughts experienced in Russia, Australia, Eastern Europe, and West Africa.

Two primary factors determine the extent to which food production systems in different regions are affected by climate change: The first: The level of exposure to potential risks, and the degree of adaptation and resilience of the food production systems. The second: Geographic location. (Ismail, 2015)

Climate change leads to alterations in the assets of the food system, whether in food production, storage and transportation, or animal husbandry assets. These components, in turn, affect and modify the dimensions of food security as follows:

1- Food availability: Climate change affects food availability by impacting agricultural production through water scarcity and soil degradation, leading to fluctuations in crop yields. In addition, it affects the health and productivity of animal husbandry and fisheries.

2. Food Access: Climate change limits the ability to obtain food, particularly as a result of the loss of assets owned by farmers, which undermines their future income-generating capacity and has consequences for
future food security. Food supply shortages will also drive up prices, thereby affecting individuals' purchasing power, especially among the poor.

3. Nutrition and Utilization (Consumption): Climate change leads to shifts in consumption patterns and available dietary choices, while also affecting the nutritional quality of crops, food safety, and increasing the risk of food contamination.

4. Stability of Food Supplies: Climate change affects the stability of food availability, access, and utilization due to fluctuations in ecosystem productivity and disruptions in food supplies. (Hanafi, 2022)

In this context, the Rajaratnam School of International Studies at Nanyang Technological University in Singapore conducted a study in 2015 entitled "The Impact of Climate Change on Food Production: Available Options for Food-Importing Countries "This study examined the potential effects of climate change on crops, animal husbandry, and fisheries by 2030, 2050, and 2050/2080. (Ismail, 2015)

the projected impacts are as follows:

- Heat stress: rising temperatures may reduce cereal crop yields by 10%.
- Water stress meaning the damage to crops caused by either water shortage (drought) or excess water (flooding).

- Increased animal husbandry mortality due to higher temperatures, leading to declines in livestock production and higher prices.
- Soil inundation or erosion, resulting in reduced yields. (Medani, 2024, pp. 508-510)
- Increased ocean temperature and acidity, causing fluctuations in fish production levels, which may worsen to the point of species extinction. (Ismail, 2015)

2. Climate Patterns and Climate Change in the African Sahel

From a geographical standpoint, the African Sahel refers to the central belt of Africa extending from the Atlantic Ocean to the Red Sea. The Sahelian states are characterized as a transitional zone located between the Sahara and equatorial Africa, (Atiqa, 2020, p. 239) which is characterized by arid and semi-arid conditions. More precisely, the Sahel is often defined as the arc stretching from Sudan to Mauritania and including three core countries: Mali, Niger and Chad; which are frequently described as pivotal states. This arc is commonly referred to as the "arc of crises", given that these countries experience recurrent security crises and are strongly affected by instability in neighbouring states. (Berkouk, 2008, p. 12)

From a political perspective, the Sahel is regarded as a broad geographical space comprising states experiencing acute economic, political and environmental challenges, most notably Senegal, Mauritania, Mali, Burkina Faso, Niger, Chad and Equatorial Guinea (Saifi, 2021, p. 218).

From an institutional perspective "the Inter-State Committee for Drought Control in the Sahel" defines the Sahel according to environmental criteria and identifies its member states as Burkina Faso, Cape Verde, The Gambia, Guinea-Bissau, Mali, Mauritania, Niger, Senegal and Chad. (Abdel-Ali Hour, 2016, p. 188)

The climatic perspective has become a central analytical tool in defining the Sahel geographically, by integrating location, climate conditions, natural resources, land characteristics and population patterns as core variables shaping the geopolitics of this strategic belt. In spatial terms, the Sahel accounts for nearly 30 per cent of the African continent. Climatic conditions vary from semi-arid in the southern zones to arid in the northern margins, with seasonal rainfall. The region is widely recognised as one of the most severely affected areas in Africa in terms of drought and desertification. Geographically, it extends westward from Senegal through Mauritania, Mali, Burkina Faso, Niger, northern Nigeria, Chad and Sudan, and reaches Ethiopia in the east. (Maslouh, 2014, p. 09)

In light of the above, the African Sahel can be conceptualised as a transitional belt separating North Africa from Central and sub-Saharan Africa. This corridor includes Mauritania, Mali, Niger, Chad and Sudan, in addition to the northern parts of Burkina Faso and Nigeria and portions of Eritrea and Ethiopia (Samir, 2020, p. 337), and lies broadly between 12° and 22° north of the Equator (Heinrigs, 2010). Current estimates suggest that the Sahel covers nearly nine

million square kilometres and extends over an east–west strip of approximately 5500 kilometres, with an average width of between 350 and 500 kilometres.

Accordingly, the region may be divided into three levels:
-The first level comprises the core states, or the strategic depth of the African Sahel, namely Mali, Niger and Chad.
-The second level consists of the peripheral edges of the African Sahel, represented by Sudan and Mauritania.
-The third level includes the secondary states located within the African Sahel region, namely Burkina Faso, Nigeria, Eritrea, Senegal and Cape Verde. (Samir, 2020, p. 337)

Turning to climate patterns and climate change in the African Sahel, the region largely coincides with the continent's low-productivity savannah zone, where climatic conditions extend from semi-arid in the southern areas to arid in the northern margins. As a result, the Sahel is one of the regions in Africa most affected by drought and desertification.

The Sahel is characterized by two main seasons. A long dry season prevails from October to May and is marked by dry, dust-laden winds. This is followed by the second season is a short one that extends from June to September. Rainfall is irregular, varies considerably from year to year, and is mostly concentrated in one or two months. (Al-Tantawi, 2014, p. 410)

According to the Köppen classification, the African Sahel can be divided into three main climatic zones:
1-The tropical summer-rain zone; which dominates the southern parts of the Sahel and is known as the savannah climate. Temperatures do not fall below 18°C, and rainfall reaches its peak in August.
2- The steppe climate, which prevails to the north of the savannah zone. It is a semi-arid or semi-desert climate, generally sunny, dry and somewhat windy throughout the year. Rainfall occurs in summer and lasts for about four months in the south and less than three months in the north.
3- The desert climate, which is more extreme in its characteristics, with almost no rainfall, higher temperatures and frequent dust storms. (Al-Tantawi, 2014, p. 406_407)

Drought and desertification in the Sahel region are mainly caused by low rainfall and poor soil productivity, alongside high temperatures and the growth of seasonal grasses, shrubs, and some thorny trees. Overall, the Sahel belt is considered a fragile area, more exposed than others to environmental imbalance (Hayati, 2000, p. 37). Annual rainfall varies from year to year, but it is generally lower in the north (100–200 mm) than in the south (500–800 mm), with the rainy season lasting one to two months in the north and four to five months in the south (The African Sahel, 2015). Temperatures remain high throughout the year, rarely

falling below 18°C, while annual sunshine ranges between 2700 hours (about 61% of daylight hours) and 3500 hours (over 79% of daylight hours) (Al-Tantawi, 2014, p. 409). Temperatures in the Sahel are increasing 1.5 times faster than the average warming rate in the world, and shorter rainy seasons have transformed large areas of the poor savanna into semi-desert. (Crisis, 2019)

Several factors have contributed significantly to drought and desertification in the African Sahel, which can be categorized into natural and human factors. Regarding natural factors, these are largely linked to long-term climatic changes throughout the geological history of the region. Studies indicate that the Sahel has experienced continuous climatic fluctuations, evidenced by alternating wet and dry geological periods. During wet periods, sand and vegetation advance northward across the Sahel, while in dry periods they retreat southward. Some researchers also attribute recent climatic variability to global warming caused by increased greenhouse gases. Modeling studies highlight the role of sea surface temperatures in regulating rainfall in the Sahel, suggesting that rainfall is negatively correlated with the temperatures of the tropical Indian and Pacific Oceans and positively correlated with the Atlantic Ocean temperature. however human factors include unsustainable environmental practices such as overgrazing, intensive agriculture, deforestation, and forest clearing, which have accelerated the pace of desertification.

The Sahel is therefore a distinct climatic and ecological transition zone. The Intergovernmental Panel on Climate Change (IPCC) projects that air temperatures over the Sahel will rise by 2.0 to 4.3°C by 2080 compared with 1876, with an increase of about 2.0°C expected by 2030. As a result, the annual number of extremely hot days (above 35°C) is expected to increase substantially, reaching up to 125 days per year in some areas. For example, parts of central Niger already experience 306 extremely hot days annually, a figure projected to rise to 339 days per year in the coming decades. (Hafiz, 2023)

Such a harsh climatic environment has significant implications for human security across political, economic, health, and social dimensions. Drought, desertification, and rising temperatures exacerbate security crises, either directly or by amplifying existing risks and accelerating environmental and non-environmental threats. They also highlight the structural link between climate change and conflicts over scarce resources, particularly land and water, often leading to tensions between settled farmers and nomadic pastoralists. These dynamics have negatively affected food security and overall stability in the region.

3. Risks and Impacts of Climate Change on Food Security in the African Sahel:

Climate change is among the most severe threats to non-traditional security in the African Sahel, due to its direct impact on food security. Extreme

weather events are a major driver of rising food insecurity and malnutrition in the region.

There is no dispute that drought has been a defining feature of the Sahel for centuries, as noted previously, and the region the most arid areas in the world. However, populations that historically adapted to this climate are increasingly unable to cope with the growing severity of climatic conditions. Rising temperatures and climate change have intensified these challenges (Baba'a, 2023). Ibrahim Thiao, the United Nations Special Advisor on the Sahel, emphasizes: "The Sahel is one of the regions most vulnerable to climate change… it is likely to have the largest number of people disproportionately affected by global warming." (News, 2020)

Global warming in the Sahel is increasing at approximately 50% above the global average, resulting in some of the most severe droughts and floods anywhere in the world. Despite having the lowest CO_2 emissions globally, Sahelian countries are among the most affected by climate change. Some studies argue that the concept of "normal" annual rainfall is almost meaningless in the Sahel, as the region is gradually transforming into desert. Recurrent food shortages affect millions, driven by prolonged drought, limited access to food, rising grain prices, and environmental degradation. (Irrum, 2023)

The worsening food crisis in the African Sahel is largely driven by the region's reliance on economic activities most vulnerable to climate change, namely agriculture, animal husbandry, herding, and fisheries. Sahelian countries are primarily agricultural societies, with the agricultural sector serving as the main pillar of food security. Between 52% and 92% of the workforce is employed in agriculture, meaning that roughly two out of three people depend on farming and livestock for their livelihoods. Agriculture contributes about 50% to the combined GDP of countries such as Burkina Faso, Mali, and Niger, while livestock accounts for up to 25% (Hafiz, 2023). The sector is highly dependent on the quantity and seasonality of rainfall, making any variation in rainfall patterns potentially catastrophic. (Mezari, 2022, p. 10)

The Sahel countries are characterized by large geographic areas but limited arable land, particularly irrigated land and land allocated for strategic crops such as grains. This scarcity affects agricultural productivity, exacerbated by recurrent droughts and crop diseases, including pest infestations and invasive weeds…Etc (Mezari, 2022, p. 09). The United Nations estimates that nearly 80% of farmland is degraded, while around 50 million people compete for land across the Sahel, many of whom depend on animal husbandry (Pongo, 2019). Mismanagement and inequitable resource distribution exacerbate these pressures, as a small elite controls most resources, leaving the majority marginalized, which has led to internal conflicts, such as the ongoing rebellions among the Tuareg and other minority groups in Mali and Niger. (Boumediene, 2016)

Rain-fed agriculture dominates in the Sahel, with limited irrigated farming, making the relationship more closely linked between climate/climate change and agricultural production, as well as livestock, which depends on natural pastures. This means that climatic variability and extreme weather events will contribute to crop failures and livestock mortality, leading to economic losses and undermining food security. (Laderach, 2021, p. 999)

Crop growth in the Sahel is closely linked to rainfall, the primary source of freshwater for plants. Variability in rainfall amounts, shifts in seasonal timing, and fluctuations in the length and onset of the growing season all induce changes in agricultural systems, which in turn affect local food systems. (Al-Tantawi, 2014, p. 424)

In these climatically stressed areas, The West African monsoon winds bring seasonal rainfall to the region, starting approximately in May and ending in September or October, while the rest of the year remains extremely dry. Heat stress affects both people and livestock during the dry months, particularly from April to May, when temperatures exceed 40°C in approximately 35 days. Crops are typically planted in late May with the onset of rains, allowing farmers to work the land. However, dry spells at the start of the rainy season can lead to crop failures, with only a fraction of farmers able to replant. During the growing season (June–September), seasonal drought affects grain filling, and heat stress can occasionally disrupt harvesting activities due to the extreme temperatures. (Laderach, 2021, p. 1002)

High temperatures increase soil evaporation rates, leading to greater soil dryness and a higher likelihood of plant stress. In addition, climate change often disrupts the timing of plant flowering, causing crops to bloom either too early or too late, which in turn reduces productivity. For example, rice; the world's second most important cereal after maize; may see yields decline by up to 40% by the end of this century due to elevated temperatures, according to a 2018 study. Heat stress also triggers a series of physiological changes in wheat plants that can result in sterility. (Hafiz, 2023)

Climate change also has negative repercussions for livestock as one of the key components of food security in the African Sahel. This occurs through its direct impact on animal health and physiology, the spread of animal diseases, and the emergence of new pests that threaten livestock, as well as through its indirect impact on the suitability of climatic conditions for animal feed production, the quality and availability of rangelands, the availability of water resources, and its effects on livestock products such as meat, milk, and dairy products. Water scarcity and droughts, especially during the rainy season, during the rainy season, further reduce fish availability, thereby weakening the potential contribution of fisheries to improving food security in the African Sahel. (Al-Tantawi, 2014, p. 426)

In this context, the Lake Chad basin represents one of the most important and vulnerable areas in the Sahel. Climate change has increasingly threatened livelihoods and food security for the countries surrounding the lake. Lake Chad supports the lives of over 47 million people across Chad, Niger, Nigeria, and Cameroon, serving as a critical economic resource. It has contributed to agricultural production, livestock rearing, fisheries, and crop cultivation, as well as providing water for drinking and various economic activities. However, over the past six decades, climate change has drastically affected the lake's size and resources. In the 1960s, Lake Chad covered more than 26,000 km², shrinking to less than 1,500 km² by 1997, and further to approximately 1,350 km² today. If water levels continue to decline, the lake could disappear entirely within the next twenty years, according to the Food and Agriculture Organization, particularly given population growth and excessive water exploitation. The shrinking lake has led to declines in fish stocks and agricultural output, as well as deterioration of pastoral activities, due to advancing desertification and severe degradation of farmland along the lake's shores, reducing overall productivity. (Kamal, 2023)

All of these factors have left a large proportion of the population in the African Sahel undernourished and unable to meet their basic food needs, exacerbating poverty, misery, and food insecurity. The suffering is particularly concentrated in the central Sahel, which includes Mali, Burkina Faso, and Niger. Although this region accounts for only 0.9% of the global population, it represents 5% of global humanitarian needs, according to the International Rescue Committee. The harsh conditions have forced residents of the region to abandon their homes and lands, as they can no longer sustain the pastoral and agricultural activities they have relied on for generations, leaving them as hungry, vulnerable populations dependent on aid for survival. (Baba'a, 2023)

Consequently, climate change in the region threatens to intensify existing food security and livelihood risks, by reducing agricultural productivity, increasing sanitation hazards, and worsening water scarcity. This, in turn, is likely to escalate resource-based conflicts and trigger humanitarian crises. Natural population growth in the Sahel consistently outpaces the potential increase in food production: under favorable rainfall, agricultural output rises by approximately 1.5% annually, while population density increases by 2.7% per year. (Lamhrehr, 2017)

As of late 2018, an estimated 33 million people in the African Sahel were classified as food insecure. Poor local communities struggle to access safe healthcare, secure schooling for their children, or reliable income, often facing difficult choices to sustain their families, including migrating along dangerous routes or joining armed groups. (Pongo, 2019)

A significant portion of the Sahelian population lives below the poverty line. According to 2019 statistics, poverty rates reached 94.41% in Niger, 92.90% in

Burkina Faso, 90.37% in Mali, and 88.05% in Chad, with Mauritania recording the lowest rate at 63.64%. These figures underscore the extent of disparities in per capita income and reflect the overall condition of food security in the region. (Mezari, 2022, p. 16)

The reduction of arable land and the diminishing of water resources due to drought and desertification have forced millions of people in the African Sahel to migrate internally and across borders in search of areas that offer viable living conditions. In many cases, these forced population movements have triggered disputes and tensions over access to grazing land and green spaces. (Threef, 2016, p. 17)

Conclusion:

Based on the insights and analyses presented, it can be concluded that climate change in the African Sahel has serious and multidimensional impacts on food security and represents a real threat. It directly reduces food availability through the negative effects of drought and rising temperatures on both crop and livestock productivity. This has led to shortages of basic food products, higher prices, and reduced access to food for large segments of the population. In addition, food quality has deteriorated, with higher levels of contamination and weaker compliance with health standards. Climate change is also expected to further disrupt the stability of food supplies in the future, as climate shocks and natural disasters become more frequent and more intense. Climate change has therefore deepened the food crisis in the African Sahel, particularly in the context of the failure and fragility of state regimes and their limited adaptive capacity. The region is characterized by a generally warmer climate and geographical conditions that make it exposed to climate risks, placing large population groups under serious threat that they did not cause, which has contributed to rising levels of malnutrition and disease, an increase in irregular migration, the spread of various social problems, and growing political instability. This situation is further compounded by persistent political crises and low levels of economic development, on the one hand, and by rapid demographic growth that exceeds both the development level and the actual capacities of the Sahelian states, on the other.

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